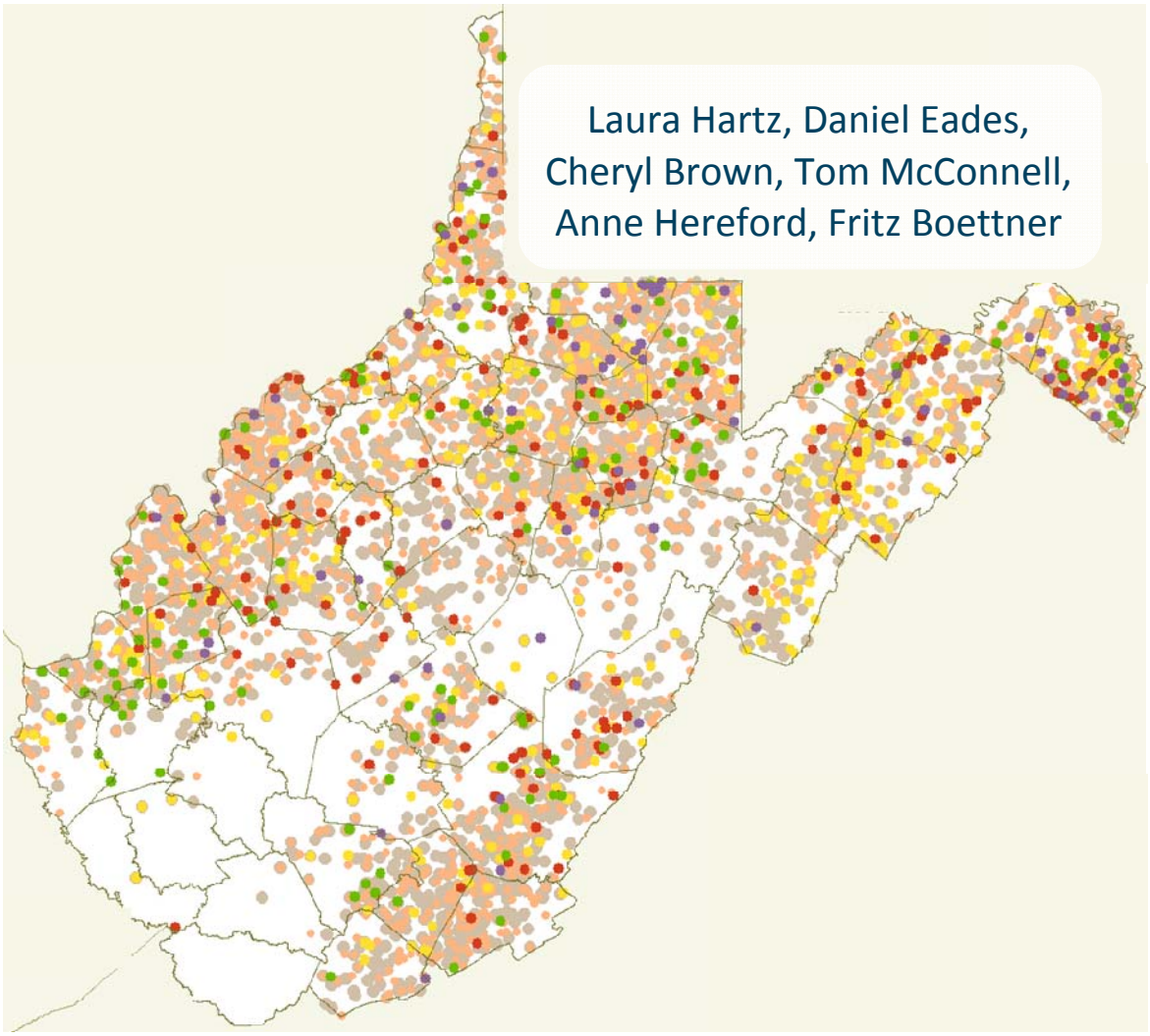
West Virginia Food System

Seasonal production expansion and its impacts



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West Virginia Food System: Seasonal production expansion and its impacts

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ABBREVIATIONS

CEO	Center for Economic Options
CSA	community supported agriculture
ES	executive summary
GDP	gross domestic product
GIS	geographic information system
IMPLAN	Impact Analysis for Planning
NASS	National Agricultural Statistics Service
NRCS	Natural Resource Conservation Service
SNAP	Supplementary Nutrition Assistance Program
US	United States
USDA	United States Department of Agriculture
WIC	Women, Infants, and Children
WVFFC	West Virginia Food and Farm Coalition
WVFMA	West Virginia Farmers Market Association
WVU	West Virginia University

FORWARD

A strong, regionally-based food system can become a substantial source of economic growth for rural communities and cities. As support for local food continues to grow, citizens, business people, farmers, extension agents, agencies, and nonprofits have begun to strategize about how West Virginia could better meet its own consumer demand for food. One part of this strategic process is the development of the West Virginia Food Charter, a roadmap for action that will help us all focus, measure, and celebrate our collective progress towards a stronger local food system. Developed through a series of public meetings and collaborations, the Charter will offer a vision for building West Virginia's local food economy and will measure the contributions of statewide and local policies, programs, and community efforts intended to strengthen the food economy.

As we set goals for the re-growth of the West Virginia food economy, there are often questions about what scale of growth is reasonable to expect. To help inform the Charter and related planning efforts, this study poses the questions: What if West Virginia farmers grew enough vegetables and fruits to meet the fresh seasonal needs of all West Virginians? How much land would be required? What would be the economic effects of making these changes? The study describes current agricultural production and explores the land resource and economic impacts of expanded vegetable and fruit production using geospatial and economic modeling software. By helping us to understand our current realities and to envision short-term agricultural growth, this information will stimulate further conversation about how best to support West Virginia agriculture.

Because this study is the first in a series, it does not answer every question. For example, readers will notice that this document focuses specifically on the vegetable and fruit sector, whose growth could have especially positive effects in terms of increasing West Virginians' access to nutritious foods. While we believe that meat and animal products will be a critical part of the growth of West Virginia's food economy, predicting growth in animal farming requires a separate study. Additionally, this study does not address the revitalization of our processing and distribution infrastructure that is required to get more local food from producer to consumer; this is another a topic we expect to tackle in the future.

We look forward to enabling this collaborative process of enhancing the West Virginia food system for West Virginians.

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EXECUTIVE SUMMARY

This project is the first in a three-part series that explores the West Virginia food system. This study uses publicly available data, geospatial analysis, and economic analysis to evaluate the current state of West Virginia's food system and future impacts if seasonal vegetable and fruit production were increased.

Despite West Virginia's mountainous terrain, many farms and much agricultural land exist in the state. Currently, most farms have cattle or calf inventory, and there is significant room for vegetable and fruit production to expand to fill the local shortage, or the difference between consumption and production. Expanding vegetable and fruit production has the following land requirements and economic impacts:

SCENARIO 1: 100% OF THE LOCAL SHORTAGE

Question: What if West Virginia farmers grew enough vegetables and fruits to meet the fresh seasonal produce needs of all West Virginians?

Percent increase by acreage: 283% increase in vegetables; 15% increase in fruits

Acres required: 7,109 additional acres of vegetables and fruits with most (6,264 acres) in vegetables

New jobs: 1,723 with 690 in farming and 510 in food and beverage retail

Additional sales: $120.8 million

SCENARIO 2: 75% OF THE LOCAL SHORTAGE

Question: What if West Virginia farmers grew enough vegetables and fruits to meet 75% of the fresh seasonal produce needs of all West Virginians?

Percent increase by acreage: 212% increase in vegetables; 11% increase in fruits

Acres required: 5,332 additional acres of vegetables and fruits with most (4,698 acres) in vegetables

New jobs: 1,330 with 519 in farming and 398 in food and beverage retail

Additional sales: $93.9 million

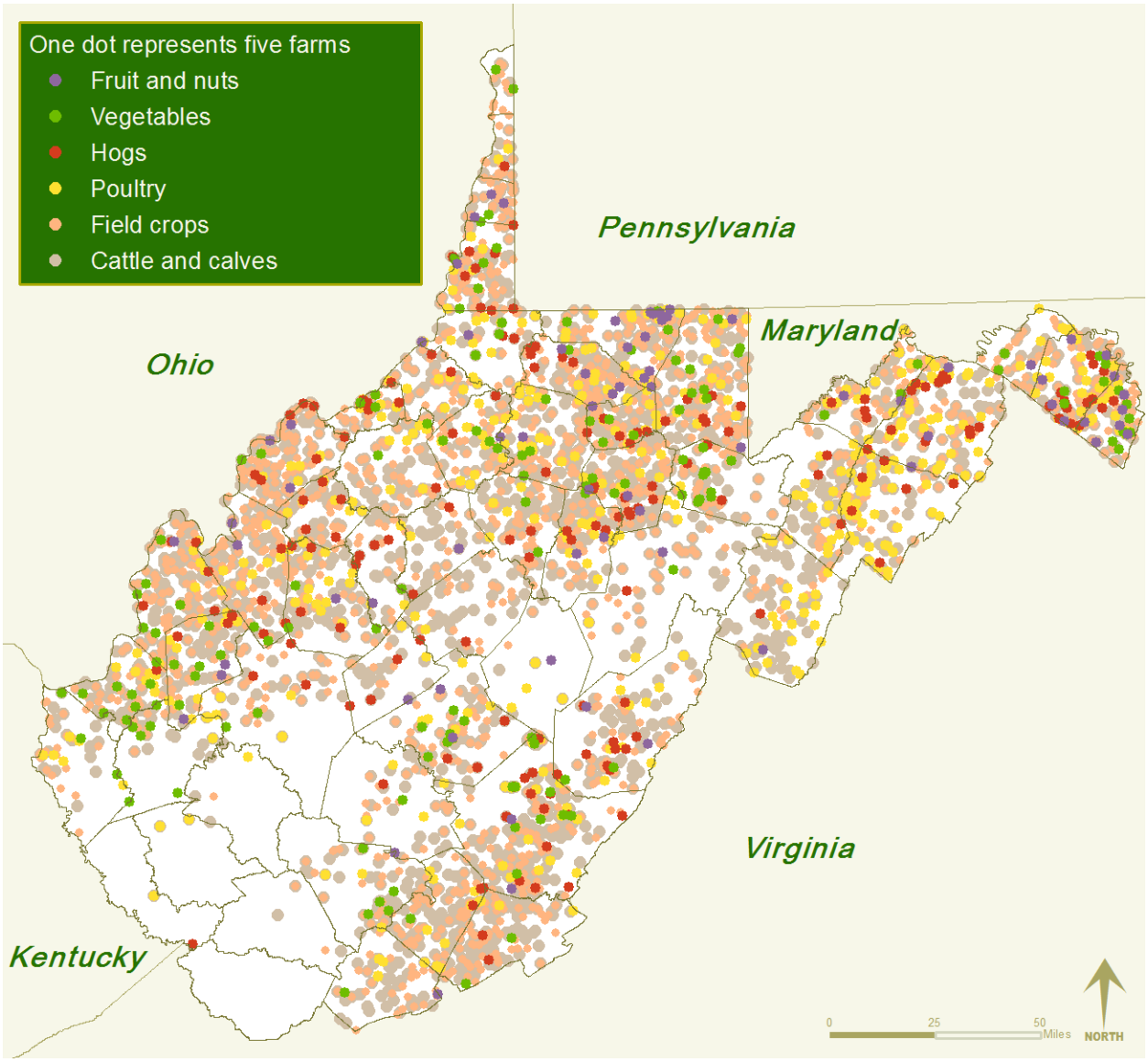
KEY FINDINGS

Farms—especially those with cattle or calves—are abundant in West Virginia.

In West Virginia, there are currently 23,618 farms on 3.7 million acres, covering more than 24% of the state's land area. This total farmland area is forested (40%), in permanent pasture (30%), and in cropland (25%). Cattle and calf farming is popular across the state. More than 12,000 farms—more than half of all farms—in all 55 of West Virginia's counties reported some cattle or calf inventory.

Figure ES-1 depicts farms in West Virginia that reported sales in fruit and nuts, vegetables, hogs, poultry, field crops, or cattle and calves. One dot represents five farms in a particular zip code.

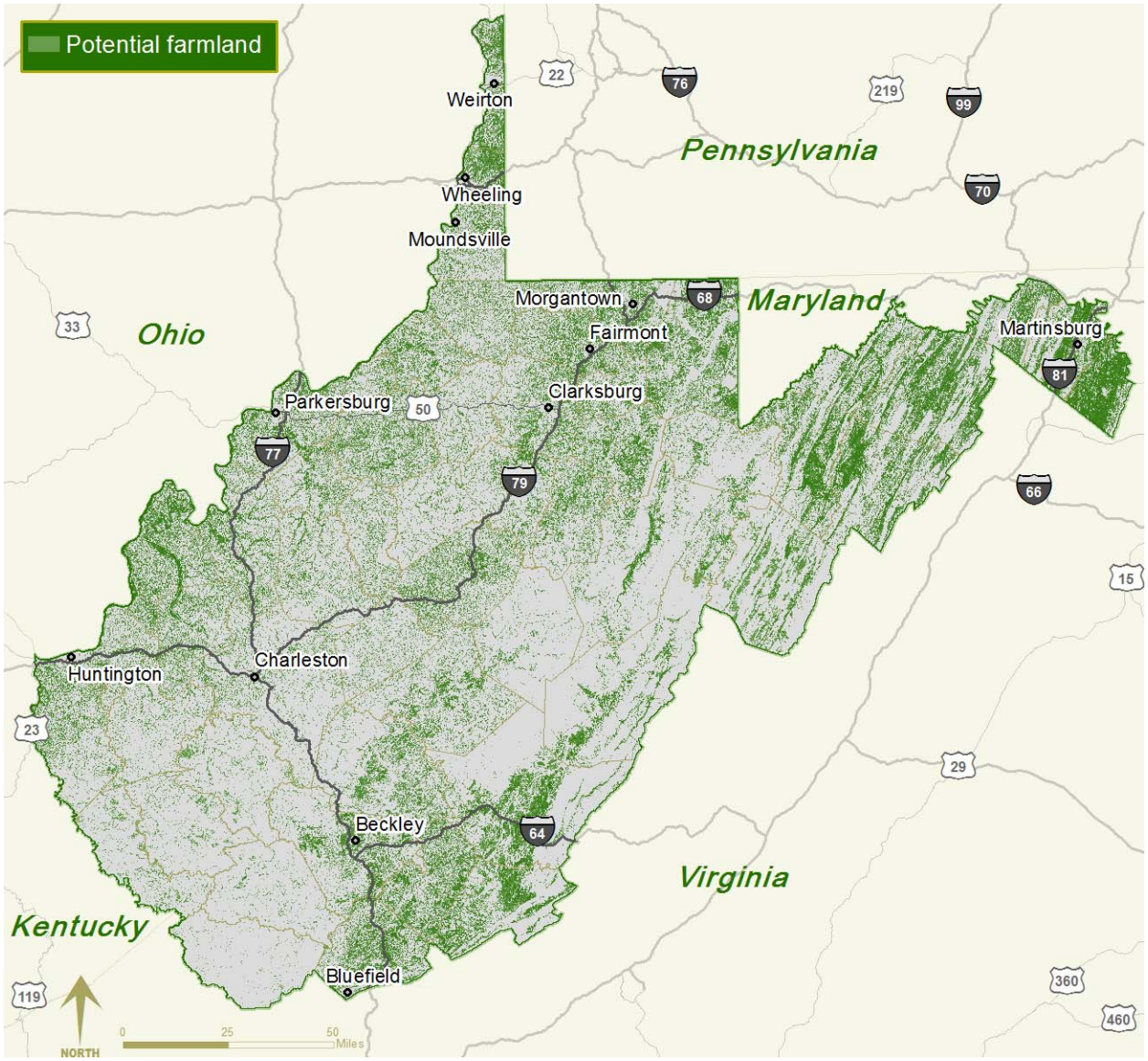
Figure ES-1: Distribution of farms in West Virginia, 2007



Despite the mountainous terrain, significant potential farmland exists.

Known as the Mountain State, West Virginia's topography is mountainous and widely covered with forest; yet, more than 4.2 million acres of potential unforested farmland exist in the state. This is 500,000 acres more than are currently reported as "farms" in the United States Department of Agriculture Census. Figure ES-2 depicts the total potential farmland in the state, as indicated by satellite imagery and Natural Resources Conservation Service land classification.

Figure ES-2: Total potential farmland, 2011



A significant market exists for vegetables and fruits.

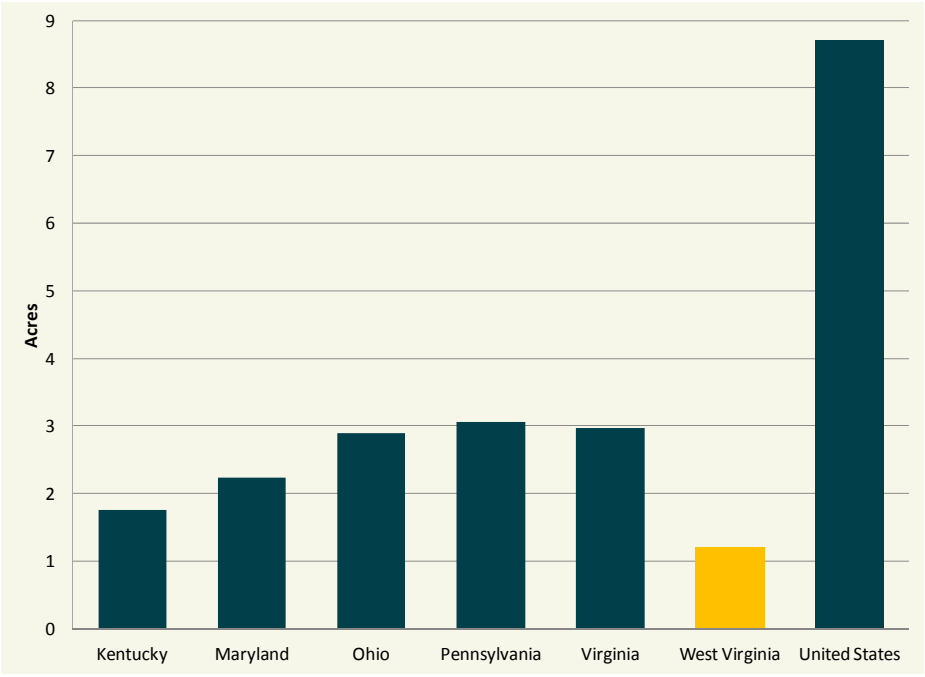
Demand for fresh vegetables is higher than demand for fresh fruits. This fact, combined with the trend of low current vegetable production, highlights a market opportunity for increased vegetable production, which could benefit the state in terms of food security, local economies, and increased revenue for farmers.

The top five most-consumed fresh vegetables, by weight, are potatoes, lettuce, tomatoes, onions, and carrots. The top five most-consumed fresh fruits, by weight, are apples, watermelon, cantaloupe, grapes, and strawberries. In West Virginia, the top five most-produced fresh vegetables, by weight, are sweet corn, potatoes, tomatoes, pumpkin, and cucumbers. West Virginia's top five most-produced fruits by weight are apples, peaches, pears, grapes, and strawberries.

Currently, West Virginia farms only produce enough sweet corn, pumpkin, apples, and peaches to meet the fresh seasonal needs of all West Virginians. For all other vegetables and fruits, West Virginia farms do not produce enough to meet the fresh seasonal needs of all West Virginians. When consumption exceeds production, a theoretical local shortage exists, as is the case for most vegetables and fruits that West Virginians consume.

West Virginia's 1,822,198 people spend $2.5 billion on food for at-home consumption. Almost 18%—or $421 million—of this amount is spent on vegetables and fruits. Yet, total vegetable production in the state is low. Farms in West Virginia grow 1.2 acres of vegetables per thousand people, which is low compared to neighboring states and the nation as a whole (Figure ES-3).

Figure ES-3: Fresh vegetables grown per 1,000 people, 2007



Vegetable production has more room to grow than fruit production.

Current vegetable production takes place on about 2,000 acres, which is less than 0.05% of all potential farmland in the state.

Currently, West Virginia farms produce $5.6 million of vegetables. In order to meet 75% of the West Virginia demand for fresh, in-season vegetables, an additional 4,698 acres are required to come into production. Producing these crops would result in $24.6 million of additional revenue and $30.2 million in total revenue (Figure ES-4).

In order to meet 100% of the West Virginia demand for fresh in-season vegetables, 1,566 acres are required in addition to the 4,698 acres required for 75% fulfillment. Producing these crops would result in $32.8 million of additional revenue and $38.4 million in total revenue (Figure ES-4).

