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# Local Food Marketing As a Growth Opportunity for Small Producers in Tennessee

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## Abstract

Various food programs present opportunities for marketing local food in Tennessee. Health-conscious consumers prefer the health benefits of local food over processed foods. To satisfy consumer demand, local restaurants are utilizing the services of local food vendors. Conventional grocery stores are broadening their food aisles to accommodate locally produced foods. Using data collected from an online survey of 250 producers, this research update reports on opportunities for marketing local foods in Tennessee.

**Keywords:** local foods, producers, marketing, online survey, Tennessee

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## Introduction

Local food systems are frequently touted as economic development strategies for rural communities (Rossi, Johnson, and Hendrickson, 2017). Although they are a small portion of the U.S. agricultural sector, their rapid growth has been remarkable in recent years. Trends show that a growing number of consumers purchase more of their foods from alternative food markets than conventional grocery stores. This is due to consumers' interest in food that is fresh and traceable to producers (Rodrigo et al., 2010). The expanding demand for locally produced foods is one of the factors responsible for the rapid growth of local foods in the United States and around the world. According to the Tennessee Department of Health (2015), two out of three Tennesseans live in urban areas, which have higher population density with greater marketing opportunities. In Tennessee, the average distance between some farms in rural areas where food is produced or processed and marketed may be farther than 400 miles. Therefore, this research defines local food as food grown, processed, distributed, and marketed within 500 miles in Tennessee.

## Objective

This research examines the opportunities in local food marketing for Tennessee small producers. The contributions of the local food system (LFS) to the economic growth of small food agribusinesses are analyzed.

## Methodology

Secondary data from the U.S Census of Agriculture, the U.S. Department of Agriculture Economic Research Service, and the National Agricultural Statistics Service provide the background information needed for thisresearch update. To accomplish the objective of this research, a 16-item online survey was used to collect data from 250 local food producers in Tennessee. In addition to collecting socioeconomic data from producers, the survey solicited responses to identify opportunities for marketing local foods in Tennessee. As part of a project funded by theU.S. Department of Agriculture , this research highlights growth opportunities for local foods in Tennessee. Data collected are analyzed using qualitative and quantitative methods. Findings will add to existing literature and shed light on the importance of local food marketing as opportunities for businesses in Tennessee.

## Acknowledgment

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# Consumer Preferences for Direct-to-Consumer Value-Added Agriculture in North Carolina: Preliminary Findings of Consumer Focus Groups

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This research focuses primarily on consumers' willingness to pay for value-added agriculture in North Carolina. In this study, we seek to understand consumers' preferences for various direct-to-consumer outlets—farmers markets, on-farm stores, roadside stands, delivery services, online services, and drive-thru services to enhance overall farm profitability among small-scale farmers in North Carolina. Small-scale farming operations make up the majority share of direct-to-consumer sales and constitute the highest percentage of farmers in the United States. A segment of these farms receiving less than $1,000 in yearly sales and a few with annual sales close to $50,000 suggests that examining contributors to sustained profitability are warranted to ensure their welfare and prosperity. The objectives of the study are twofold: 1) to conduct an exploratory research study of value-added agriculture in North Carolina and to evaluate consumers' attitudes toward and willingness to pay for value-added products and services in North Carolina.

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We address the objectives of the study respectively by 1) reviewing literature and existing projects addressing value-added agriculture and by 2) conducting informal small focus group interviews with consumers from the Western, Piedmont, and Coastal regions of North Carolina. During the months of June, July, and August of 2020, virtual focus group meetings were conducted via Zoom conferencing. Thirty-nine consumer participants were solicited from five major metropolitan areas across North Carolina (Charlotte, Raleigh/Durham/Chapel Hill, Greensboro, Wilmington, and Asheville) were interviewed and asked a series of questions related to their attitudes toward and purchases of value-added products. QDA Miner, a qualitative analytical software program, was used to identify common themes by applying codes associated with developed focus group questions. Common themes found throughout consumer responses included attitudes toward WTP, sales outlet visit experience, interest in participating in delivery services from farm operations, and knowledge of farmers within a 50-mile radius. Findings reveal that consumers within the Wilmington and Charlotte areas are willing to pay for value-added agriculture. Participants had a clear preference for goods sold by farmers at farmers markets, on-farm stores, and roadside stands. Consumers' ability to know and interact with farmers and on the farm play an important role in agricultural products/services in the Greensboro area more than others. Consumers' awareness of farmer proximity was higher in the more densely populated area—Raleigh/Durham/Chapel Hill and Charlotte. However, consumers appear to share mixed views on their preferences for purchasing value-added products/services online but are collectively more willing to participate in drive-thru services.

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# Factors Influencing Fruit and Vegetable Farmers' Willingness to Participate in Market Outlets with a Food Justice Mission: The Case of Fresh Stop Markets

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In the United States, low-income households tend to eat less nutritious diets compared to higher-income households. This could be explained by their challenges associated with food access, their food budget allocation, the time they have to prepare healthier foods, and their perceptions of food affordability.