Figure ES-4: Vegetable revenue, current and potential

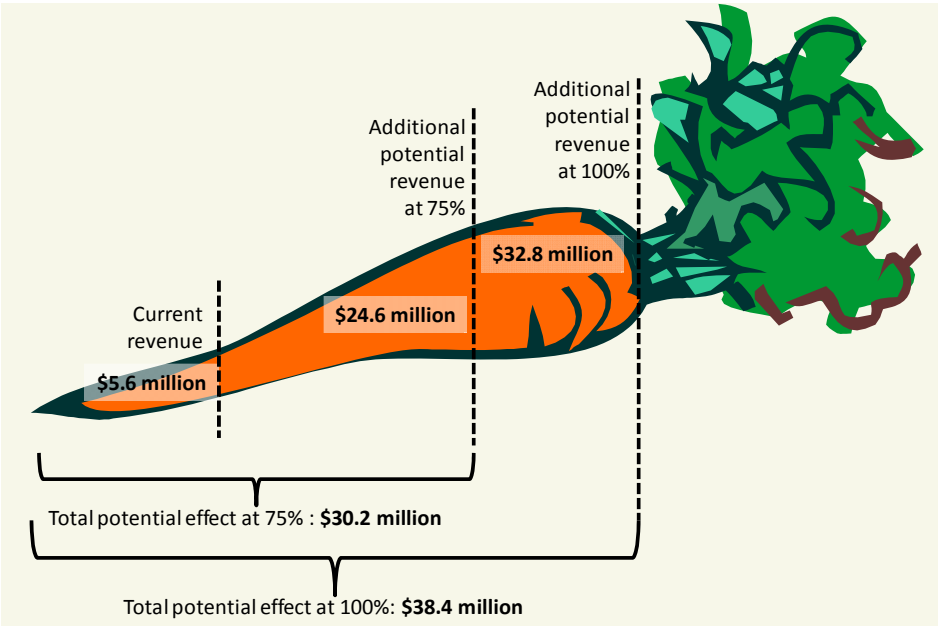
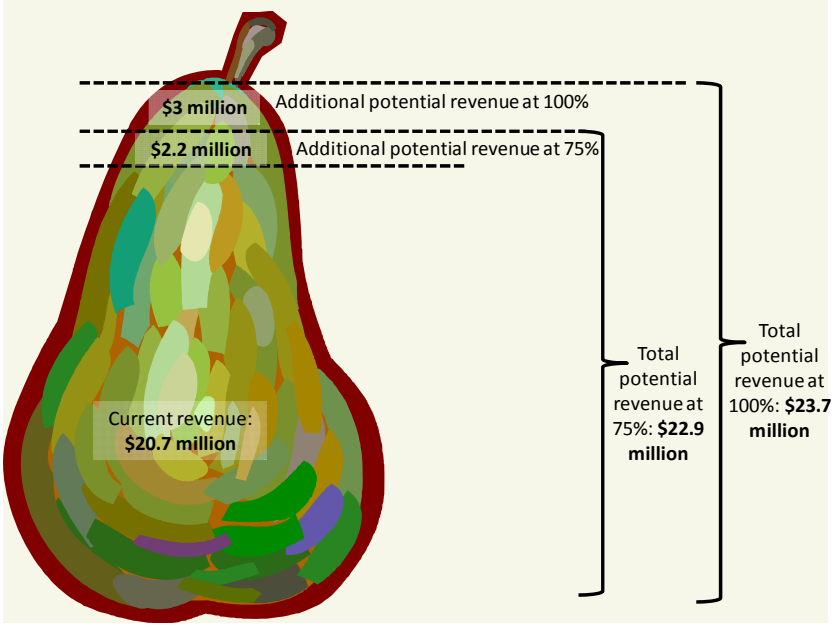


Figure ES-5: Fruit revenue, current and potential



Currently, West Virginia farms produce $20.7 million of fruits. In order to meet 75% of the West Virginia demand for fresh, in-season fruits, an additional 634 productive acres are required to come into production. Producing these crops would result in $2.2 million of additional revenue and $22.9 million in total revenue (Figure ES-5).

In order to meet 100% of the West Virginia demand for fresh in-season fruits, 211 acres are required, in addition to the 634 acres required for 75% fulfillment. Producing these crops would result in $3 million in additional revenue and $23.7 million in total revenue (Figure ES-5).

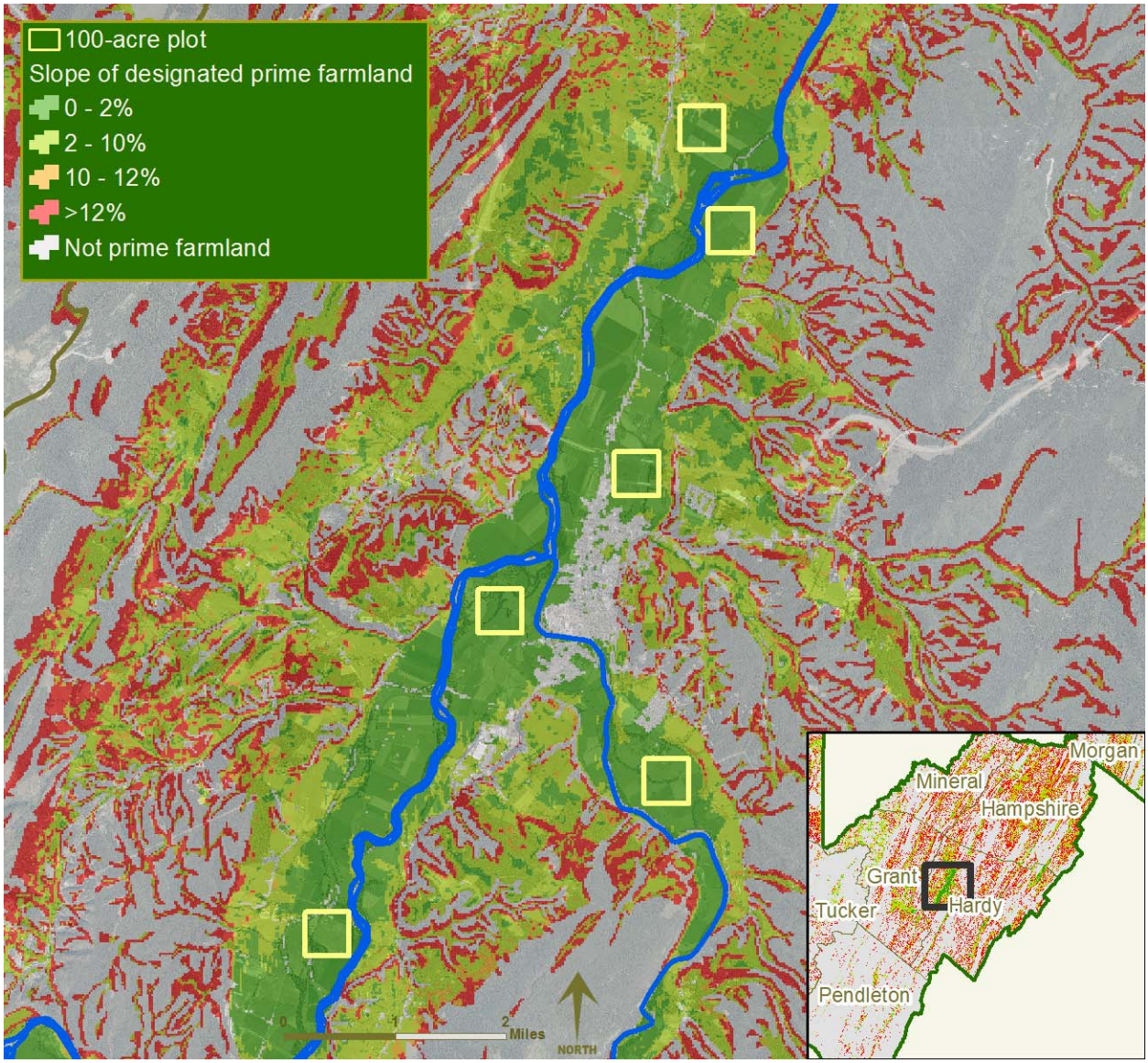
Filling 100% of the local shortage—or all of the population's needs—for fresh seasonal vegetables and fruits would require an additional 7,109 acres coming into to production, in addition to the current 7,979 acres. This would add 1,723 new jobs to the state.

The acreage devoted to fruit of bearing age is 5,769 acres, more than twice that devoted to vegetables. Similarly, current revenue from fruit production in the state far exceeds that of revenue from vegetable production. The apple and peach industries are the largest contributors to the fruit sector's prominence. Yet, based on our economic analysis, the total possible revenue from vegetable production (to meet demand for seasonal local vegetables) exceeds that of the total possible revenue from fruit production (to meet demand for seasonal local fruits), meaning that the vegetable sector has more room to grow.

Despite having abundant steep terrain, West Virginia could produce a significant amount of vegetables and fruits.

The steep slope of some of West Virginia's terrain can be prohibitive to growing vegetables and fruits, although there are 166,500 acres with slopes less than 2%. This is over ten times more land area than is required to grow sufficient fresh seasonal vegetables and fruits to meet West Virginians' demand. Small amounts of farmland have the capacity to provide a significant amount of vegetables and fruits. As shown in Figure ES-6, the five yellow boxes in Hardy County alone provide enough land area to provide 10% of the additional fresh seasonal vegetables that West Virginians require.

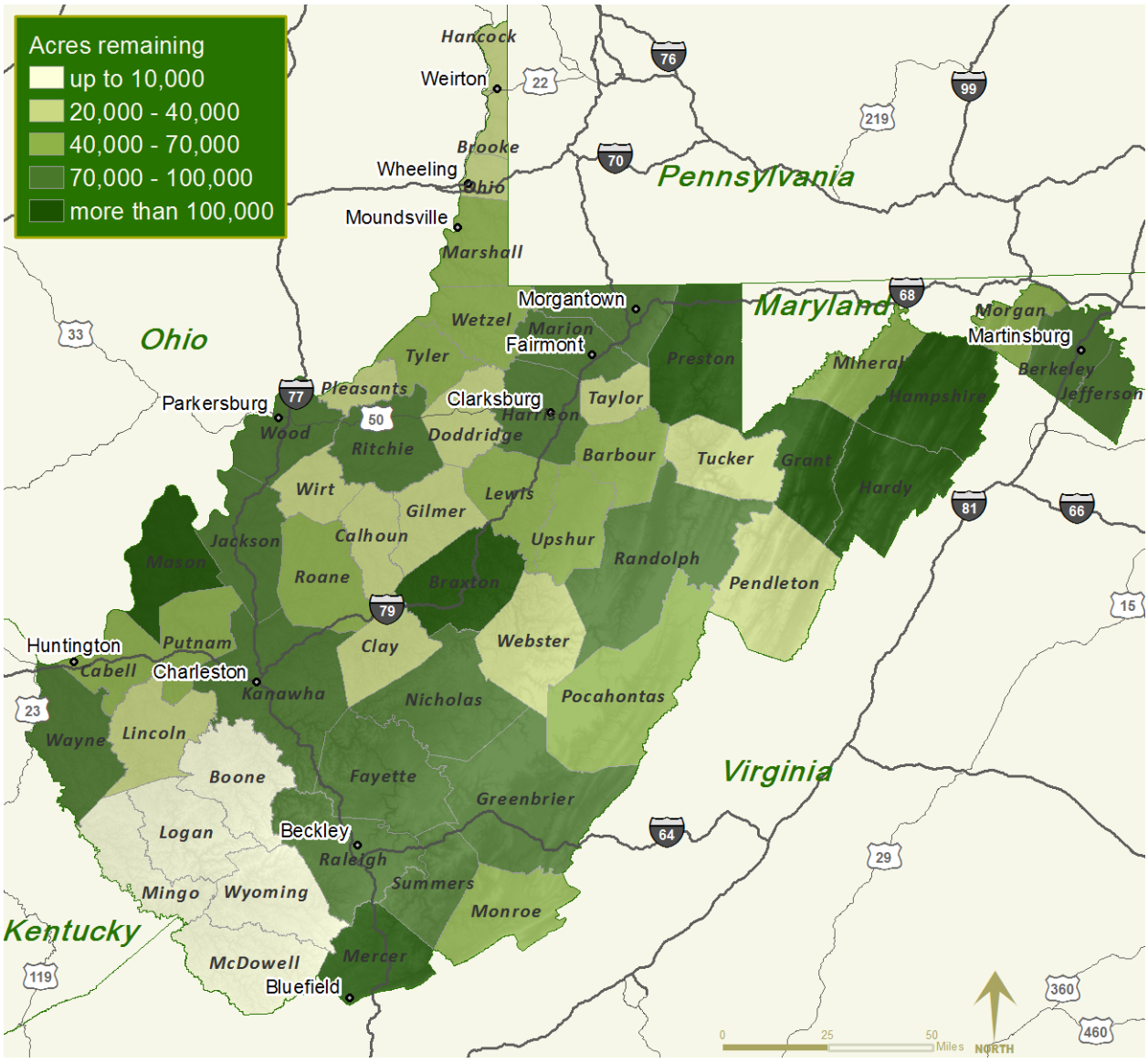
Figure ES-6: Slope of prime farmland in Hardy County, West Virginia



There is enough room for both increased vegetable and fruit production and current agricultural activities to thrive.

Increases in vegetable and fruit production need not be at the expense of the current cattle and calf inventory in the state. Figure ES-7 shows the remaining prime farmland if existing cattle were distributed on pasture according to management-intensive grazing principles. Prime farmland is a land designation based on the physical and chemical properties of soil, and generally indicates the best agricultural land.

Figure ES-7: Prime farmland remaining, if cattle were managed intensively

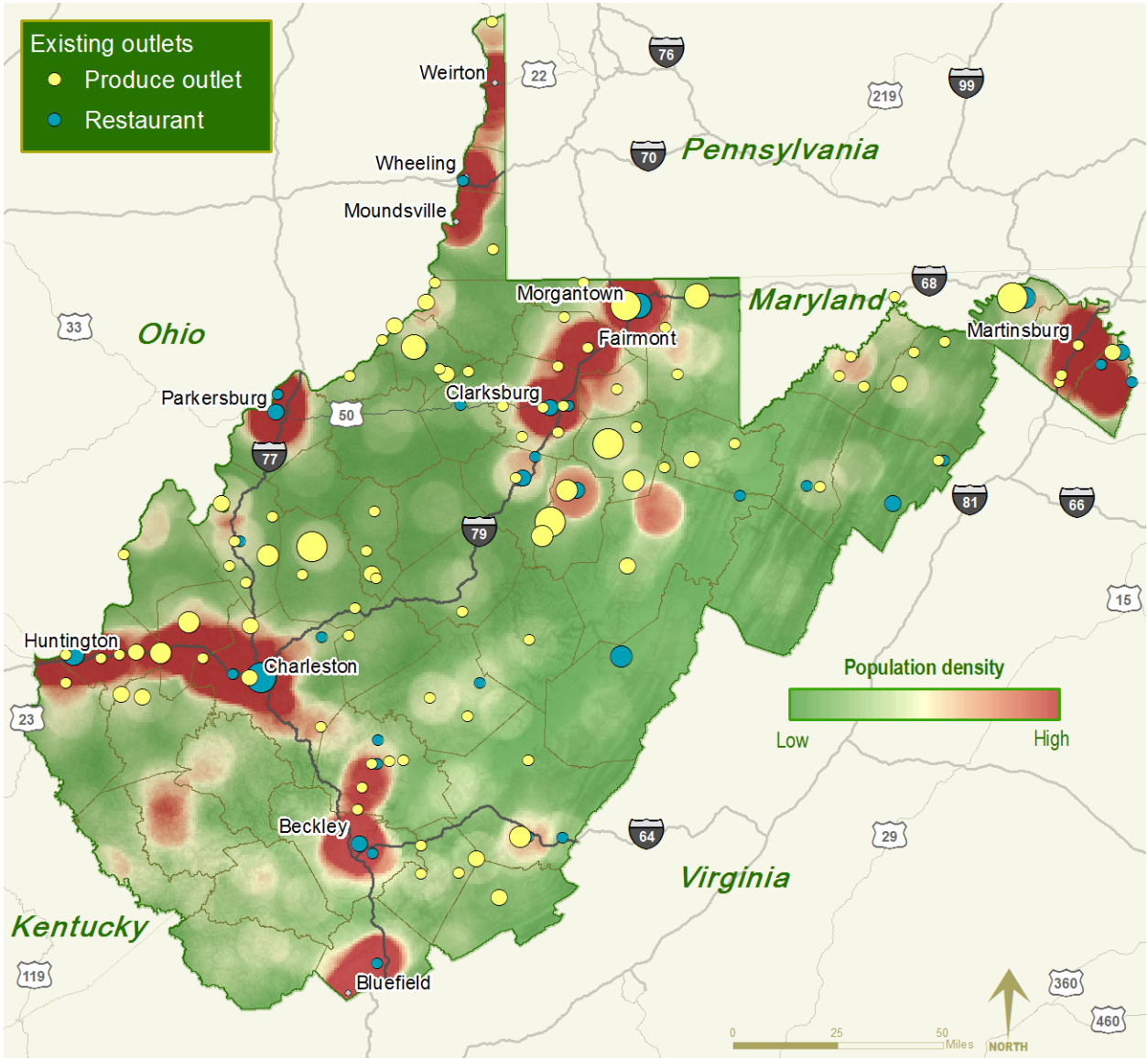


The future of local food in West Virginia looks bright.

West Virginia's potential remains largely underutilized. National trends of increased public interest in food and farming have found a foothold in West Virginia, where the number of farmers markets has doubled in the past decade and where over 80% of farms are small operations grossing less than $10,000 per year.

There is growing interest in local food. Already, local food can be purchased at numerous locations. These patterns are indicative of existing progress in the state related to a local food economy. Local food outlets, including places to buy and eat fresh local produce, correlate with population (Figure ES-8). The presence of more local food marketing opportunities in urban areas may be a benefit to nearby producers, but as population grows, urbanization is likely to directly compete with local agriculture for land use in these areas.

Figure ES-8: Local food outlets and population



1. INTRODUCTION

A strong, regionally-based food system can provide a wellspring of economic growth for rural communities and cities. While other areas in the United States (US) have realized some gain from developing agricultural and food-based resources, West Virginia's potential remains largely underutilized. Communities across West Virginia are now working together with the West Virginia Food and Farm Coalition, West Virginia University Extension, state agencies, and local actors to develop a West Virginia Food Charter, a roadmap for action that will help measure and celebrate the collective progress towards a stronger local food system. This research project, the first in a series, is intended to serve as part of the research base for the Charter, as well as other efforts in agricultural expansion.

West Virginia has a population of 1.8 million people (US Census Bureau, 2007) that spend $4.4 billion on food, including $2.5 billion on food purchased for at-home consumption (Meter, 2010). Almost 18%—or $421 million—of this amount is spent on vegetables and fruits. Yet, farms in West Virginia produce few vegetables and fruits, with the exception of apples and peaches. This project looks at the land base available for increasing vegetable and fruit production as well as the economic benefits of growing West Virginia vegetables and fruits for West Virginians.

1.1 Local food

Local food provides a variety of positive impacts to the well-being of the residents and environment of the region (Dillon, 2007; Martinez et al., 2010). Other benefits include enhanced food safety (Peters et al., 2008) and overall community building. The most immediate benefits relate to the economy, residents' health and food security, and environment.

The positive economic impacts of a local food system are many. Primarily, economic benefits take the form of income and employment by two main mechanisms: substitution (buying local food instead of food from far away) and localization (bringing processing activities into the region instead of processing food far away) (Martinez et al., 2010). Both of these methods result in more jobs and more re-circulated dollars, as an enhanced local food system can even stimulate neighboring businesses and increase the sharing of local skill sets (Martinez et al., 2010). "If consumers purchase food produced within a local area instead of imports from outside the area, sales are more likely to accrue to people and businesses in the area" (Martinez et al., 2010). In fact, "money spent on local produce at farmers' markets, at locally owned shops, or on locally produced foods stays in the community longer, creating jobs, raising incomes, and supporting farmers" (Halweil, 2002, p. 7). In an evaluation of the impact of farmers markets in West Virginia, Hughes et al. (2008) found that farmers markets generated $2.4 million in industry output and 69 full time equivalent jobs in the state.[1]

Local food systems improve the health of residents, in addition to helping the economy. Local food is usually fresher and less processed, and may have more nutrients than its counterparts produced far away (Martinez et al., 2010). Aside from the nutrients contained in the food itself, readily accessible local food may lead to healthier diet choices, like eating more vegetables and fruits. The availability of healthy food options is associated with better health outcomes (Morland, et al., 2002). People who have a community supported agriculture (CSA)[2] membership may eat more vegetables and fruits (Perez et al., 2003 and Olberholtzer, 2004; as cited in Martinez et al., 2010). Additionally, local food may also improve school children's diets (Martinez et al., 2010). School-based healthy food programming increases fruit intake, and may positively increase vegetable intake (French and Stables, 2003). In sum, "local food systems are an invaluable resource for

[1] When Hughes et al. assumed that the expenditures at farmers markets would displace some food spending at grocery stores, the net effect of farmers markets was positive at $1 million output and 43 full time equivalent jobs (Hughes et al., 2008).

[2] A CSA share is a portion of a farm's produce that is purchased prior to the season. CSAs enhance farm viability by providing guaranteed, predictable demand throughout the growing season, and pre-season capital to help with upfront expenses.

creating healthy communities because their actors have the ability to increase the amount of affordable fresh food available in community stores, farmers markets, low income food basket programs, road side stands, and restaurants" (Dillon, 2007, p. 4).

A necessary component of health, "food security" is a federal term that refers to the accessibility of an adequate amount of food to lead a healthy life; low-income people often face low food security. Local food may increase food security for certain populations, especially via federal and state programming that enables farmers markets to accept—and in some cases double—Supplementary Nutrition Assistance Program (SNAP) benefits.[3]

An improved local food system can improve both the local and global environment. Shorter distances between consumers and producers can lessen the amount of energy spent in transporting food, and therefore lessen its greenhouse gas emissions (Peters et al., 2008; Ikerd, 2005). If not grown locally, vegetables and fruits travel on average 1,494 miles before reaching the consumer (Pirog, 2003). Supporting local foods may help to preserve farmland (Dillon, 2007; Ikerd, 2005). Local food systems build relationships between producers and consumers, which may improve producers' commitments to environmental stewardship (Peters et al., 2008).

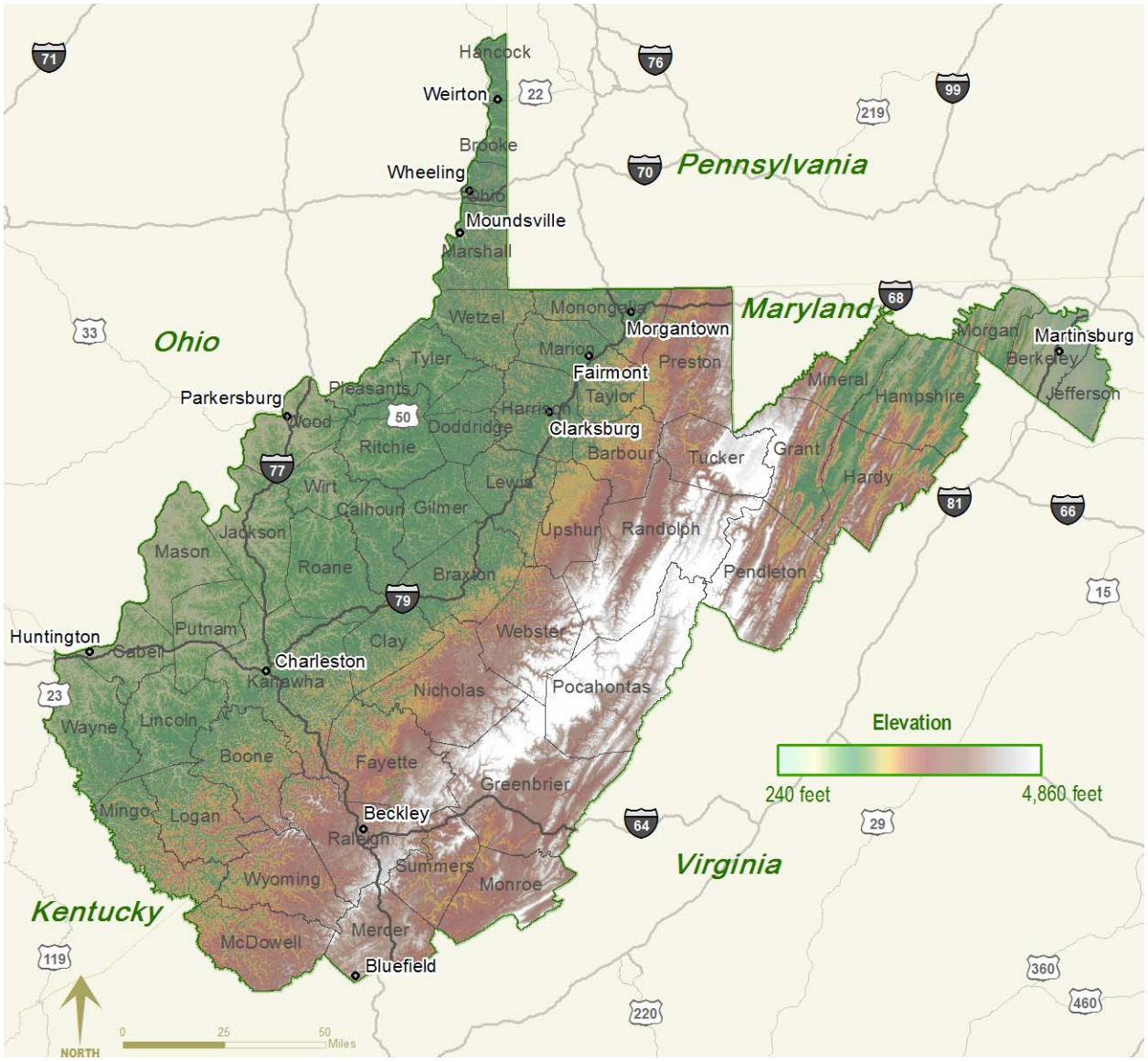
Many definitions of local food exist. Our project defines local food as that which is grown within the state of West Virginia, like Kane et al. (2010), who defined local as "grown in Georgia" (p. 3). We realize that this boundary is somewhat arbitrary, but it is required in order to calculate economic impacts via IMPLAN (Impact analysis for PLANning). Our selected definition matches that of Walmart and the US Department of Agriculture (USDA), even though USDA does not regulate the term.

[3] SNAP benefits were formerly known as food stamps.

2. BACKGROUND

West Virginia is a state of rolling hills, mountains, and scenic rivers (Figure 1). The state reaches from the Ohio River through the heart of the Appalachian mountain chain nearly to the eastern coast; its elevation ranges from 240 feet above sea level at Harpers Ferry to over 4,800 feet at Spruce Knob. Seventy-seven percent of the land area is covered with forests (US Forest Service, 2010). Most of the state is in USDA hardiness zones five and six (National Gardening Association, 2011). West Virginia is currently home to 1.8 million people (US Census Bureau, 2007); the state has experienced only minor population fluctuation in the last few decades. The current population is 100,000 less than the state's 1980 population (USDA, 2011).

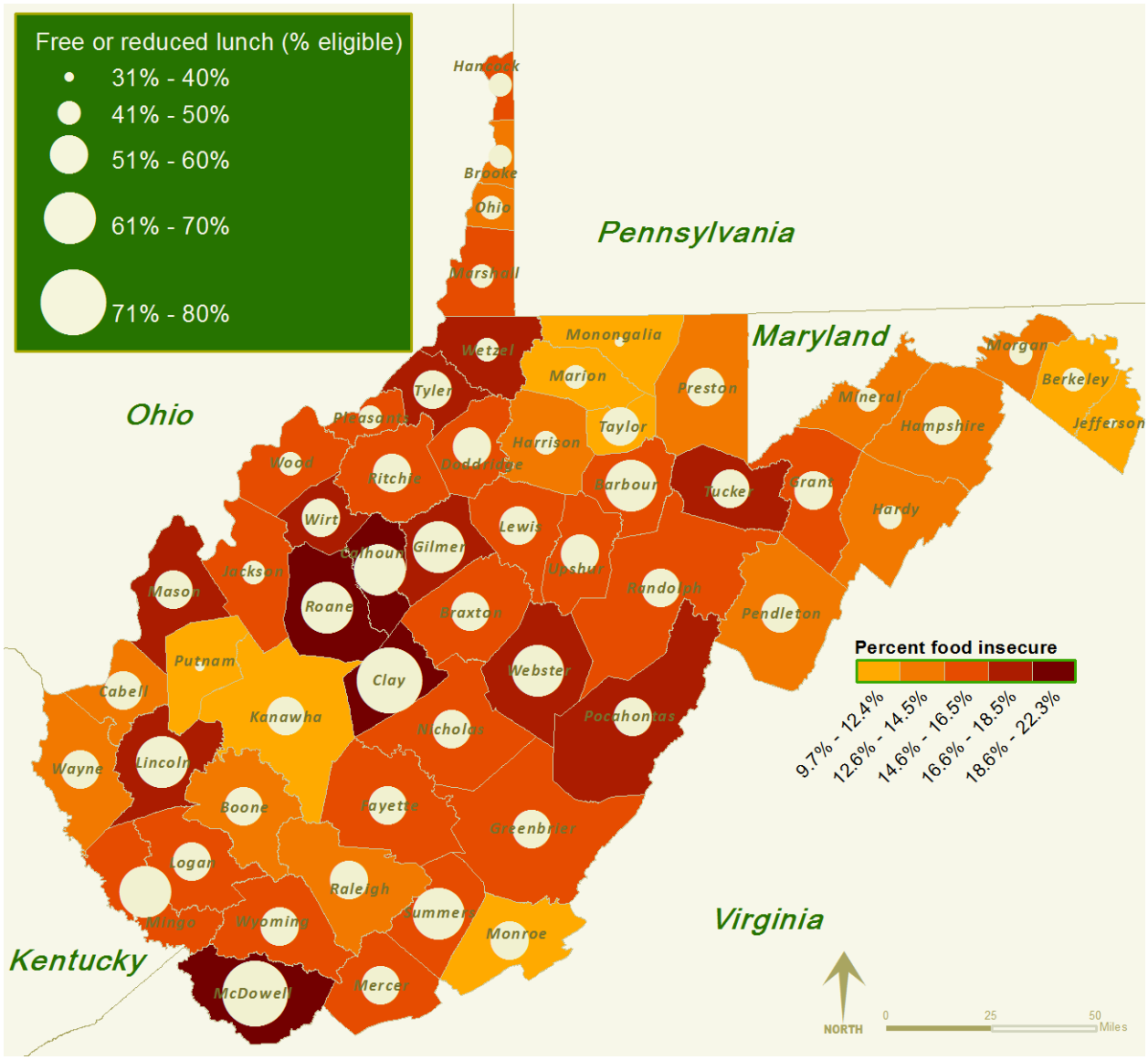
Figure 1: West Virginia, study area



Source: Elevation from statewide elevation grid, 30 meter from US Geological Survey (2011). Base Map from ESRI mapping data (2010).

Poverty is a significant factor in the food system for obvious reasons, but most especially because of the amount of federal purchasing assistance flowing to residents of the state in the form of SNAP benefits and Women, Infant, and Children (WIC) coupons. These benefits totaled $314 million in 2008 (Meter, 2011). From 1979 to 2009, the average poverty rate in the state increased from 15% to 17.8% (USDA, 2011). Poverty rates vary regionally in West Virginia, with the highest rates occurring in the southern coalfields and center of the state, and the lowest rates occurring in the eastern panhandle. Despite these poverty levels, rates of food insecurity in West Virginia are the same as the national average, because of the relatively high participation rates in SNAP and WIC. In 2007, 85% of those eligible participated in SNAP (US Food and Nutrition Service, 2007). Figure 2 depicts county-level rates of food insecurity and eligibility for free or reduced lunch among school-aged children.

Figure 2: Food insecurity and free or reduced lunch eligibility in West Virginia, 2008-2009

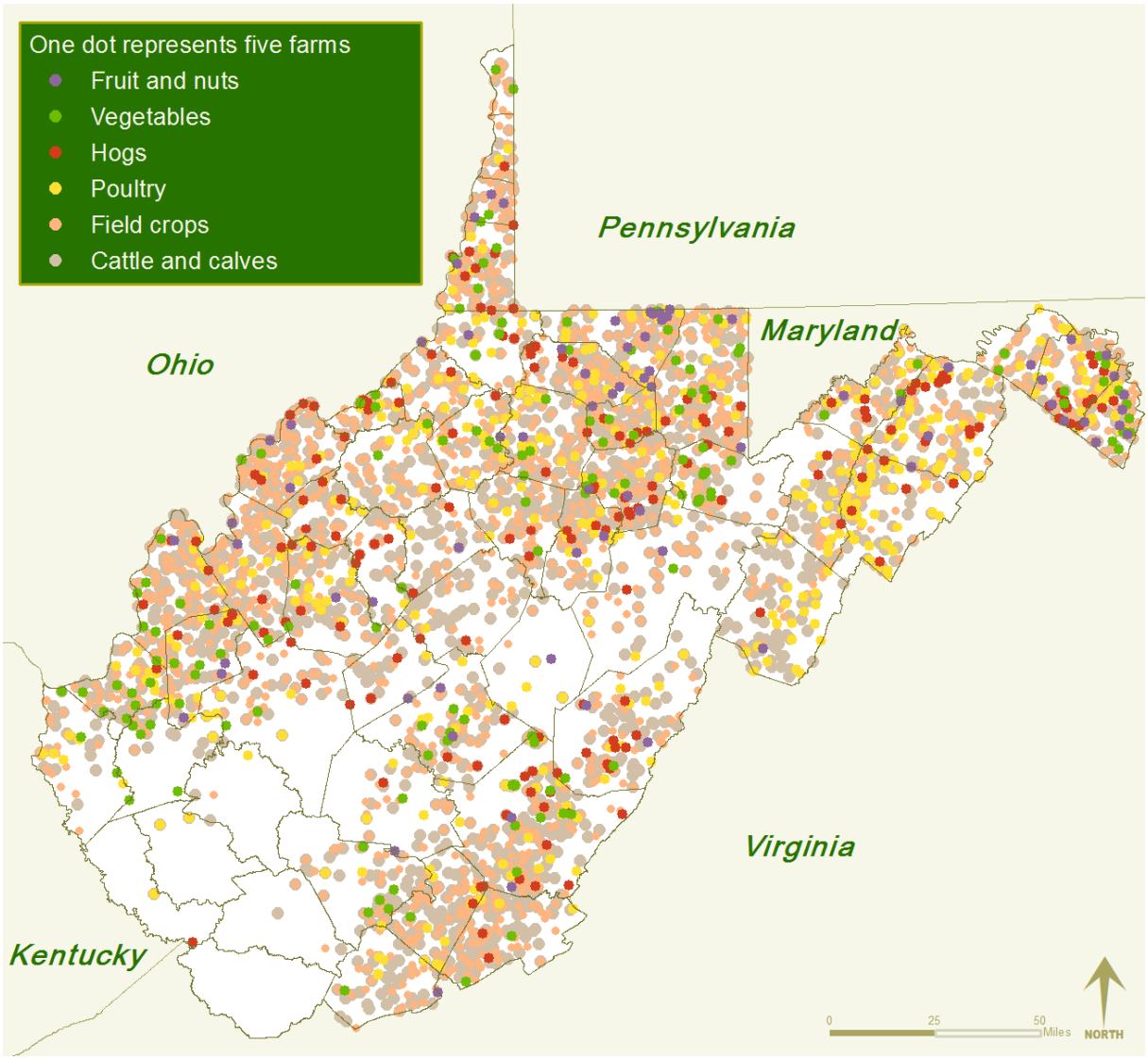


Source: National Center for Education Statistics (2008) and US Census Bureau (2009).

2.1 Agriculture in West Virginia

In 2007, West Virginia was home to 23,618 farms, which contained 3.7 million acres, more than 24% of the state's land area (USDA, 2007). Figure 3 depicts farms that reported sales from fruits and nuts, vegetables, hogs, poultry, field crops,[4] or cattle and calves. These farms are distributed throughout the state with the exception of the southern coalfields and the mountainous region west of the eastern panhandle. The eastern panhandle and the north-central regions have particularly high concentrations of farms (Figure 3).

Figure 3: Distribution of farms in West Virginia, 2007

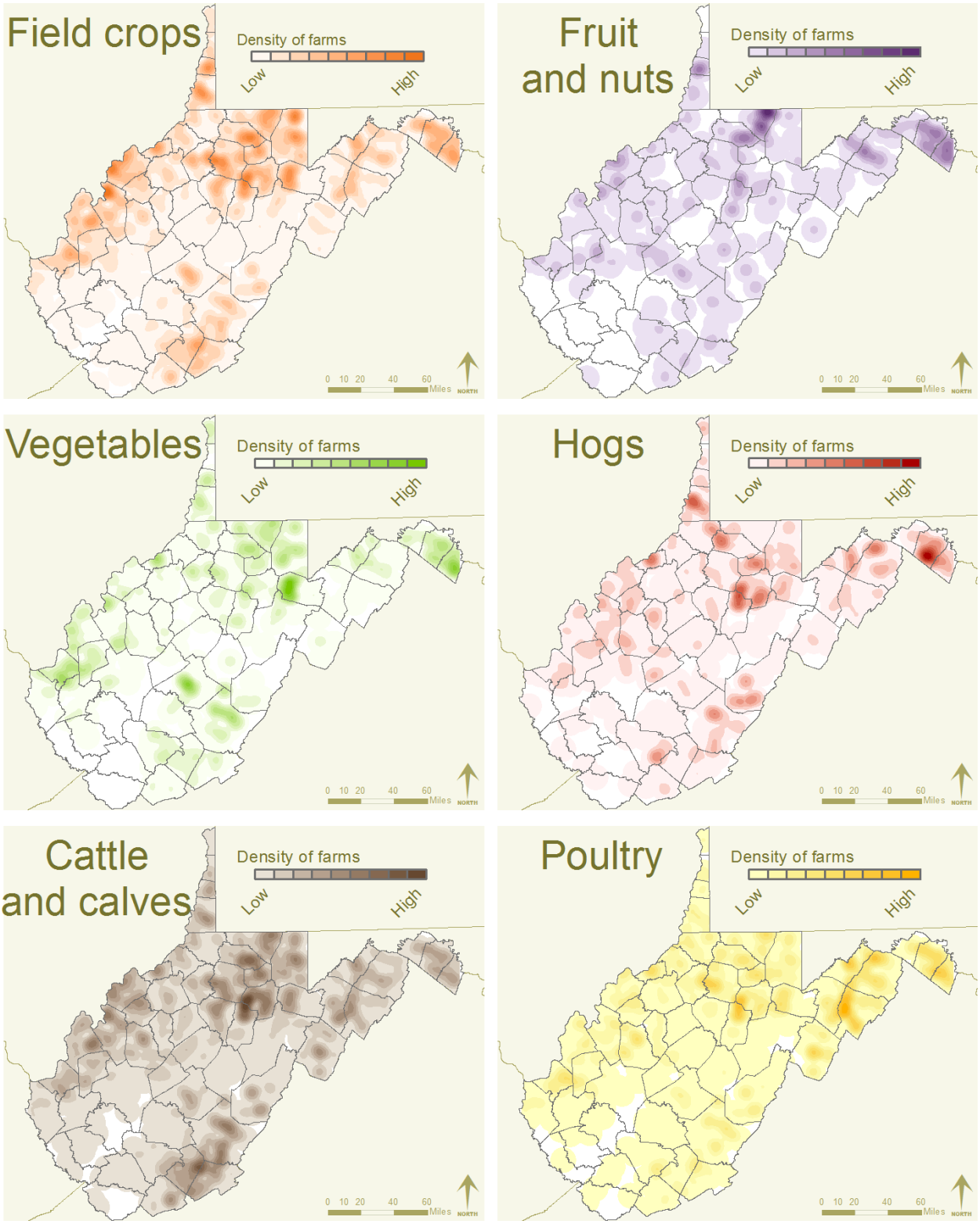


Source: USDA (2007). Each dot represents five farms in a zip code. If there are fewer than five farms in a zip code, there is no dot. Only farms with more than $1,000 in sales are represented. If a farm had more than $1,000 for more than one commodity, the farm receives one fifth of a dot for each commodity.

Figure 4 shows farms that reported sales for each commodity group. Cattle and calves are by far the most widespread. More than half of all West Virginia farms reported having cattle or calf inventory (USDA, 2007), and farms in all 55 of West Virginia's counties reported sales of cattle or calves in 2007 (Figure 4).

[4] Field crops include row crops, hay, and pasture.

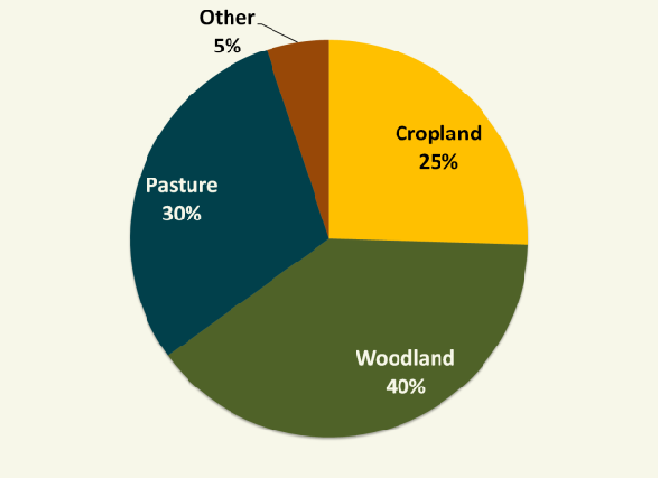
Figure 4: Density of farms in West Virginia by crop, 2007



Source: USDA (2007). Note: Map colors correspond to the dot colors in Figure 3.

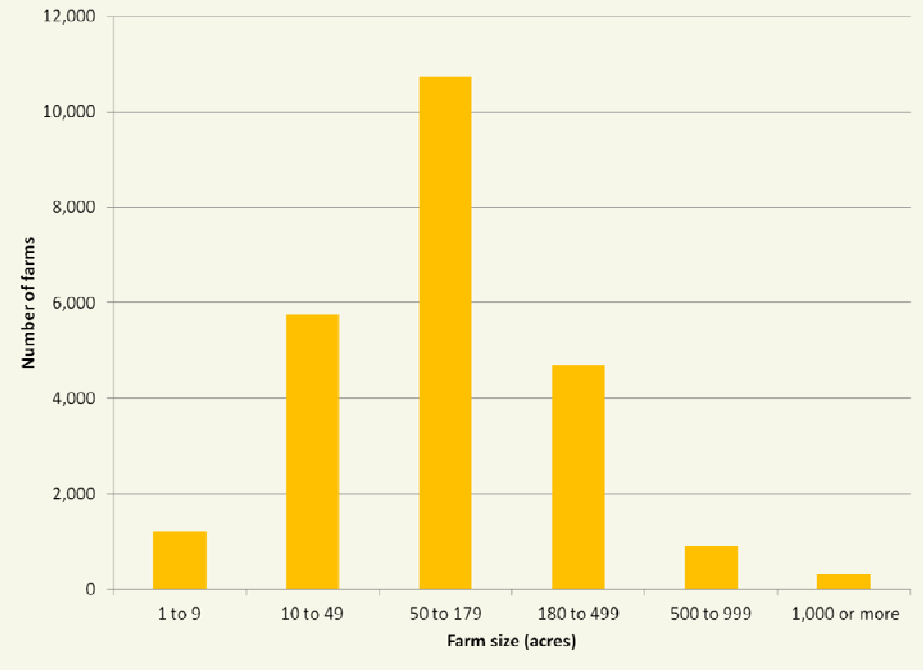
Total farmland acreage is primarily composed of woodland (40%), cropland (25%), and pasture (30%) (Figure 5). Most of the farms in West Virginia are small: Average farm size is 157 acres and the most common size range is 50 to 179 acres (Figure 6). The average farm size in the US is much larger: 418 acres (USDA, 2007).

Figure 5: Farmland composition



Source: USDA (2007). Note: "Other" includes land in farmsteads, buildings, livestock facilities, ponds, roads, wasteland, and other miscellaneous categories. "Pasture" includes only permanent pasture and rangeland other than woodland and cropland.

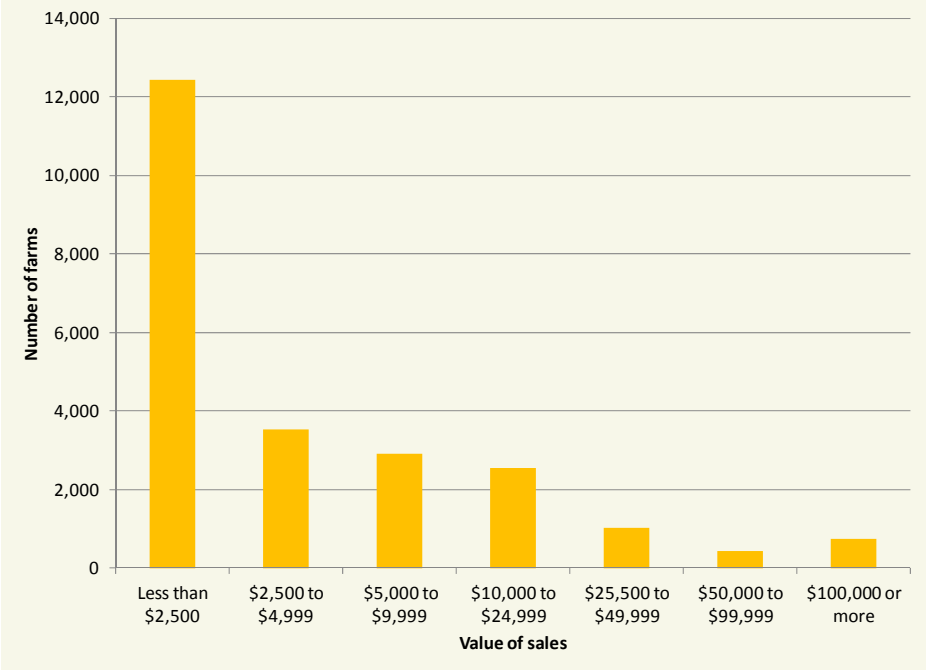
Figure 6: Farm size, 2007



Source: USDA (2007).

In addition to being small in physical size, most farms in West Virginia have low annual value of sales (Figure 7). Almost half of all farms in the state sell less than $2,500; 80% of all farms sell less than $10,000 annually.

Figure 7: Value of sales, 2007



Source: USDA (2007).

Although total farm sales in the state increased by 19% to $591 million from 2002 to 2007, these amounts pale in comparison to other states; West Virginia still ranked 43rd in the nation for total farm product sales in 2007 (USDA, 2007 as quoted in Meter, 2011).

2.1.1 *Livestock*

Economically speaking, the most influential components of agriculture in the state are the livestock industries, which comprised 77% of the value of total farm receipts in West Virginia in 2010 (Table 1). Some view cattle and hay as representative of the state's local food system (Jung, 2002), although this perspective diminishes the importance of poultry—the first, third, and fourth most important commodities—and other significant crops like apples, which grossed over $9.8 million in 2010 (Table 1).

Table 1: Top ten commodities in West Virginia, 2010

Order	Commodity	Value of receipts	Percent of state farm receipts	Percent of US farm receipts
1	Broilers	$166,772,000	32%	0.7%
2	Cattle and calves	$115,232,000	22%	0.2%
3	Turkeys	$53,940,000	10%	1.2%
4	Chicken eggs	$38,911,000	8%	0.6%
5	Greenhouse/nursery	$26,594,000	5%	0.2%
6	Dairy products	$26,195,000	5%	0.1%
7	Hay	$21,366,000	4%	0.4%
8	Corn	$10,811,000	2%	0.0%
9	Apples	$9,845,000	2%	0.4%
10	Soybeans	$7,212,000	1%	0.0%
	All commodities	**$520,077,000**		

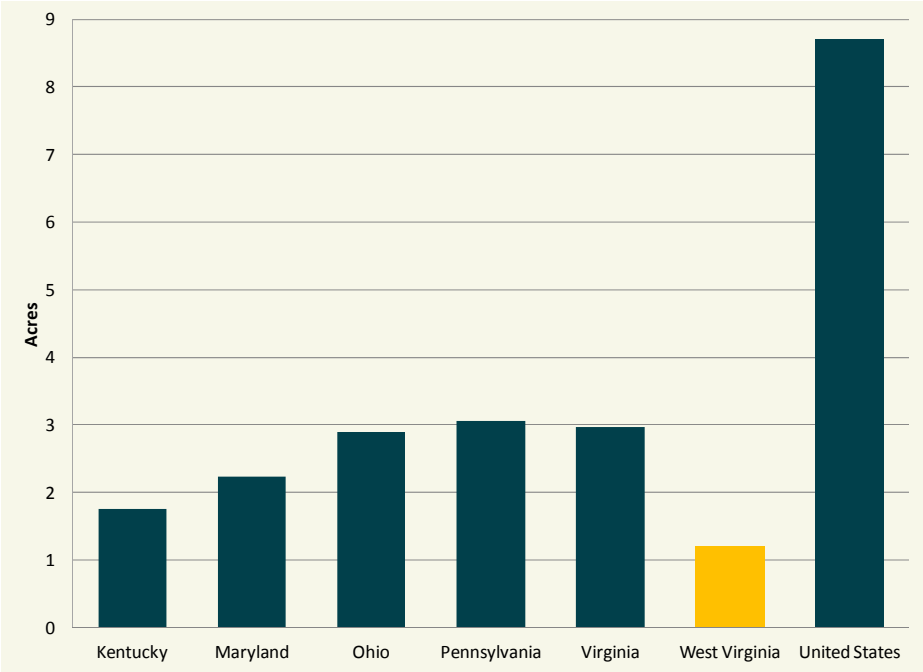
Source: USDA (2011). Note: The percentage of state farm receipts does not sum to 100% due to listing only the top ten commodities.

2.1.2 *Vegetables and fruit*

Vegetable production in West Virginia has more room to grow than fruit production. In 2007, only 726 farms reported harvesting vegetables for sale; this number of farms is less than 3% of all the farms in the state. These 726 farms comprise 2,210 acres and sold $5.8 million in vegetables (USDA, 2007). Although this number of farms represents a significant increase from 2002 (73%), the value of farm sales from vegetables only increased 26% over the same period (USDA, 2007 as cited in Meter, 2011).

In comparison to other Central Appalachian states and the US as a whole, West Virginia grows fewer fresh vegetables per person (Figure 8). In 2007, West Virginia farmers grew 1.2 acres of fresh vegetables per 1,000 people, compared to nearly double that in Pennsylvania and Virginia, and triple that in the US as a whole.

Figure 8: Fresh vegetables grown per 1,000 people, 2007



Source: USDA (2007a) and US Census Bureau (2007).

Fruit production is currently more significant than vegetable production. The state ranks 10th in the nation for apple production and 17th for peach production (NASS, 2011a). In 2010, the value of the utilized production of the commercial apple industry was $8.8 million and the value of utilized production of the commercial peach industry was $4.6 million (NASS, 2011a).[5] There are fewer fruit farms than vegetable farms—584 compared to 726—but their acreage is much larger. In 2007, there were 5,687 acres in fruit and nuts—76% of which were dedicated to apples—compared to 2,210 acres in vegetables (USDA, 2007).

In sum, livestock is significant in the state, in terms of prevalence and value. Yet, fruit is significant as well. We chose to focus on vegetable and fruit production in the state because of the room for growth and the many potential positive benefits of vegetables and fruits. For example, increased vegetable and fruit consumption is associated with the prevention of cancer, coronary heart disease, stroke, cataracts, diverticulitis, and hypertension (Van Duyn and Pivonka, 2003). Vegetable and fruit production could be expanded due to their relatively low need for processing facilities in comparison to meat, which requires

[5] Utilized production is the amount of produce that is available for sale. Utilized production is less than total production because some amount of the product may be damaged or inedible.

additional infrastructure like slaughter houses. Growing vegetables and fruits may also be relatively easy for aspiring farmers because of the low amount of start-up capital required.

2.2 Previous works

The most influential model for this project was Swenson (2010), who evaluated the regional economic impact of increased vegetable and fruit production in southwest Iowa. Swenson conducted two scenarios; the first examined the economic impact of increasing the production of 22 vegetables and fruits to meet the region's demand for these vegetables and fruits during a typical Iowa growing season. This scenario resulted in 902 acres of new vegetable and fruit production, resulting in $928,373 in labor and 16 additional jobs. The second scenario examined the economic impact of increasing the production of 22 vegetables and fruits to meet a portion of the Omaha and Des Moines demand for these vegetables and fruits during a typical Iowa growing season. This scenario resulted in an additional 2,107 acres of new vegetable and fruit production, resulting in $1.75 million in labor and 29 additional jobs.

Our project mirrored Swenson's with a few significant modifications: our geographic scope was broader, in that it covered an entire state instead of a 10-county area; our list of primary vegetables and fruits was longer, in that we included all those that could reasonably be grown in the state (40 vegetables and fruits); and our economic scope was smaller, in that we did not consider the economic impact of meeting the vegetable and fruit demand for large metropolitan areas outside of the primary study area. As shown by Swenson's results, large metropolitan areas have significant demand, and meeting that demand calls for significant increases in production and produces significant economic impacts.

Another influential study was conducted by Kane et al. (2010), who posed the question, "What if Georgians ate Georgia produce?" Kane et al. used USDA Agriculture Census data to evaluate the economic impact of three scenarios: if Georgia vegetable, melon, fruit, and nut farmers increased direct-to-consumer sales up to national levels; if all Georgia farmers increased direct-to-consumer sales up to national levels; and if Georgia consumers increased their direct purchases from Georgia farmers in 5% increments. Most significant for our project, Kane et al. employ the concept of a utilization gap, or "the difference between statewide production and consumption" for a given commodity (Kane et al., 2010, p. 1). A utilization gap can indicate a state surplus—when production exceeds consumption of a given commodity, or a state shortage—when consumption exceeds production of a given commodity.

Our project is similar to Kane et al.'s in that we use the same demand data from the Leopold Center for Sustainable Agriculture (2008), the same application of the concept of utilization gap, the same statewide boundary for local, and the same economic modeling software. Yet, our approach differs in that their focus is on the impact of direct-to-consumer sales and the power of aggregated buying power from small increases in direct purchases from consumers. Our process assumes that the current wholesale and distribution channels remain the same; additionally, we assume no changes in purchasing patterns on the behalf of consumers.

Timmons et al. (2008) use a similar methodology as ours for calculating the maximum potential for a state to feed its citizens, although they exclude the expansion or shifting of agricultural production and base their estimates on current US production value per capita. According to their methodology, which measures consumption in dollars rather than pounds, West Virginia farms can currently meet 31% of West Virginians' demand for all food categories (Timmons et al., 2008). Because most of the value of West Virginia's agricultural production is in poultry or cattle and calves, not vegetables and fruits, Timmons et al.'s estimate is inordinately high (Table 1); meat products have higher values than vegetables on a pound-basis.

All of these previous works provide significant instruction for the economic modeling portion of our study, although our approach differs from all of these in that it also examines the land-based potential for expanding agricultural production. Our study asks two questions: What if West Virginians ate West Virginia

vegetables and fruits? And, do we have the land base on which to grow these additional vegetables and fruits?

2.3 The IMPLAN model: uses and limitations

We used the IMPLAN modeling system (MIG, Inc., 2009) to calculate the economic impacts of increased vegetable and fruit production. IMPLAN is an input-output linear model that assumes that the structure of regional economies is parallel to that of the national economy. IMPLAN uses secondary data—like employment levels—to estimate the movement of products and revenue through the economy. In general, input-output models provide information on the current state of a regional economy in terms of jobs, labor income, the dollar value of total production, and the dollar value of value-added revenue. Input-output models are used to analyze an industry's employment levels, output, and incomes; describe supply and demand relationships between industries; and estimate the demands for goods and services by regional industries, institutions, and households. As predictive models, they allow for the construction of "what if" scenarios. The resulting impacts describe the reaction of a local or regional economy to an economic "shock" such as a new industry entering a region's economy or the loss of a major employer (Schaffer et al., 2004).

Impact analyses are driven by export base theory, the idea that regions generate income from sales to the "outside" world, or that which is outside of the given region. Input-output models apply this theory to all sectors of the economy, whether they are specifically export-oriented or not. Input-output models also show how money injected into the economy from increased sales is re-spent locally, a phenomenon which is called the multiplier effect—essentially the ripple effect of spending through the economy. The level of re-spending is determined by how much local businesses and consumers purchase from each other. More local purchases generate larger economic multipliers, while lower rates of re-spending or re-spending at businesses outside of the region generate smaller multipliers.

Multipliers generated by input-output models are based on the key assumption of fixed proportion production functions: An industry's increased output will result in a proportional increase in the use of inputs. Because inputs and outputs must move in this lock-step fashion, the models also assume elastic supply where increased demand for inputs results in additional production, but no change in price. Other assumptions include that resource availability is not constrained and that increases in employment and household spending are driven by new entrants to the labor force.

IMPLAN calculates three types of impacts: direct, indirect, and induced effects. Direct effects are initial changes in an industry or industries resulting from increased demand. An example of a direct effect in this study would be an increase in farming jobs or an increase in the amount of labor income from farming jobs. Indirect effects are one step removed from direct effects. Indirect effects are changes from industry transactions as suppliers increase their output and input purchases. An example of an indirect effect in this study would be the increase in sales of a farm supply store to keep up with the increase in demand for its products on the behalf of farmers. The final type of effect that IMPLAN calculates is induced effects, which are changes in household spending resulting from increased payments to workers. For example, as a result of the increase in production, the employee at the farm supply store receives more labor income, thereby increasing the amount of money that her household spends on other goods and services. IMPLAN measures all three types of effects—direct, indirect, and induced—in terms of:

- employment, or the number of jobs;
- output, which is the sale or dollar value of total production;
- value added, which is the sum of employee compensation (wages and benefits), proprietary income, other property income (rents, royalties, dividends), and indirect property taxes (excise and property taxes, fees, sales taxes); and
- labor income, which is the sum of employee compensation and proprietary income.

3. METHODS

This study uses two distinct methodologies for the geospatial and economic analyses. The geospatial or land-based methodology is derived from a similar study that examined the potential to expand food production in a three-county region in southern West Virginia (Hartz et al., 2011). It uses geographic information systems (GIS) to synthesize and analyze spatial data. The economic impact methodology is adapted from Swenson (2010) and uses economic modeling software to estimate the current and potential economic impact of vegetable and fruit production in West Virginia.

Wherever possible, we erred on the side of conservative estimates. Some of these decisions include using:

- Low estimates of per-acre yields for vegetables and fruits, thereby producing high estimates for the amount of land area required.
- Low estimates of possible storage duration for vegetables and fruits, thereby shortening the overall window of availability for fresh vegetables and fruits and decreasing the total amount required to satisfy fresh seasonal demand.
- Conservative estimates for the types of land classes that are included in our total potential farmland estimate. For example, we excluded land that is developed, forested, or open water.
- Only the production needed for fresh vegetables and fruits—not that which is frozen, canned, dehydrated, or juiced—thereby reducing the total amount of production needed.
- Only a season length that is possible without the use of season extension technology, like high tunnels, low tunnels, and greenhouses, thereby shortening the season length.
- High estimates for the amount of each vegetable and fruit consumed annually. We used "production needed" consumption data, which includes the amount of food lost during the steps from producer to wholesaler, wholesaler to retailer, retailer to consumer, and consumer to what is actually consumed.

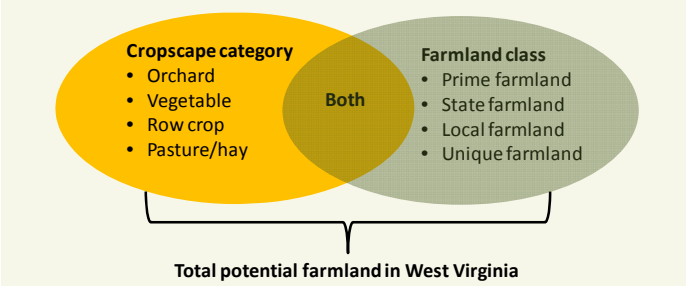
Similarly, our assumptions for the study include:

- West Virginians' consumption patterns of vegetables and fruits are equal to that of the average American. This is because there are no region-specific consumption data available.
- West Virginians will not alter the total and individual amounts of vegetables and fruits that they consume if there are more locally produced vegetables and fruits available.
- Yields of West Virginia vegetable and fruit farms are roughly equivalent to that of farms in neighboring states with similar topography. We used West Virginia yield data where available, which was only for apples and peaches.
- Locally grown vegetables and fruits are the same products as their conventionally procured counterparts, meaning that there is no difference in perceived quality and price between an apple grown in West Virginia and an apple grown in New Zealand.

3.1 Geospatial analysis

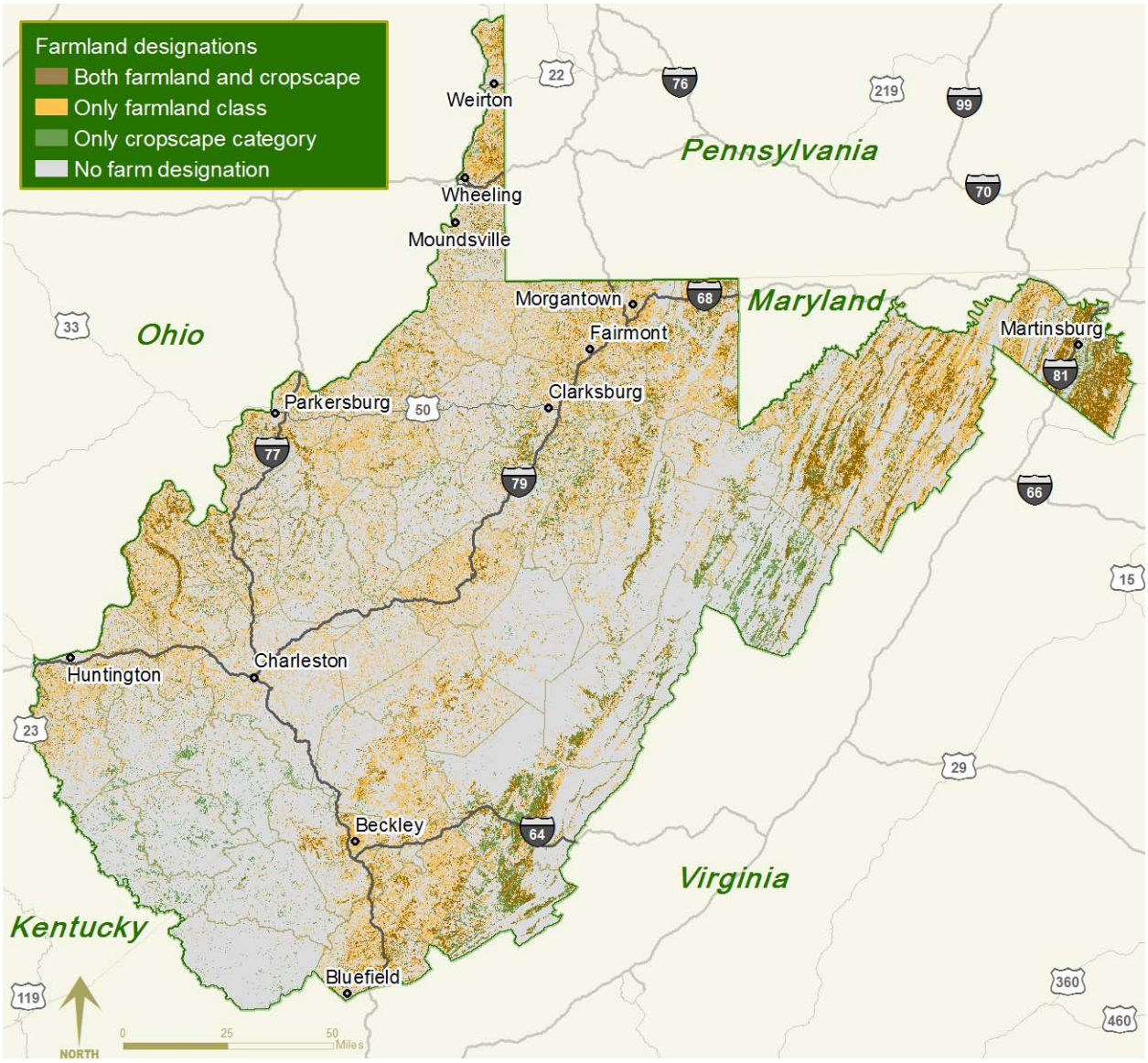
To calculate the total potential farmland in the state, the project team used geospatial data from two different sources: Cropscape (NASS, 2011b) and farmland determined by the Natural Resources Conservation Service (NRCS) and county and local governments (NRCS, 2011a). The data collected via Cropscape are remotely sensed information on current areas of production. The data collected via NRCS and county and local governments are determined by physical and chemical information that is used to project potential areas to farm. The Cropscape data is a measure of what is already farmed, and the NRCS data is a measure of what could be farmed (Figure 9and Figure 10). We combine these two spatial datasets to represent the area of potential farmland in the state (Figure 12). For more information on these two datasets and our geospatial methodology, see Appendix C.

Figure 9: Process flow diagram, farmland designation



Source: NRCS (2011a) and NASS (2011b).

Figure 10: Farmland designations, West Virginia, 2011

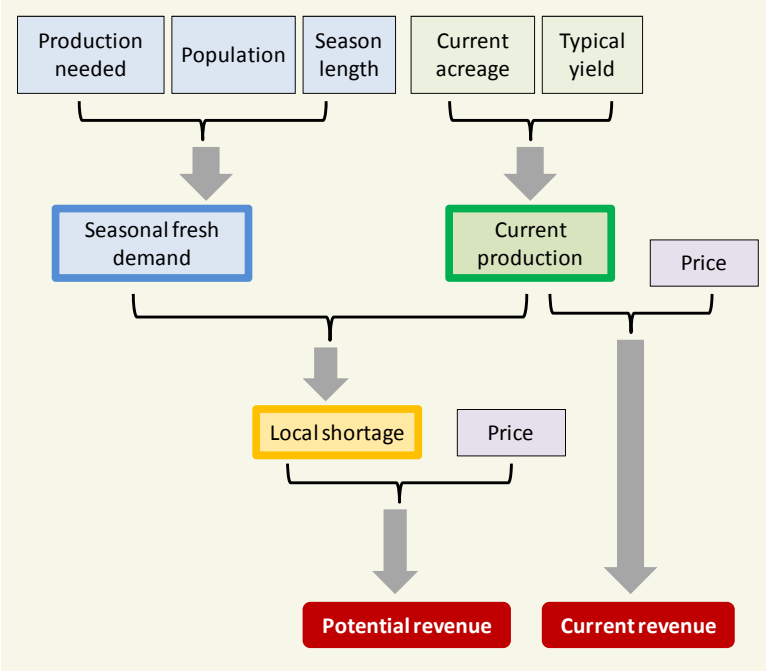


Source: NASS (2011b) and NRCS (2011a).

3.2 Economic analysis

To establish the economic impact for an expanded food system in West Virginia, we first had to establish boundaries on our system. Even though typical food system assessments describe production, processing, distribution, consumption, and waste as well as components of food access and food justice, this report is focused only on the economic implications of expanded vegetable and fruit production, as well as the land base required to make these expansions. Figure 11 depicts the overall method for the economic impact portion of this study; the color-coded boxes correspond to equations embedded in the following text.

Figure 11: Process flow diagram



To calculate the economic impact of expanded agricultural production in the state, we first had to decide how much we were going to expand production. Swenson (2010) weighted the amount of production increase by estimating the percent of the year that a given crop would be available for fresh or minimally preserved consumption. These percent weights ranged from 25%—as in the case of apricots and cucumbers—to 75%—as in the case of sweet corn (Swenson, 2010). We decided to increase the amount of vegetable and fruit production with respect to the amount of each vegetable and fruit already consumed and produced in the state (blue and green boxes, Figure 11).

We estimated the demand for vegetables and fruits in the state by using USDA's Economic Research Service Food Availability Data via the Market Estimator (Leopold Center for Sustainable Agriculture, 2008). The data that runs the Market Estimator are national-level consumption data, which provide a snapshot of the average amount of food consumed by the average American in one year, by product type—like raspberries, beef, or wheat flour, for example. We selected annual production needed in pounds for all vegetables and fruits.[6] We then shortened this list to reflect only those vegetables and fruits that can be grown in West Virginia and those that had per capita annual consumption rates of greater than 0.23 pounds per year. For example, we omitted lima beans from the study—even though they can be grown in West Virginia—because the average American requires 0.04 pounds per year. We also restricted the amounts of production needed to that which

[6] "Production needed" represents the amount of the product that is required to meet the consumption needs of consumers. The amount that individuals actually consume ("[amount] consumed") is much smaller, due to waste between the point-of-first sale, retailer, and consumer. Examples of this waste include bruised or damaged produce and/or moldy leftovers.

is consumed fresh, excluding amounts of products that are frozen, dried, canned, or otherwise processed. This step means that our calculations exclude the produce required for frozen potatoes, dried chilies, and applesauce, for example. All of these refinements resulted in a list of products that includes 31 vegetables and nine fruits (Table 2 and Table 3).

After establishing the list of vegetables and fruits for the study, we then took the per capita consumption rates ("production needed") for these vegetables and fruits and multiplied them by the population of the state and typical season length in months, and then divided by 12 months per year, resulting in West Virginia seasonal fresh demand (Equation 1).

Equation 1: Seasonal fresh demand

$$Seasonal\ fresh\ demand_x = production\ needed_x \times population \times season\ length_x \div 12$$

West Virginia seasonal fresh demand represents the amount of each vegetable and fruit that is required to meet the needs of West Virginians during a typical growing season. We used a West Virginia-specific harvest calendar to estimate the months out of the year when the product is available to eat (WVFARM2U.org, 2011), and our professional judgment on the amount of additional months that the product could be stored without the use of preservation techniques like freezing, canning, or drying. For example, the WVFARM2U (2011) harvest calendar says that potatoes can be harvested in West Virginia (hardiness zones 5 and 6) July through October, a period of four months. We agree that potatoes can be easily stored without significant processing for at least two additional months, bringing the season length for potatoes up to six months. Half of the annual West Virginia demand for fresh potatoes is 33 million pounds, which is the amount of seasonal production needed for potatoes (Table 2).

Because the focus of this project is West Virginia vegetables and fruits for West Virginians, we then examined the amount of current vegetable and fruit production in the state. As depicted in Figure 8, few acres are devoted to vegetable production in comparison to surrounding states and the national average. The USDA Agriculture Census reports acres harvested for the primary vegetables and fruits in this study, with the exception of Brussels sprouts, celery, escarole, mushrooms, mustard greens, radishes, and turnip greens, for which there was little or no production (USDA, 2007). We then multiplied these vegetable production acreages by average yield per acre to get current production in pounds (Equation 2). Yields are listed in Appendix D.

Equation 2: Current production

$$Current\ production_x = current\ acreage_X \times typical\ yield_x$$

The difference between the production needed and current production amounts is equivalent to the utilization gap for fresh vegetables and fruits for West Virginians (Equation 3). The utilization gap can either be a shortage or surplus.

Equation 3: Local shortage

$$Local\ shortage_x = Seasonal\ fresh\ demand_x - current\ production_x$$

As employed by Kane et al. (2010), a utilization gap can discern whether a state has a shortage or surplus of a commodity. Where consumption exceeds production, we call it a local shortage; and where production exceeds consumption, we call it a local surplus. For example, West Virginia farms currently grow 26,000 pounds of asparagus, which is 485,000 pounds short of meeting the needs of its residents for fresh asparagus for three months out of the year. This means that—theoretically—West Virginia has a 485,000 pound local shortage of asparagus (Table 2). Because vegetable and fruit commerce commonly transcends state and national boundaries, there is not actually a physical shortage of asparagus in West Virginia. However, buying 485,000 pounds of asparagus from out-of-state growers represents foregone revenue for West Virginia farmers.

After estimating West Virginia fresh seasonal demand and current production, we estimated the amount of revenue from the vegetable and fruit sectors.[7] We multiplied current production (Equation 2) by price per pound at the first point-of-sale, also known as the farm gate price (Equation 4). This estimate of current revenue represents the amount of revenue received by farmers for each commodity. For example, in 2007, 26,229 pounds of asparagus were produced. Farm gate price for asparagus was $0.98 per pound, so the total farm gate sales of asparagus in West Virginia were equivalent to $26,000 (Equation 4).[8]

Equation 4: Current revenue

$$Current\ revenue_x = current\ production_x \times price_x$$

The sum of all of the current revenues for each sector represents the economic impact of that sector (Equation 5).

Equation 5: Total revenue

$$Total\ revenue_{all\ vegetables} = \sum_{x=asparagus}^{watermelon} current\ revenue_x$$

After establishing the total amount of current revenue, we proposed two scenarios. The first scenario asks the question, "What would be the economic impact if West Virginia farms filled 100% of demand for all fresh vegetables and fruits that can be grown in West Virginia, during a typical West Virginia growing season?" The additional revenue from Scenario 1 is found via Equation 6.

Equation 6: Additional revenue, Scenario 1

$$Additional\ revenue_{scenario\ 1} = \sum_{x=asaparagus}^{watermelon} (utilization\ gap_x \times price_x)$$

[7] The vegetable sector includes melons, because they are annuals not perennials, like other fruits. Therefore, these melons (honeydew, watermelon, and cantaloupe) are excluded from the fruit sector and included in the vegetable sector for the balance of the report.
[8] Price data were obtained from various sources, see Appendix E for references.

Because of the significant changes required to meet 100% of the local shortage, our second scenario asks the question: What would be the economic impact if West Virginia farms filled only 75% of demand for all fresh vegetables and fruits that can be grown in West Virginia, during a typical West Virginia growing season? We selected 75% because, even if the entire shortage were produced by new farmers, only 980 new farmers would be required in a state of 1.8 million people. The additional revenue from supplying only 75% of the region's needs for fresh vegetables is represented in Equation 7.

Equation 7: Additional revenue, Scenario 2

$$Additional\ revenue_{scenario\ 2} = \left[\sum_{x=asaparagus}^{watermelon} (shortage_x \times price_x)\right] \times 0.75$$

We used the sum of the current revenue from fruits or vegetables and additional revenue from Scenarios 1 and 2 for fruits or vegetables to establish the inputs for use in IMPLAN (Equation 8 and Equation 9).

Equation 8: New input, Scenario 1

$$New\ input_{scenario\ 1} = additional\ revenue_{scenario\ 1} + current\ revenue$$

Equation 9: New input, Scenario 2

$$New\ input_{scenario\ 2} = additional\ revenue_{scenario\ 2} + current\ revenue$$

We ran IMPLAN using a standard procedure and altering the regional purchase coefficients. Regional purchase coefficients, a measure of the local use of a commodity, were changed to reflect new purchasing patterns by state residents and industries. All institutions (households and governments) and industry sectors purchasing fresh vegetables and fruits for meal preparation (restaurants, hotels, schools, hospitals, etc.) were assumed to purchase all of their fresh, seasonal produce from local sources. Local purchases by industries involved in food manufacturing and direct purchases by retail outlets were held constant. Ordinarily, these standard regional purchase coefficients are relatively low: 6.9% for vegetables and 1.2% for fruits.

DEFINITION OF SCENARIO 1 AND SCENARIO 2

Scenario 1 entails fulfilling 100% of the local shortage with vegetables and fruits grown in West Virginia. This means that farmers increase production of vegetables and fruits enough that all the residents in the state can purchase locally-grown produce to satisfy their fresh vegetable and fruit needs in season.

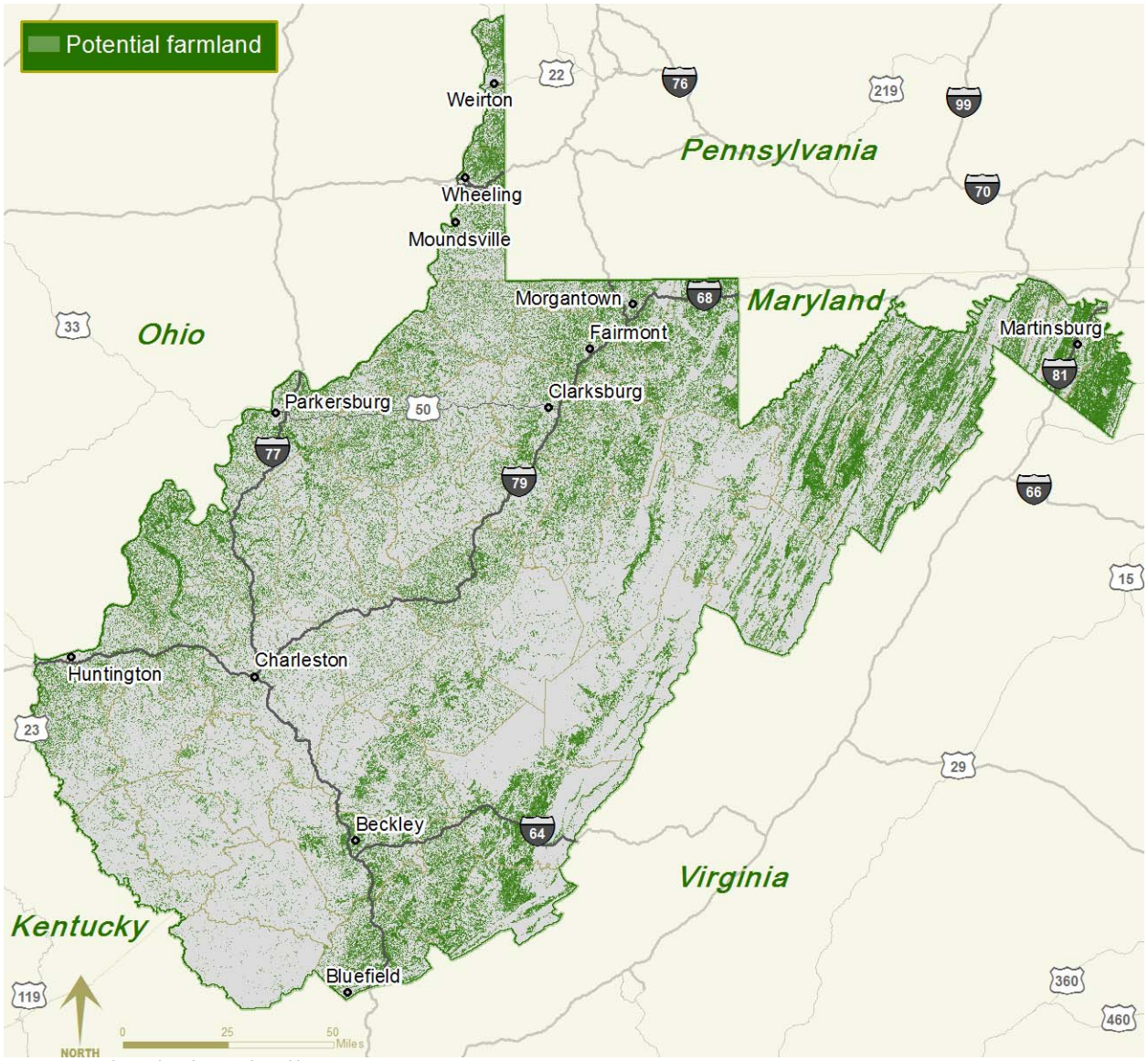
Scenario 2 entails fulfilling only 75% of the local shortage with vegetables and fruits grown in West Virginia. This means that farmers would only increase production enough that all the residents in the state can purchase locally-grown produce to satisfy most of their fresh vegetable and fruit needs, but not all.

4. RESULTS

4.1 Geospatial analysis

Following the method described in Section 3.1, the total potential farmland in West Virginia is 4.2 million acres, and excludes that which is currently forested, developed, or open water (Figure 12). This number represents all of the land that is currently farmed as pasture, row crops, orchard, or vegetables and that which could be farmed, according to NRCS and state, county, or local officials. This is 27% of the land area in the state. This number is 500,000 acres greater than the amount of farmland (3.7 million acres) that is reported by the USDA Agriculture Census, which includes 1.5 million acres of forest.[9]

Figure 12: Total potential farmland, 2011



Source: NRCS (2011a) and NASS (2011b).

[9] Our estimates for farmland area are higher than USDA's estimates for farmland area because our estimates represent what could be farmed in addition to what is currently farmed; here, USDA only includes the land that is currently part of a farm.

4.2 Economic analysis

4.2.1 *Fresh seasonal vegetable and fruit utilization gap*

Following the method described in Section 3.2, Table 2 lists the production needed per person and overall for West Virginians, season length, amount of seasonal production needed, amount of current production, and the utilization gap for vegetables included in the study. The top ten most consumed vegetables are highlighted in bold. In West Virginia there is a surplus of sweet corn and pumpkin (indicated by a negative utilization gap), meaning that West Virginia farms currently produce more sweet corn and pumpkin than are needed to satisfy the seasonal fresh needs of its residents, according to our calculations.

Table 2: Fresh vegetable demand, season length, production, and utilization gap; 2007

Vegetable or melon	Demand (pounds per capita)	West Virginia demand (pounds)	Season length (months)	Seasonal production needed (pounds)	Current production (pounds)	Utilization gap (pounds)
Asparagus	1.13	2,046,654	3.0	511,663	26,429	485,234
Bell peppers	**7.01**	**12,696,498**	**3.3**	**3,491,537**	**895,322**	**2,596,215**
Broccoli	6.13	11,102,644	5.0	4,626,102	58,050	4,568,052
Brussels sprouts	0.28	507,135	3.0	126,784	0	126,784
Cabbage	**8.19**	**14,833,712**	**5.0**	**6,180,713**	**300,000**	**5,880,713**
Cantaloupe	**9.57**	**17,333,165**	**3.0**	**4,333,291**	**490,014**	**3,843,277**
Carrots	**8.72**	**15,793,647**	**5.3**	**6,975,527**	**81,000**	**6,894,527**
Cauliflower	1.71	3,097,149	5.6	1,445,336	12,000	1,433,336
Celery	6.07	10,993,972	3.0	2,748,493	0	2,748,493
Collard greens	0.53	959,935	8.0	639,957	15,200	624,757
Cucumbers	6.33	11,464,883	3.6	3,439,465	1,260,000	2,179,465
Eggplant	0.96	1,738,750	3.6	521,625	213,328	308,297
Escarole	0.24	434,688	4.0	144,896	0	144,896
Garlic	2.38	4,310,651	9.0	3,232,988	54,000	3,178,988
Honeydew	2.12	3,839,740	3.0	959,935	19,628	940,307
Kale	0.33	597,695	8.0	398,464	120,000	278,464
Lettuce (all)	**35.15**	**63,663,610**	**4.0**	**21,221,203**	**120,732**	**21,100,471**
Mushrooms	2.55	4,618,555	12.0	4,618,555	0	4,618,555
Mustard greens	0.38	688,255	6.0	344,128	0	344,128
Onions	**19.79**	**35,843,608**	**8.0**	**23,895,739**	**226,664**	**23,669,075**
Potatoes	**37.19**	**67,358,454**	**6.0**	**33,679,227**	**5,775,000**	**27,904,227**
Pumpkin	4.79	8,675,638	2.0	1,445,940	3,587,922	-2,141,982
Radishes	0.53	959,935	7.0	559,962	0	559,962
Snap beans	2.12	3,839,740	3.6	1,151,922	766,053	385,869
Spinach	2.01	3,640,508	4.0	1,213,503	10,900	1,202,603
Squash	5.02	9,092,214	4.7	3,561,117	793,322	2,767,795
Sweet corn	**8.64**	**15,648,751**	**3.6**	**4,694,625**	**6,080,764**	**-1,386,139**
Sweet potatoes	4.57	8,277,175	4.0	2,759,058	19,000	2,740,058
Tomatoes	**19.89**	**36,024,728**	**3.6**	**10,807,418**	**4,214,396**	**6,593,022**
Turnip greens	0.37	670,143	6.0	335,072	0	335,072
Watermelon	**15.91**	**28,816,160**	**3.0**	**86,448,481**	**699,485**	**6,504,555**

Source: Leopold Center for Sustainable Agriculture (2008), USDA (2007), WVFARM2U (2011), yields from sources listed in Appendix D. Note that all melons are included in the vegetable sector in order to match IMPLAN sectors (Appendix C) and because of their annual harvest, as opposed to all other fruits. Lettuce includes both head and leaf.

Table 3 lists the same results as in Table 2, but for the fruits included in the study. The top five most-consumed fruits are highlighted in bold. In West Virginia there is a surplus of apples and peaches (shown as a negative utilization gap), indicating that West Virginia farms currently produce more apples and peaches than are needed to satisfy the fresh seasonal needs of its residents, according to our calculations.

Table 3: Fresh fruit demand, season length, production, and utilization gap; 2007

Fruit	Demand (pounds per capita)	West Virginia demand (pounds)	Season length (months)	Seasonal production needed (pounds)	Current production (pounds)	Utilization gap (pounds)
Apples	**17.77**	**32,184,988**	**6.0**	**16,092,494**	**79,632,000**	**-63,539,506**
Blueberries	0.56	1,014,271	3.5	295,829	210,000	85,829
Cherries	1.10	1,992,318	2.0	332,053	45,500	286,553
Grapes	**7.68**	**13,910,001**	**2.0**	**2,318,333**	**835,000**	**1,483,333**
Peaches	**4.58**	**8,295,287**	**2.0**	**1,382,548**	**9,999,160**	**-8,616,612**
Pears	**3.19**	**5,777,722**	**5.0**	**2,407,384**	**876,223**	**1,531,161**
Plums	1.01	1,829,310	2.0	304,885	185,997	118,888
Raspberries	0.44	796,927	2.5	166,026	81,000	85,026
Strawberries	**6.14**	**11,120,756**	**2.0**	**1,853,459**	**326,250**	**1,527,209**

Source: Leopold Center for Sustainable Agriculture (2008), USDA (2007), and WVFARM2U (2011). Yields from sources listed in Appendix D. Note that all melons are included in the vegetable sector in order to match IMPLAN sectors (Appendix C).

4.2.2 *Potential impacts of filling vegetable local shortage*

Filling the entire local shortage (100%) of vegetables would require an additional 6,264 acres (Table 4), which is about three times that which was under vegetable cultivation in 2007. In order to meet 75% of the West Virginia demand for fresh, in-season vegetables, an additional 4,698 acres are required to come into production.

The most significant acreage increases would be in potatoes, onions, lettuce, broccoli, and cantaloupe (Table 4). Sweet corn and pumpkin show a local surplus (Table 2), so no additional acreage was required and no additional revenue was generated.

Table 4: Vegetable land and revenue: current, Scenario 1, Scenario 2

Vegetable	Required land (acres)	Current land (acres)	Additional land (acres)		Current revenue ($)	Additional revenue ($)	
			Scenario 1	Scenario 2		Scenario 1	Scenario 2
Asparagus	252	13	239	179	26,138	479,897	359,923
Bell peppers	133	34	99	74	296,352	859,347	644,510
Broccoli	478	6	472	354	21,304	1,676,475	1,257,356
Brussels sprouts	9	0	9	7	0	44,881	33,661
Cabbage	247	12	235	176	49,200	964,437	723,328
Cantaloupe	371	42	329	247	72,522	568,805	426,604
Carrots	258	3	255	192	17,901	1,523,691	1,142,768
Cauliflower	120	1	119	90	4,128	493,068	369,801
Celery	51	0	51	39	0	582,681	437,010
Collard greens	84	2	82	62	4,393	180,555	135,416
Cucumbers	131	48	83	62	309,960	536,148	402,111
Eggplant	20	8	12	9	53,545	77,383	58,037
Escarole	8	0	8	6	0	42,744	32,058
Garlic	239	4	235	177	22,248	1,309,743	982,307
Honeydew	49	1	48	36	3,474	166,434	124,826
Kale	10	3	7	5	34,680	80,476	60,357
Lettuce (all)	703	4	699	524	30,988	5,415,788	4,061,841
Mushrooms	17	0	17	13	0	4,849,483	3,637,112
Mustard greens	23	0	23	17	0	96,356	72,267
Onions	843	8	835	627	43,973	4,591,801	3,443,850
Potatoes	1,604	275	1,329	997	626,010	3,024,818	2,268,614
Pumpkin	94	234	0	0	387,496	0	0
Radishes	56	0	56	42	0	167,989	125,991
Snap beans	212	141	71	53	468,824	236,152	177,114
Spinach	111	1	110	83	3,521	388,441	291,330
Squash	153	34	119	89	220,544	769,447	577,085
Sweet corn	689	892	0	0	1,380,333	0	0
Sweet potatoes	145	1	144	108	3,477	501,431	376,073
Tomatoes	482	188	294	221	1,466,610	2,294,372	1,720,779
Turnip greens	22	0	22	17	0	96,836	72,627
Watermelon	288	28	260	195	79,042	735,015	551,261
Total	**7,904**	**1,983**	**6,264**	**4,698**	**$5,626,663**	**$32,754,690**	**$24,566,018**

Source: USDA (2007), Leopold Center for Sustainable Agriculture (2008). See Appendix E for price data. Numbers may not exactly sum due to rounding .Note that this does not represent all vegetables grown in West Virginia, only those that are included in this analysis.

Currently, West Virginia farms produce $5.6 million of vegetables. Producing enough crops to fill 75% of the local shortage of vegetables would result in $24.6 million of additional revenue and $30.2 million in total revenue (Figure 13).Producing enough crops to fill 100% of the local shortage of vegetables would result in $32.8 million of additional revenue and $38.4 million in total revenue (Figure 13).

Figure 13: Vegetable revenue, current and potential

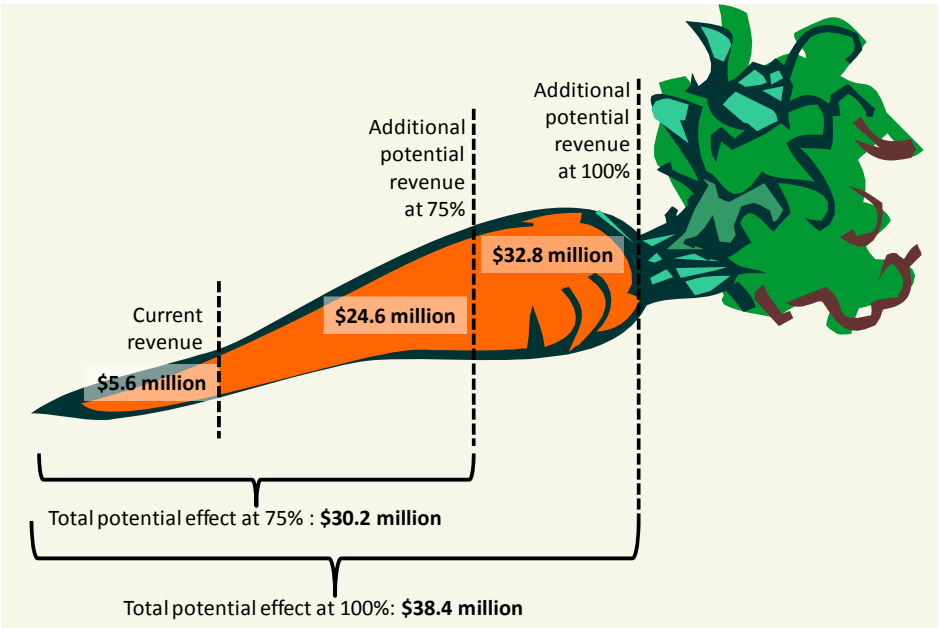
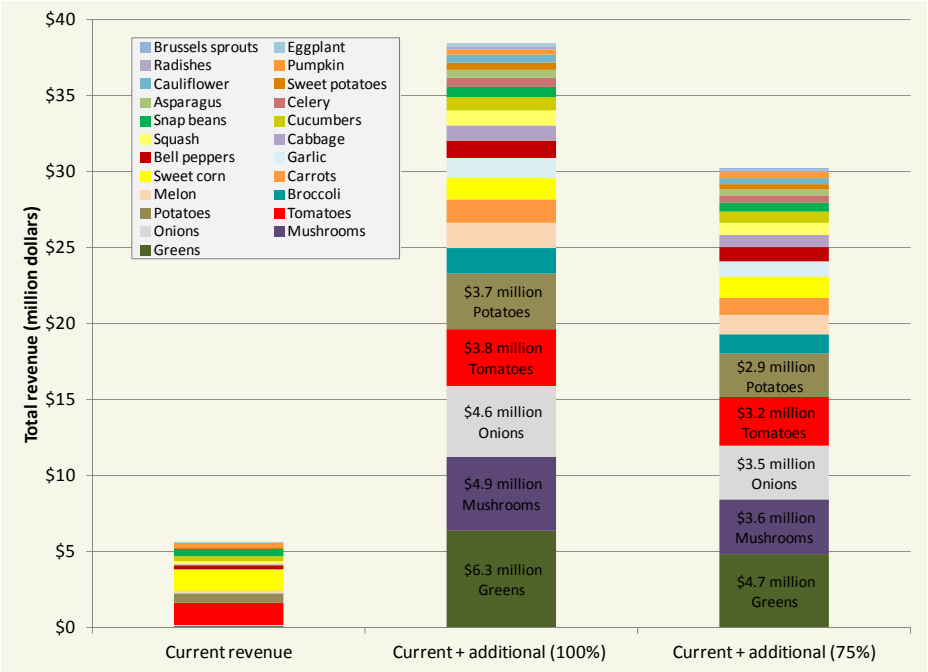


Figure 14 depicts the breakdown of revenue by the type of produce. Greens—including lettuce, spinach, kale, escarole, turnip greens, mustard greens, and collard greens—are the largest contributor to additional revenue (Figure 14), due in part to the high per capita demand for lettuce, which is 35.2 pounds per year (Table 2). The second largest contributor to total revenue is mushrooms, due in large part to the length of the mushroom season, which is 12 months for indoor cultivation (Table 2). Onions, tomatoes, and potatoes are the next largest contributors to total revenue; their relatively high contributions are due to high per capita consumption rates, which are 19.8, 19.9, and 37.2 pounds per year, respectively (Table 2).

Figure 14: Vegetable revenue, by type of produce



4.2.3 *Potential impacts of filling fruit local shortage*

We followed the same methodology for fruits (Table 5). Filling the entire local shortage of fruits (excluding melons, which are included with vegetables) would require an additional 845 acres, which is less than 15% of that which was under cultivation in 2007. The most significant increases would be in grapes, strawberries, and pears. In order to fill 75% of the local shortage, 634 additional acres would be required (Table 5).

If all acres currently devoted to fruits were productively bearing fruit,[10] a total of 637 new acres of strawberries, cherries, grapes, and pears would be required. There are already enough acres of blueberries, raspberries, apples, peaches, and plums under cultivation, just not productively bearing fruit.

[10] Fruit trees and bushes sometimes require several years of maturation prior to producing at full potential. Some of the acres listed as "non-bearing" or "non-harvested" in the Agriculture Census are in these phases of maturation. Other acreage is past full productive potential.

Table 5: Fruit land and revenue: current, Scenario 1, Scenario 2

Fruit	Required land (acres)	Current land (acres)	Additional land (acres)		Current revenue ($)	Additional revenue ($)	
			Scenario 1	Scenario 2		Scenario #	Scenario 2
Apples	894	4,424	0	0	14,891,184	0	0
Blueberries	70	50	20	15	449,400	183,674	137,756
Cherries	102	14	88	66	50,278	316,641	237,481
Grapes	464	167	297	223	364,478	647,475	485,606
Peaches	126	914	0	0	4,289,640	0	0
Pears	294	107	187	140	233,952	408,820	306,615
Plums	34	21	13	10	57,845	36,974	27,731
Raspberries	55	27	28	21	110,160	115,636	86,727
Strawberries	256	45	211	158	267,851	1,253,839	940,379
Total	**2,296**	**5,769**	**845**	**634**	**$20,714,786**	**$2,963,059**	**$2,222,294**

Source: USDA (2007), Leopold Center for Sustainable Agriculture (2008). See Appendix E for price data.

Currently, West Virginia farms produce $20.7 million of fruit. Producing enough crops to fill 75% of the local fruit shortage would result in $2.2 million of additional revenue and $22.9 million in total revenue (Figure 15).Producing enough crops to fill 100% of the local fruit shortage would result in $3 million in additional revenue and $23.7 million in total revenue (Figure 15).

Farms in West Virginia already produce a significant amount of apples and peaches—together they make up 93% of the acres in fruit cultivation in 2007—and no increases are required for either of these crops, so there is also no additional revenue from these two fruits.

Figure 15: Fruit revenue, current and potential

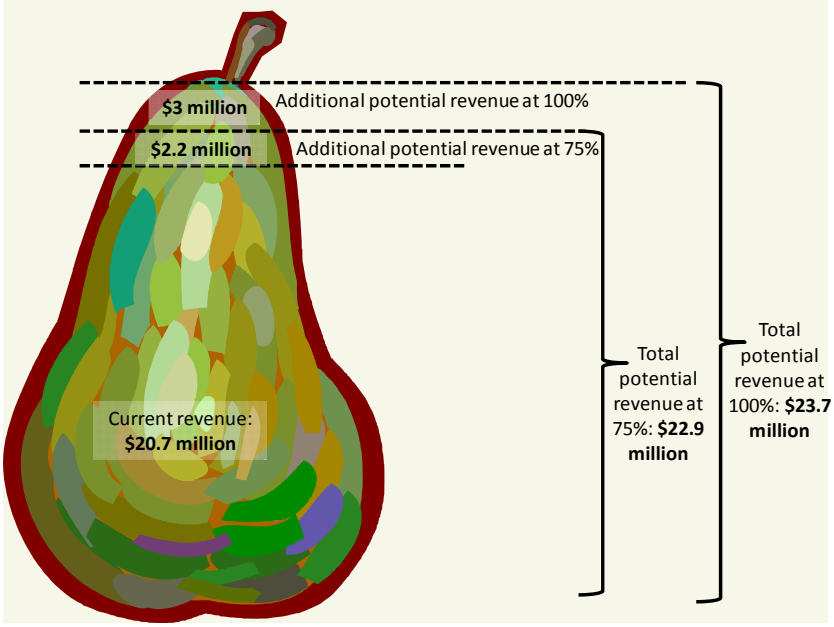


Figure 16 depicts the breakdown of revenue by type of fruit. Apples and peaches are the most valuable at $14.9 million and $4.3 million in current revenue, respectively. These are large industries in the state that were held constant in this analysis. Strawberries offer the most additional potential revenue, due in large

part to their high per capita consumption rate (Table 3). Grapes have higher per capita consumption rates than strawberries, but their price per pound is much lower—44 cents per pound versus 82 cents per pound—making for an overall lower revenue contribution (Appendix E).[11]

Figure 16: Fruit revenue, by type of produce

4.2.4 *Economic impact: Current situation*

The current economic impact of the vegetable and fruit sectors is small but not insignificant. In 2007, these sectors created 1,059 jobs, $15.8 million in labor-related income, and $34.6 million in value added–related income, with a total effect of $68.6 million (Table 6). Total gross domestic product (GDP) for West Virginia in 2007 was $59.8 billion; even if we ramped up production to fill 100% of the demand for fresh seasonal vegetables and fruits, the total economic impact would be less than 1% of West Virginia's GDP.

Table 6: Current economic situation

Impact type	Employment	Labor income	Value added	Output
Direct effect	893	$10,207,555	$24,649,010	$51,182,160
Indirect effect	87	$3,038,053	$5,379,161	$10,021,283
Induced effect	79	$2,507,874	$4,541,810	$7,433,677
Total	**1,059**	**$15,753,482**	**$34,569,981**	**$68,637,120**

[11] In this study, we assumed that West Virginia grapes were equivalent to the kinds of grapes that people eat. Most of those who grow grapes in West Virginia, however, grow kinds that are more palatable for wine and juice making, rather than snacking.

DEFINITIONS

Direct effect: Initial change in an industry or industries resulting from increased demand.

Indirect effect: Changes that result from input suppliers increasing their output and their own input purchases.

Induced effect: Changes in household spending that result from increased payments to workers.

Employment: Number of jobs for each industry. Note that IMPLAN does not distinguish between full-time and part-time.

Labor income: The sum of employee compensation and proprietary (owner) income.

Value added: The sum of employee compensation (wages and benefits), proprietary income, other property income (rents, royalties, dividends), and indirect property taxes (excise and property taxes, fees, sales taxes).

Output: Sales, or dollar value of total production.

The current economic situation contributes most to the fruit farming and retail store sectors, which have 447 and 280 jobs and $23.6 million and $13.2 million in output, respectively (Table 7). Negative labor income in fruit farming is due to unfavorable agricultural production conditions in 2009, leading to unusually high farm owner losses.

Table 7: Current economic situation by sector, top ten sectors

Description	Employment	Labor Income	Value added	Output
Fruit farming	447	-$24,106	$6,671,347	$23,593,098
Retail stores - food and beverage	280	$6,928,094	$11,244,596	$13,242,440
Vegetable and melon farming	108	$79,907	$1,686,114	$5,595,358
Wholesale trade businesses	48	$2,676,866	$4,602,134	$7,266,282
Transport by truck	27	$1,255,852	$1,616,456	$3,362,600
Real estate establishments	13	$103,264	$766,385	$998,928
Food services and drinking places	13	$207,253	$293,104	$589,271
Support activities for agriculture and forestry	11	$218,648	$188,546	$238,612
Monetary authorities and depository activities	6	$291,075	$607,099	$1,195,740
Private hospitals	5	$304,310	$324,836	$642,627
All other sectors	102	$3,712,319	$6,569,364	$11,912,164
Total	**1,059**	**$15,753,482**	**$34,569,364**	**$68,637,120**

4.2.5 *Economic impact: Scenario 1*

Scenario 1 asks: What would be the economic impact if West Virginia farms filled 100% of demand for all fresh vegetables and fruits, during a typical West Virginia growing season? Fulfilling Scenario 1 would require 7,109 additional acres in vegetables and fruits, including 6,264 acres of vegetables, and 845 acres of fruit (Table 4 and Table 5). Scenario 1 results in almost $189.5 million in total economic output and 2,782 jobs (Table 8). This is equivalent to 1,723 additional jobs and $120.8 million additional sales.

Table 8: Economic impact, Scenario 1

Impact type	Employment	Labor income	Value added	Output
Direct effect	2,260	$39,345,572	$70,168,190	$135,791,445
Indirect effect	228	$8,130,930	$14,581,340	$26,208,842
Induced effect	294	$9,241,055	$16,786,225	$27,447,329
Total effect	**2,782**	**$56,717,557**	**$101,535,755**	**$189,447,617**

These effects are distributed throughout the economy, but most significantly affect the retail store and vegetable farming sectors, which see 790 and 739 jobs and $37.4 and $38.4 million in total sales, respectively (Table 9). This is equivalent to an additional 510 and 631 jobs and $24.2 million and $32.8 million total sales, respectively.

Table 9: Economic impact, Scenario 1, for top ten sectors

Description	Employment	Labor income	Value added	Output
Retail stores - food and beverage	790	$19,570,210	$31,763,298	$37,406,730
Vegetable and melon farming	739	$4,868,633	$11,578,598	$38,420,093
Fruit farming	506	$2,618,128	$7,551,274	$26,704,538
Wholesale trade businesses	175	$9,854,234	$16,941,640	$26,749,055
Transport by truck	101	$4,685,300	$6,030,635	$12,545,103
Real estate establishments	44	$355,122	$2,635,586	$3,435,297
Food services and drinking places	44	$721,954	$1,021,009	$2,052,689
Private hospitals	19	$1,109,229	$1,184,047	$2,342,413
Offices of health practitioners	18	$1,166,699	$1,244,932	$1,967,100
Monetary authorities and depository activities	16	$718,004	$1,497,552	$2,949,571
All other sectors	332	$11,050,044	$20,087,184	$34,875,028
Total	**2,782**	**$56,717,557**	**$101,535,755**	**$189,447,617**

4.2.6 *Economic impact: Scenario 2*

Scenario 2 asks: What would be the economic impact if West Virginia farms filled 75% of the demand for all fresh vegetables and fruits, during a typical West Virginia growing season? Fulfilling Scenario 2 would require 5,332 additional acres, of which 634 would be devoted to fruit and 4,698 would be devoted to vegetables (Table 4 and Table 5). Scenario 2 results in 2,389 jobs and $162.5 million in output (Table 10). This is equivalent to an additional 1,330 jobs and $93.9 million in total sales.

Table 10: Economic impact, Scenario 2

Impact type	Employment	Labor income	Value added	Output
Direct effect	1,943	$33,657,197	$60,183,357	$116,661,171
Indirect effect	195	$6,947,717	$12,430,127	$22,367,296
Induced effect	251	$7,902,675	$14,354,906	$23,471,934
Total effect	**2,389**	**$48,507,589**	**$86,968,390**	**$162,500,402**

These effects are distributed throughout the economy, but most significantly affect the retail store and vegetable farming sectors; Scenario 2 results in 678 and 582 jobs and $32.1 million and $30.2 million in total sales, respectively (Table 11). This is equivalent to an additional 398 and 474 jobs and $18.9 million and $24.6 million in output, respectively.

Table 11: Economic impact, Scenario 2, for top ten sectors

Description	Employment	Labor income	Value added	Output
Retail stores - food and beverage	678	$16,808,396	$27,280,754	$32,127,765
Vegetable and melon farming	582	$3,829,980	$9,108,469	$30,223,714
Fruit farming	492	$2,545,038	$7,340,466	$25,959,032
Wholesale trade businesses	150	$8,458,721	$14,542,439	$22,960,970
Transport by truck	85	$3,931,995	$5,061,027	$10,528,095
Food services and drinking places	37	$618,073	$874,097	$1,757,329
Real estate establishments	37	$297,550	$2,208,308	$2,878,370
Private hospitals	16	$948,620	$1,012,604	$2,003,247
Offices of health practitioners	15	$997,752	$1,064,656	$1,682,249
Monetary authorities and depository activities	14	$622,199	$1,297,729	$2,556,001
All other sectors	284	9449265	17177841	29823630
Total effect	**2,389**	**$48,507,589**	**$86,968,390**	**$162,500,402**

5. DISCUSSION

Evaluating the possibility of a local food economy requires understanding its current state. Total current revenue from the fruit sector ($20.7 million) is much higher than total current revenue from the vegetable sector ($5.6 million). This is due in large part to West Virginia's robust apple industry, which ranks tenth in the nation. According to our estimates, the apple industry generates $14.9 million in revenue, which is almost three times that of all of the vegetable production considered in this study. The peach industry in West Virginia is also strong and generates $4.3 million in revenue according to our estimates.

SCENARIO 1: 100% OF THE UTILIZATION GAP

Question: What if West Virginia farmers grew enough vegetables and fruits to meet the fresh seasonal produce needs of all West Virginians?

Percent increase by acreage: 283% increase in vegetables; 15% increase in fruits

Acres required: 7,109 additional acres of vegetables and fruits with most (6,264 acres) in vegetables

New jobs: 1,723with 690 in farming and 510 in food and beverage retail

Additional sales: $120.8 million

SCENARIO 2: 75% OF THE UTILIZATION GAP

Question: What if West Virginia farmers grew enough vegetables and fruits to meet 75% of the fresh seasonal produce needs of all West Virginians?

Percent increase by acreage: 212% increase in vegetables; 11% increase in fruits

Acres required: 5,332 additional acres of vegetables and fruits with most (4,698 acres) in vegetables

New jobs: 1,330 with 519 in farming and 398 in food and beverage retail

Additional sales: $93.9 million

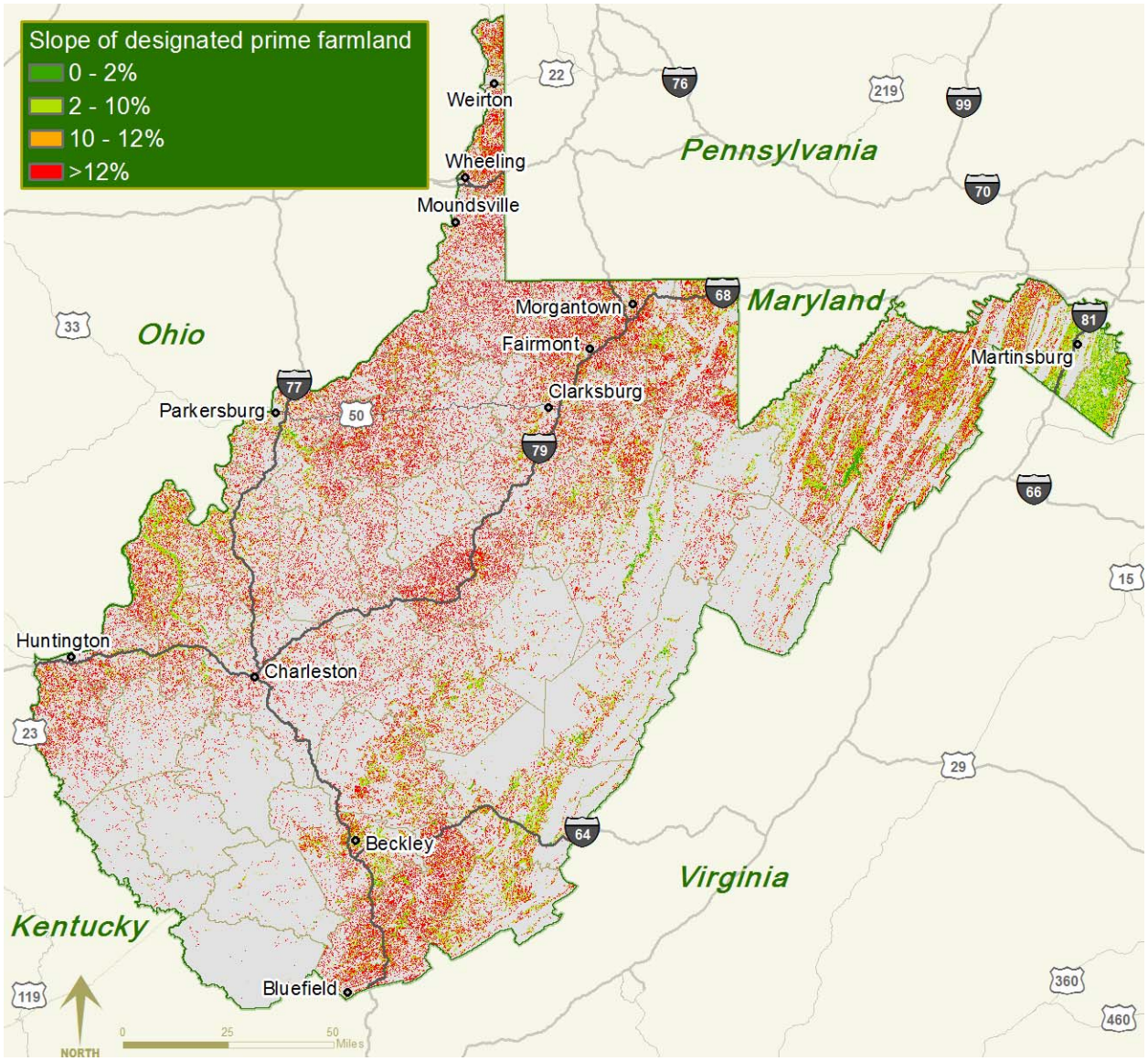
Filling the local shortage for all vegetables and fruits requires an additional 7,109 acres (Table 4 and Table 5). Although 7,109 acres is a small amount of land area—less than 1% of the state's total farmland—it represents a 283% increase in the land area devoted to vegetables in the state and a 15% increase in the land area devoted to fruits. A 283% increase is substantial, and would require many changes, including: the entrance of new farmers into the profession and/or current farmers expanding their production significantly; new equipment, knowledge, and labor; and infrastructure and processing improvements. These types of considerations will be evaluated in the second stage of this project.

Other important considerations for filling any portion of the local shortage include those related to the topography of West Virginia, the Mountain State; the persistence of existing cattle and calf inventory; and the initial viability and coordination of local food in the state. These issues are further discussed below.

5.1 Slope and land use

A potential constraint to increasing agricultural production in West Virginia is the terrain's steep slope: Almost 80% of the state's total land area has a slope greater than 12%. Generally, land with a slope of 0 to 2% can be used for row crops; land that has a slope of 2 to 10% can be used for contour cropping of row crops;[12] land that has a slope of 10 to 12% can be used for pasture and haying; and land that has a slope greater than 12% should only be used for grazing, as it is too steep for the safe operation of most tractors (Bryan, 2011). Figure 17 depicts the slope class of all prime farmland, including federal, state, local, and unique farmland classes. These farmland classes represent the area that could be farmed according to NRCS, as described in Section 3.1. See Appendix C for more detail on farmland classes.

Figure 17: Slope of prime farmland



Source: Prime farmland from NRCS (2011a). Slope from statewide elevation grid, 30 meter from US Geological Survey (2011).

[12] Contour cropping is "using ridges and furrows formed by tillage, planting and other farming operations to change the direction of runoff from directly downslope to around the hillslope" (NRCS, undated).

Almost 2.1 million acres have slopes greater than 10%, although there are 166,500 acres with slopes less than 2%, suitable for row crops. An additional 1.2 million acres are suitable for contour cropping (Table 12).

Table 12: Prime farmland by slope and development status (acres)

Slope class	Undeveloped land	Developed land	Total
0-2% slope	166,500	10,900	177,500
2-10% slope	1,156,200	53,900	1,210,100
10-12% slope	299,700	9,100	308,800
Greater than 12% slope	1,863,700	31,700	1,895,500
Total	**3,486,100**	**105,700**	**3,591,800**

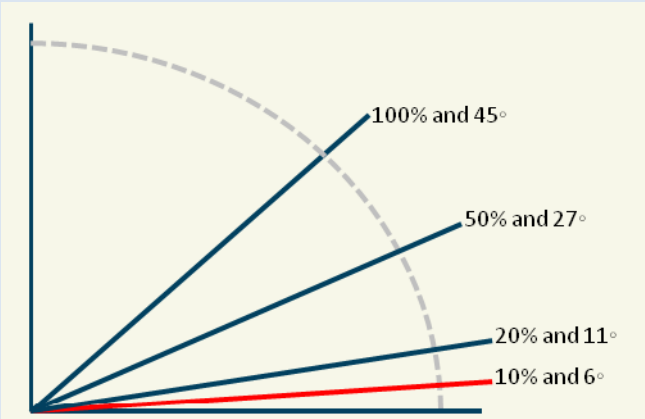
Source: NRCS (2011a) and US Geological Survey (2011). Numbers have been rounded.

Significantly, there are almost 65,000 acres of prime farmland with less than 10% slope that have been developed (Table 12). Although this is a relatively small share—less than 2%—of total prime farmland area, if available for farming, these 65,000 acres could have more than satisfied the amount of land required to grow enough vegetables and fruits to fill 100% of the local shortage of fresh produce. In fact, just the prime farmland in 0-2% slope class that is developed—less than 11,000 acres—would have been enough land to meet 100% of the local shortage. For the future, preserving prime farmland in this lowest slope class is a strategic land management strategy; preserving only small areas of the best kind of agricultural land could have vast implications on the region's ability to grow enough vegetables and fruits for West Virginians.

Small amounts of productive farmland have the capacity to provide a significant amount of vegetables and fruits for West Virginians. For example, Figure 18 shows a close-up of a particularly suitable area of farmland in Hardy County. The dark green colors show prime farmland with slopes of 2% or less. Each yellow box represents a 100-acre plot of land. These six boxes contain 600 acres of prime farmland, which is enough to satisfy 10% of the additional acres required to grow enough vegetables to fill 100% of the local shortage.

MORE ON SLOPE

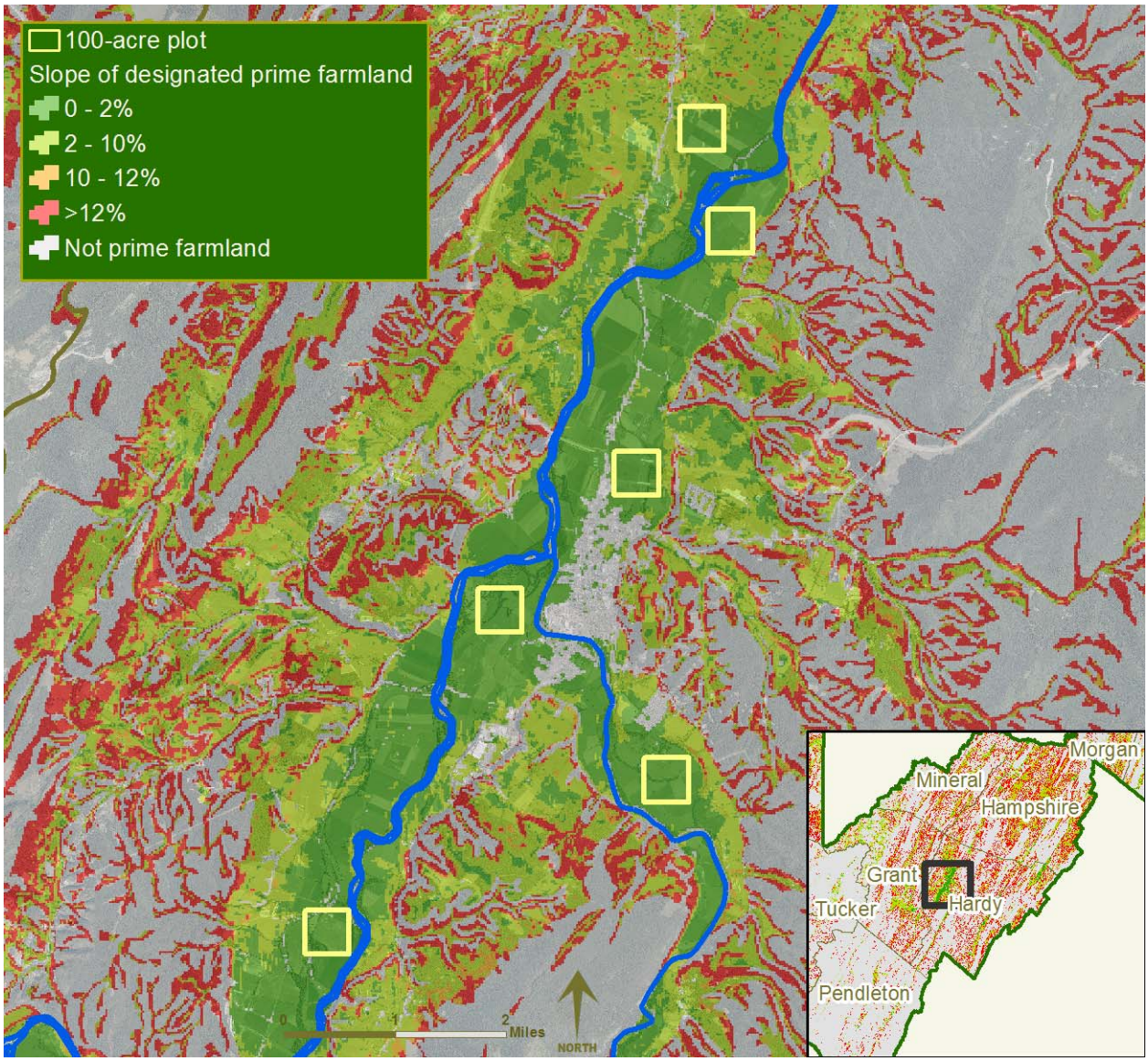
The slope or grade of land is an important factor in evaluating its potential best use. Steeply sloped land is more likely to erode, causing soil and nutrients to wash into streams and rivers, ultimately depleting farmland and clogging waterways with sediment.



As depicted in Figure 17, much of the prime farmland in the state is located on land with slopes of greater than 12%. In farming, it is standard to represent slope as a percent; this can be misleading to those who are unfamiliar with how slope is calculated.

The diagram to the left depicts slope in both degrees and percent. The red line indicates the slope of a line with a 10% slope (or six degree grade).

Figure 18: Slope of prime farmland in Hardy County, West Virginia

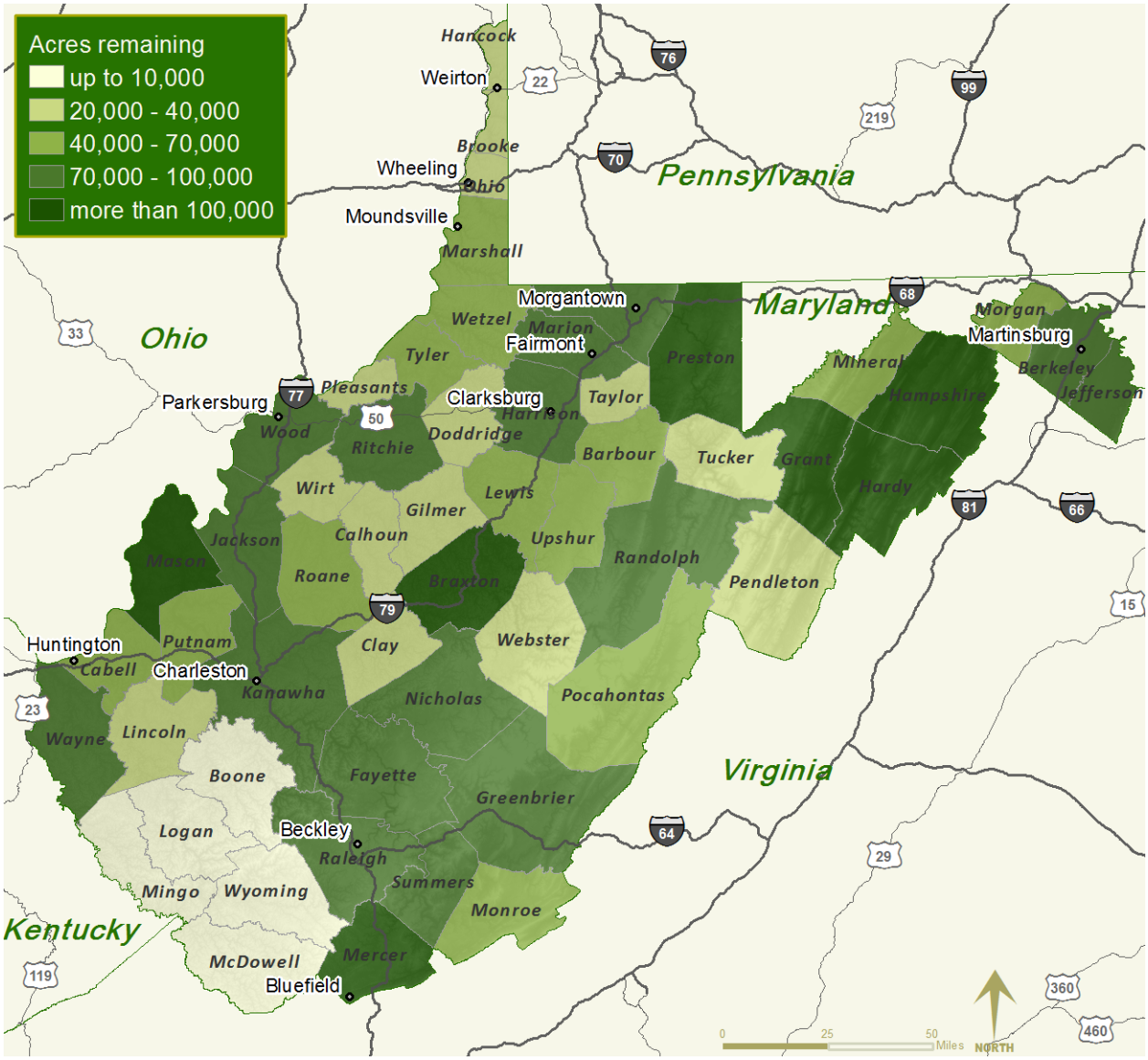


Source: Statewide elevation grid, 30 meter, US Geological Survey (2011).

5.2 Current cattle and calf inventory

Increases in vegetable and fruit production need not be at the expense of the current cattle and calf inventory in the state. With management-intensive grazing, farmland resources could be more efficiently used, resulting in additional available land for the expansion of other forms of agricultural production. Management-intensive grazing requires the planning and facilitated movement of animals onto different sections of pasture at given intervals. The practice results in many environmental benefits, including: reduced soil erosion, better pasture health and diversity, and improved fish and wildlife habitat (Ohio State University Extension Service, undated). Figure 19 shows the amount of prime farmland remaining, if existing cattle were distributed on pasture according to management-intensive grazing principles.

Figure 19: Prime farmland remaining, if cattle were managed intensively



Source: USDA (2007), NRCS (2011a), and NASS (2011b).

We use one cow per two acres, which is a generous amount of land for a management-intensive grazing grass-fed operation. For example, a high intensity cow-calf operation would require two animals (cow and calf) per two acres, and a high intensity stocker calf operation would require one cow per half an acre (Ohio State University Extension Service, undated).

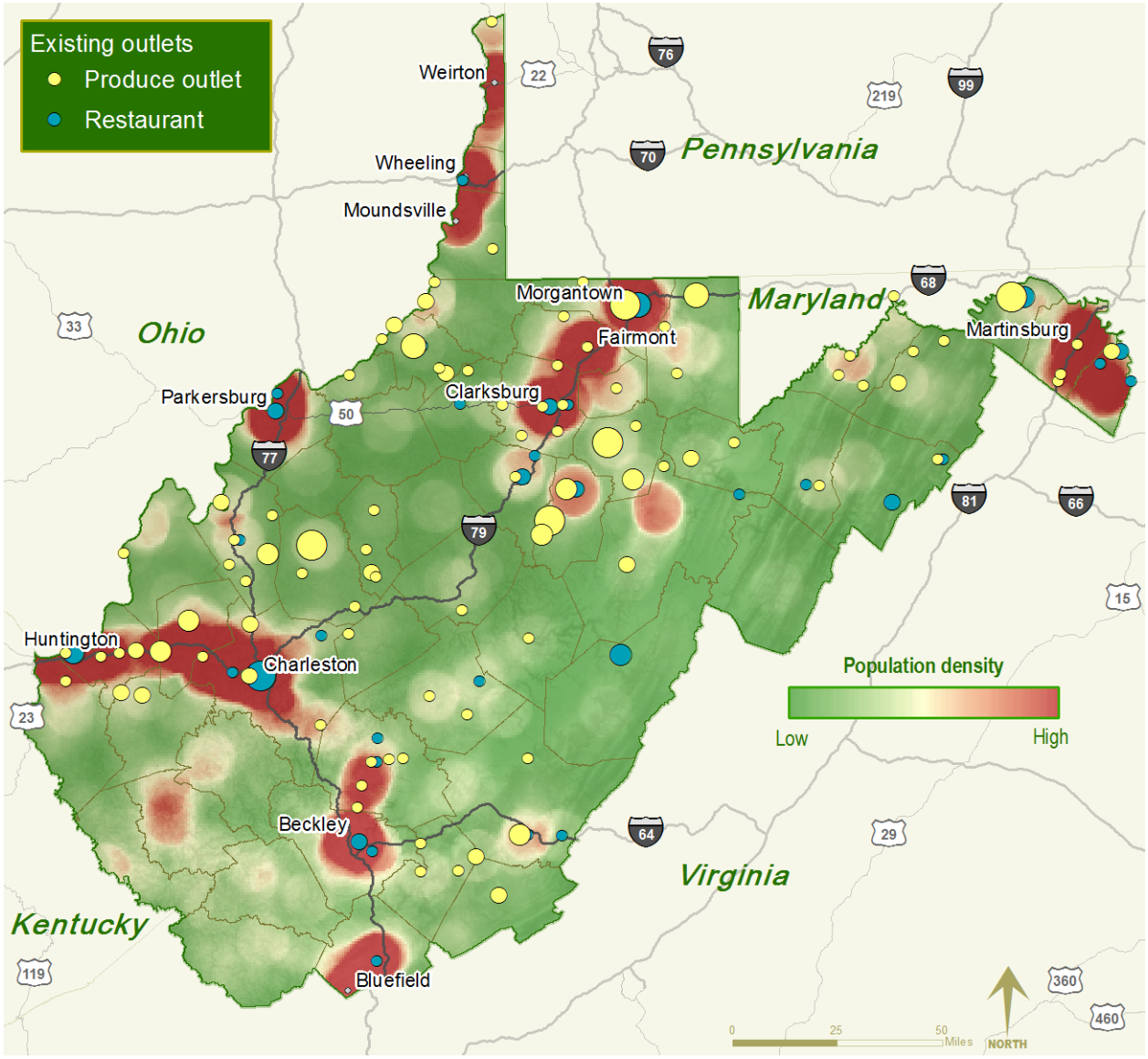
Currently, there are 232,000 acres of prime farmland being used for pasture (NRCS, 2011a and NASS, 2011b). If cattle could be concentrated on existing pasture, there would be additional highly productive land available for vegetable and fruit production. Improved herd management could prove beneficial for the farmer, surrounding environment, and burgeoning agricultural industry.

5.3 Coordinating local food production and consumption

There are a number of existing outlets for local food in West Virginia. One online local food database, maintained by the nonprofit WVFarm2U Collaborative, has documented many of these outlets (www.wvfarm2u.org). Figure 20 depicts outlets in the state that sell locally-grown food. Produce outlets include all farmers markets, CSA arrangements, roadside stands, and farms that engage in on-farm sales of their products. Restaurants include all those that indicate that they use locally-sourced products (WVFARM2U, 2011).

Currently, local food production is somewhat correlated with population density, although there are some aberrations: Bluefield, Weirton, Wheeling, and Moundsville show high population but low availability of restaurants that serve local food and no availability of produce outlets (Figure 20). The southern coalfields region shows some middle-to-high population density, but no produce outlets or restaurants that serve local food. These patterns are indicative of the existing state of the local food economy. See Appendix A for a list a list of organizations that are working with producers and food businesses to help build a stronger local food economy.

Figure 20: Local food outlets and population



Source: WVFARM2U.org (2011b). Note: The size of the dot corresponds to the number of outlets that self-reported.

Figure 20 also depicts a possible constraint to increased popularity of local food: Urban centers usually drive local food demand, but also encroach on neighboring farmland. This trend is especially significant for the easternmost counties in the eastern panhandle of West Virginia. Berkley and Jefferson counties, especially, contain much of the prime farmland in the state with less than 2% slope, but they also face urbanization pressures from Washington, D.C. and its surrounding population hubs. In the future, this pattern may persist for other urban areas in West Virginia, like Monongalia County, for example.

6. CONCLUSIONS AND RECOMMENDATIONS

A local food economy in West Virginia has ample room to grow. Currently, West Virginia farms produce little of the vegetables and fruits that are consumed by West Virginians. Increasing production will affect the economy, landscape, and residents.

The potential economic impact of the vegetable and fruit sectors is small but not insignificant. Fulfilling 100% of the demand for fresh seasonal vegetables and fruits would require 7,109 additional acres in vegetables and fruits (Table 4 and Table 5). This scenario results in $189.5 million in total economic output, 1,723 new jobs, and $56.7million in labor income (Table 8). Total GDP for West Virginia in 2007 was $59.8 billion; even if farmers increased production to fill 100% of fresh seasonal demand, the total economic output would be less than 1% of the state's GDP. This estimate for the total economic impact of increased vegetable and fruit production, however, is quite conservative for the reasons listed in Section 3, and also because we assumed that the farmer would receive farm gate prices for all produce sold. Farm gate prices are low because they do not include any mark-ups that occur along the supply chain from farmer to wholesaler to retailer to consumer.

For example, the farm gate price for apples is $0.19 per pound (Appendix E), whereas the retail price for apples ranges from $1.00 to $2.00 per pound. If farmers were to direct market their produce, selling it directly to consumers, restaurants, and institutions like schools, for example, they would be more likely to receive higher prices and thus higher total incomes. These higher prices need not eliminate cost-constrained consumers from buying locally grown vegetables and fruits. Even if a farmer were to increase her farm gate price by 100%, the price of apples, for example, would still be quite low—less than 50 cents a pound. This type of direct marketing does not come without a cost: It requires that a farmer do the work of marketing and transportation in addition to farming. In order for farming to be an economically viable profession, these types of duties may be required so that the farmer captures the margins that normally go to traditional intermediaries.

In total, West Virginians spend $421 million on vegetable and fruit purchases annually (Meter, 2010); yet if they were purchasing these products from West Virginia farmers, $421 million would stay in the state instead of flowing beyond its borders. These locally spent dollars would re-circulate in the economy and add to the vitality of the region.

Given the potential positive outcome—in terms of dollars, jobs, and other benefits to the community and state as a whole—we make the following recommendations to local and state policymakers and advocates:

1. **Incentivize local procurement of vegetables and fruits.** This could take the form of a local preference sourcing policy for publicly funded institutions like universities and public offices, or financial assistance to schools so that they can use whole (and local) ingredients. This study has demonstrated that the land base exists and that there are significant economic gains from expanded vegetable and fruit production. Increasing access to fresh local vegetables and fruits will benefit the economy and health of residents.
2. **Fund programs that assist farmers with direct marketing.** Direct marketing and intermediated marketing enhances the economic viability of farming, enabling it to be an occupation instead of a hobby.
3. **Investigate possible bottlenecks in local food distribution and infrastructure.** This study only examined the economic impacts and land base required to fill the seasonal fresh produce needs, meaning that we excluded production required for canned, dried, frozen, or juiced vegetables and fruits. This is a significant amount of produce and may present a market niche for West Virginia farmers. For example, the climate of West Virginia is especially conducive to growing grapes for juice. This represents a potential $5.7 million in revenue from the sale of the grapes to make enough

juice to meet the needs for grape juice for all West Virginians. Yet, no commercial-grade juicing facilities exist. Clearly understanding these types of bottlenecks will enhance the profitability and viability of an expanded local food system.

4. **Consider forward-thinking farmland protection policy that preserves flat, prime farmland from encroaching urban centers**. A little prime farmland goes a long way towards providing enough vegetables and fruits for West Virginians. Preserving prime farmland—and especially flat land—from urban and suburban development would enhance food security and the economy for generations to come.
5. **Promote the wise stewardship of existing farmland resources.** Using best management practices like management-intensive grazing can increase the productivity of agricultural land by enhancing the productivity of agricultural land and allowing expanded or additional uses, including vegetable and fruit production.
6. **Understand and build on the unique nature of West Virginia agriculture and food culture.** There are many unique historical and cultural components of West Virginia's food culture that are under-appreciated and may have significant impacts on the economy of the region. For example, the average American requires 94.3 pounds of beef annually, yet a large number of West Virginians substitute venison for beef. Traditional agricultural statistics do not account for the impact and extent of this trend, nor do they account for other forms of self-provisioning including gardens, foraging, and trading.

There are many facets to an expanded local food system. Some of these issues—particularly those related to youth and new farmers, schools and institutions buying local foods, improved access to healthy local food, and farmer viability—will be addressed in later stages of this project. Other relevant themes include food access, implications of increasing animal production, and self-provisioning of vegetables and fruits through personal gardens and social networks. Finally, West Virginia has a history of natural resource extraction, and an expanded local food system would have to address the flux of the quality and quantity of available land. For example, land availability will fluctuate as certain areas are reclaimed and others are used for new mineral and gas extraction.

Agriculture in West Virginia is a significant land use—24% of the state's land area is in farms—yet these farms produce little food that is immediately available for consumption by West Virginians. Except for apples and peaches, vegetable and fruit production is low. An increase in vegetable and fruit production is just one of the many ways in which an expansion of West Virginia agriculture could benefit its economy and residents. It is clear that West Virginia has the land base to satisfy the fresh seasonal produce needs of the population and that significant expansion of the state's food system is a realistic possibility. In the future, additional opportunities such as expanded local marketing of animal products, local processing of food, and local distribution channels must be explored as well.

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APPENDIX A: STATEWIDE AND REGIONAL RESOURCES

West Virginia Department of Agriculture

The West Virginia Department of Agriculture provides various resources for the development of agriculture, preservation of plant and animal health, and protection of the food supply in the state. The most relevant part of West Virginia Department of Agriculture's mission, "to foster economic growth by promoting West Virginia agriculture and agribusinesses throughout the state and abroad" (West Virginia Department of Agriculture, 2002), is implemented by the Marketing and Development Division. More information can be found at: www.wvagriculture.org.

Collaborative for 21st Century Appalachia

The Collaborative for 21st Century Appalachia "is a grassroots organization concerned with preserving the small farm, the environment, and a more traditional way of life" (WVFARM2U, 2011). In addition to hosting the highly popular "Cast Iron Cook-Off," a culinary competition featuring Appalachian cuisine, the Collaborative provides an online list of farmers markets, roadside stands, CSA operations, restaurants that use local food, and other resources by county. Learn more at: www.wvfarm2u.org.

West Virginia University Extension

West Virginia University (WVU) Extension works to connect West Virginians with the knowledge gained through the land grant university system. With extension offices in each of the state's 55 counties, WVU Extension is well positioned to assist the development of an improved agricultural industry in the state. With specialists that focus on poultry, pests, aquaculture, and hay, for example, WVU Extension can assist current and potential farmers in addressing issues that might arise during production. Learn more at: www.ext.wvu.edu.

West Virginia Small Farm Center

The WVU Extension Small Farm Center provides education, leadership, and support to West Virginia's 23,000 farm families. The Center aims to help West Virginia farm families become sustainable by exploiting the local food opportunities found throughout the state and region. It resides at WVU in Morgantown and offers face-to-face farmer training in nearly every county, including the West Virginia Small Farm Conference in March and the Tri-State Farm and Food conference in November. As a part of WVU Extension, the Center works to fulfill its mission "to offer educational programs and research in the areas of community development, agriculture and family and consumer sciences to people and communities." The Small Farm Center also publishes the Small Farm Advocate, a paper for West Virginian farmers. Learn more at http://smallfarmcenter.ext.wvu.edu or call Carrie See at (304) 293-2715.

West Virginia Farmers Market Association

The West Virginia Farmers Market Association (WVFMA) is a statewide organization with the goal of strengthening the viability of farmers markets across the state. WVFMA assists markets with market advertising, collaboration on shared issues like liability insurance, and education for market managers. One of WVFMA's main initiatives is its Buy Fresh Buy Local project, a way to increase brand recognition for West Virginia–grown locally-produced goods. WVFMA is a member of the National Farmers Market Coalition (http://farmersmarketcoalition.org). For more information, visit: www.wvfarmers.org.

West Virginia Food and Farm Coalition

Providing a statewide resource and network, the West Virginia Food and Farm Coalition (WVFFC) is establishing a statewide conversation about the development of local food systems across West Virginia to provide healthy, locally-produced food to all citizens, especially low-income families and other vulnerable groups. They hope to form a government-sanctioned Food Council for the state. WVFCC also provides connections to many of the nonprofit organizations throughout the state. For more information, visit: www.wvhub.org/foodandfarmcoalition.

Center for Economic Options

The Center for Economic Options (CEO) is an independent nonprofit organization that has a long history of developing innovative and replicable model programs. CEO supports people's initiatives to create sustainable jobs for themselves and others and to contribute to their local economies, the environment, and community wealth through business ownership. To do this, CEO targets failed market systems and helps create the missing pieces that help fill gaps and enable the natural flow and vitality of responsible, locally owned enterprise. CEO hosted a conference on farm-to-school in West Virginia in September 2011. For more information, visit: www.centerforeconomicoptions.org.

Central Appalachian Network

The Central Appalachian Network is a network of six nonprofit organizations that focuses on building lasting relationships, developing policy and infrastructure, providing technical and business assistance, and building value-added assets. It works across Kentucky, West Virginia, Tennessee, Ohio, and Virginia to create wealth and reduce poverty while restoring and conserving the environment. One focus is building a resilient local food system. Learn more at: www.cannetwork.org.

Crossroads Resource Center

Although located beyond West Virginia's borders, the Crossroads Resource Center is a nonprofit organization that works with communities and their allies to foster democracy and local self-determination towards a more sustainable future. Ken Meter, the Center's director, substantially contributed to this report. Learn more at: www.crcworks.org.

APPENDIX B: IMPLAN SECTORS

Table 13: IMPLAN sectors

Sector number	Sector name
1	Oilseed farming
2	Grain farming
3	Vegetable farming
4	Fruit farming
5	Tree nut farming
6	Greenhouse, nursery, and floriculture production
7	Tobacco farming
8	Cotton farming
9	Sugarcane and sugar beet farming
10	All other crop farming
11	Cattle ranching and farming
12	Dairy cattle and milk production
13	Poultry and egg production
14	Animal production, except cattle and poultry and eggs
19	Support activities for agriculture and forestry

Source: MIG, Inc. (2009).

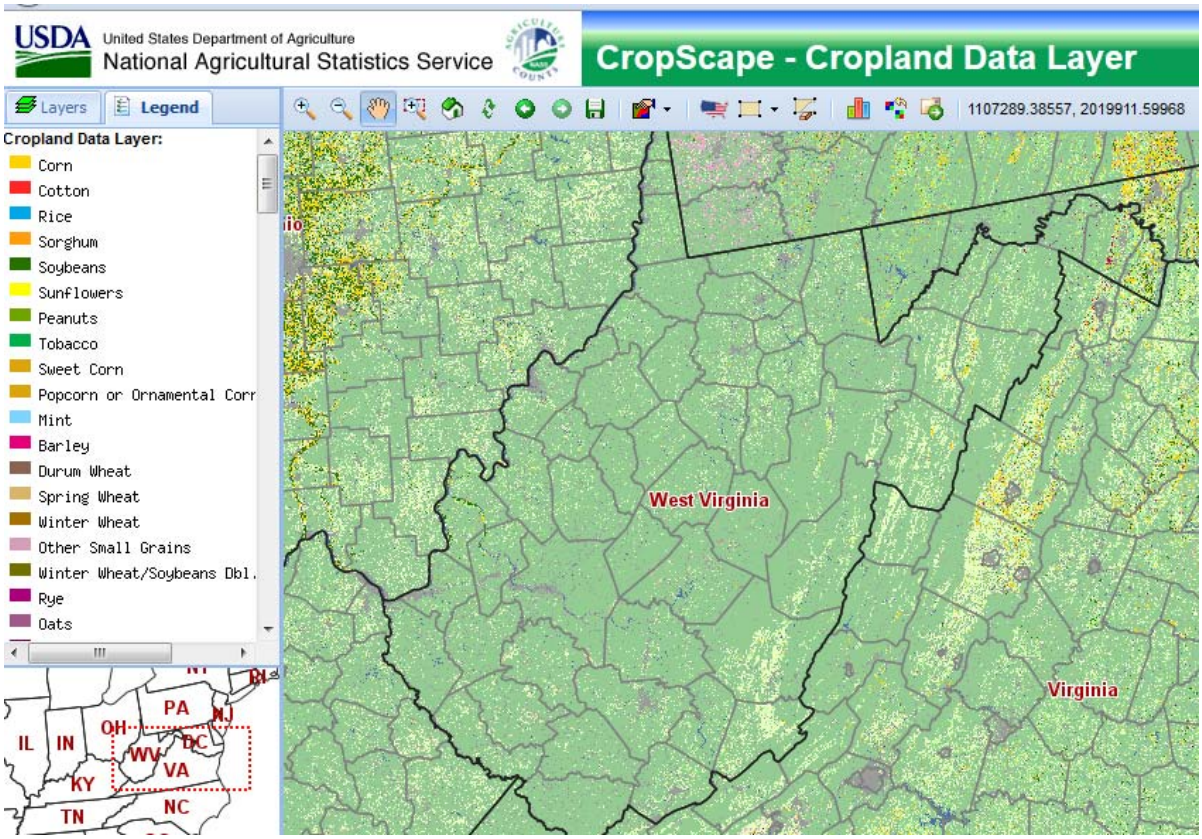
APPENDIX C: FARMLAND DESIGNATION

For the spatial analysis of agricultural land, we relied on two primary datasets: one called "Cropscape," which uses aerial photography and remotely sensed data to evaluate what land is currently being farmed (NASS, 2011b), and a second that describes farmland classes based on government designation of potential land use (NRCS, 2011a). Using both datasets enables us to see all of the land that is farmed or could be farmed.

Cropscape categories

Cropscape data are based on remotely sensed information and aerial photography (NASS, 2011b). Our definition of agricultural land in West Virginia included the following categories from Cropscape: row crops, vegetables, fallow/idle cropland, shrubland, grassland herbaceous, grass/pasture, seed/sod grass, hays, orchards, and pasture. Our definition of farmland excludes the following categories: publicly-owned, forest, open water, developed, or barren.

Figure 21: Cropscape screen shot



Source: NASS (2011b).

Natural Resources Conservation Service farmland class

By federal law, NRCS is required to maintain a current list of all prime and unique farmlands in the country. The prime farmland designation is determined by a variety of factors:

> *Prime farmland is land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops and that is available for these uses. It has the combination of soil properties, growing season, and moisture supply needed to produce sustained*

high yields of crops in an economic manner if it is treated and managed according to acceptable farming methods. In general, prime farmland has an adequate and dependable water supply from precipitation or irrigation, a favorable temperature and growing season, an acceptable level of acidity or alkalinity, an acceptable content of salt or sodium, and few or no rocks. Its soils are permeable to water and air. Prime farmland is not excessively eroded or saturated with water for long periods of time, and it either does not flood frequently during the growing season or is protected from flooding (NRCS, 2011b, 622.04).

Farmland of statewide importance is determined by the West Virginia Department of Agriculture. Generally, these are farmlands with soil properties that do not meet the federal standard, but are still viable for use in agricultural production. Farmland of local importance is determined by local county commissions. NRCS works with both state and local governments to help with the classification of farmland (Delp, 2011). There is another category of farmland—unique farmland, suitable for growing specific crops like rice or cranberries.

APPENDIX D: VEGETABLE AND FRUIT YIELD

Because there is not West Virginia-specific yield data for most vegetables and fruits, we used yield data from neighboring states, where available, and where unavailable, national data.

Table 14: Vegetable yield

Product	Pounds per acre
Asparagus	2,033
Bell peppers	26,333
Broccoli	9,675
Brussels sprouts	14,488
Cabbage	25,000
Carrots	27,000
Cauliflower	12,000
Celery	53,500
Collard greens	7,600
Cucumbers	26,250
Eggplant	26,666
Escarole	19,000
Garlic	13,500
Kale	40,000
Lettuce	30,183
Mushrooms	275,299
Mustard greens	15,000
Onions	28,333
Potatoes	21,000
Pumpkin	15,333
Radishes	10,000
Snap beans	5,433
Spinach	10,900
Squash	23,333
Sweet corn	6,817
Sweet potatoes	19,000
Tomatoes	22,417
Turnip greens	15,000

Sources: NASS (2011d), NASS (2012), University of Kentucky College of Agriculture (2011a), University of Kentucky College of Agriculture (2011b), Oregon State University (2004), USDA (2010), Michigan State University (2002), Purdue University (2009), Welbaum (1993), NSF IPM (2011), and Prince Edward Island Department of Agriculture and Forestry (2003).

Table 15: Fruit yield

Product	Pounds per acre
Apples	18,000
Blueberries	4,200
Cantaloupe	11,667
Cherries	3,250
Grapes	5,000
Honeydew	19,628
Peaches	10,940
Pears	8,189
Plums	8,857
Raspberries	3,000
Strawberries	7,250
Watermelon	24,981

Sources: NASS (2011a), University of Kentucky College of Agriculture (2011a), Robinson et al. (undated), NASS (2007), Rieger (2004), and Gusmini and Wehner (2008).

APPENDIX E: VEGETABLE AND FRUIT FARM GATE PRICES

Because West Virginia–specific price data are not available for most vegetables and fruits, we used price data from neighboring states, where available, and where unavailable, national data.

Table 16: Vegetable farm gate prices, 2007 and 2010

Vegetable	Cents per pound, 2007	Cents per pound, 2010	Percent change
Asparagus	99	122	23%
Bell peppers	33	41	22%
Broccoli	37	35	-4%
Brussels sprouts	35	N/A	N/A
Cabbage	16	17	3%
Carrots	22	26	19%
Cauliflower	34	40	15%
Celery	21	20	-7%
Collard greens	29	N/A	N/A
Cucumbers	25	23	-7%
Eggplant	25	N/A	N/A
Escarole	30	N/A	N/A
Garlic	41	71	72%
Kale	29	N/A	N/A
Lettuce	26	24	-8%
Mushrooms	105	N/A	N/A
Mustard greens	28	26	-8%
Onions	19	17	-14%
Potatoes	11	10	-8%
Pumpkin	11	11	2%
Radishes	30	N/A	N/A
Snap beans	61	60	-2%
Spinach	32	42	30%
Squash	28	31	12%
Sweet corn	23	26	13%
Sweet potatoes	18	20	10%
Tomatoes	35	48	38%
Turnip greens	29	N/A	N/A
Average	**33**	**35**	**10%**

Note: Due to lack of data, prices for turnip greens, radishes, kale, and collard greens are averages of escarole, spinach, collard greens, and lettuce. Source: NASS (2011d).

Table 17: Fruit farm gate prices, 2007 and 2010

Fruit	Cents per pound, 2007	Cents per pound, 2010	Percent change
Apples	19	31	66%
Apricots	42	68	63%
Blackberries	127	167	31%
Blueberries	214	187	-13%
Cantaloupe	15	17	13%
Cherries	111	140	27%
Grapes	44	24	25%
Honeydew	18	16	-44%
Peaches	43	40	-12%
Pears	27	30	-9%
Plums	31	28	11%
Raspberries, black	181	132	-11%
Raspberries, red	136	159	-27%
Strawberries	82	90	17%
Watermelon	11	12	10%
Average	**75**	**79**	**9%**

Sources: NASS (2011a), NASS (2011c), and Oregon State University (2011).