An example of a market model trying to promote access to local and healthy foods among low-income families is the Fresh Stop Markets (FSMs). FSMs are "pop up" farm fresh markets organized biweekly for 22 weeks during the season at public spaces in food-insecure neighborhoods. FSMs provide local fresh produce to each market's shareholders on a sliding scale based on income. The relative success FSMs have had in addressing the food access needs of low-income communities in Kentucky has increased the interest in the replicability of this model among various stakeholders (e.g., nonprofit organizations, government agencies, community leaders) in other states.

Evaluating farmers' willingness to sell produce through FSMs is an important component for assessing the replicability of the model in other regions of the country, and one that has been limitedly explored in previous literature. We conducted a survey of Tennessee and Kentucky fruit and vegetable farmers to evaluate farmers' willingness to sell produce through FSMs. Preliminary results suggest survey respondents willing to sell produce through FSMs perceive reduction of marketing efforts, ability to plan before production season, and to sell to low-income families as the most advantageous characteristics of FSMs. Additionally, survey results suggest more educated farmers, with annual gross on-farm revenue below $25,000, selling produce through farmers' markets, who run on-farm programs to educate the community about sustainable agriculture and food systems, would be more willing to sell produce through FSMs.

**Keywords:** food justice, Fresh Stop Markets, fruits and vegetables, willingness to sell, farmer survey

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# Economic Contributions of the Local Food Systems in Tennessee

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## Abstract

Local food systems (LFS) are often viewed as development pathways for local economies due to their ability to create a multiplier effect in an economy through a significant contribution to output and job creation. There is limited information on these impacts for Tennessee. Therefore, this study measures the gross economic contributions of Tennessee's local food system using IMPLAN's input-output model. Results show that LFS is a crucial component of Tennessee's economy with an estimated total economic contribution of $37.5 billion. The region's local food system directly employs more than 99,000 people and has an income multiplier of 2.56 and a value-added multiplier of 2.06.

**Keywords:** economic contributions, local food system, farmers markets, IMPLAN, multipliers, Tennessee

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## Introduction

There is a growing interest in the promotion of local foods due to consumers' increasing demand for local produce, powered by the belief that the purchase of local food options are healthier and more supportive of the local economy. An indication of rising consumer demand is the tremendous growth in the sale of local foods through direct marketing channels. According to the U.S. Department of Agriculture (USDA), sales from direct marketing channels for local foods increased from $511 million in 1997, to $1.2 billion in 2007, to $6.1 billion in 2012, and to $8.7 billion in 2015 (Low and Vogel, 2015), and the demand for locally grown food continues to grow at a rapid rate, representing a crucial market opportunity for local food producers (Pinchot, 2014). Some of the motives for consumers to buy local food items are concerns for food safety, lower prices, and the perception that local foods are of higher quality in terms of freshness and taste (Ekanem et al., 2016). The perception that local foods enhance the local economy, benefit the environment, and help to build social capital are additional reasons consumers shop local (Brown and Miller, 2008).

Local food systems are localized food production on a small scale, with direct-to-consumer sales made through market channels, such as farmers markets, Community Supported Agriculture (CSA), and intermediate sales to local grocery stores, restaurants, and organizations, such as schools, prisons, and hospitals. Promoting local food systems is a popular focus of communities across the United States. For example, the USDA identified local and regional food systems as one of its pillars of agriculture and rural economic development. Between 2009 and 2015, the USDA invested over $1 billion in more than 40,000 local and regional food system projects. This investment proves that measuring and understanding the contributions of these investments is crucial (U.S. Department of Agriculture, 2015; Vilsack, 2016; Deller et al., 2017). Local food systems are viewed as development pathways for local economies, due to their potential to keep a good percentage of money in the local economy and their ability to create more jobs. Several studies have also examined the economic contributions of local food systems in various states; however, there is limited information on these impacts for Tennessee.

Moreover, most of the evaluation of local food system is limited to one component of this system, such as food hubs or farmers markets. Therefore, there is a need to evaluate the contribution of the local food system on all possible sectors, including producers, processors, and distributors. This article provides a comprehensive approach to evaluating the economic impact of local food systems in Tennessee.

## Literature Review

The word "local" implies "from or in a nearby location"; however, there is no general agreement on the definition of "local foods." For some, the term has a geographical connotation; for others it is defined by the market arrangement. In the 2008 Food, Conservation, and Energy Act (2008 Farm Act), the U.S. Congress defined local food as food within 400 miles of its production site or within the state in which it is produced. This definition emphasizes geographical proximity (Hands and Martinez, 2010). Alternatively, local foods are defined based on market channels, which include

direct-to-consumer arrangements, such as farmers markets (Rossi et al., 2017). For this article, local food is defined as food produced, processed, and distributed within the article area, including agricultural produce (fruits and vegetables, dairy, meats and other value added products) sold directly to consumers or through short supply chains. A short supply chain implies more than short distances between production and consumption; it indicates fewer middlemen to no intermediary between the producers and consumers. Venues for direct farmer-to-consumer marketing of local food includes farmers markets, community-supported agriculture (CSAs), and farm stand operations" (Martinez et al., 2010; Ekanem et al., 2016).

Farmers markets are the poster child for local food systems, and they are common areas where several farmers gather regularly to sell an array of fresh fruits, vegetables, and other farm products directly to consumers (Brown and Miller, 2008; Martinez et al., 2010). Since 2007, the number of farmers markets in the United States has grown by more than 180%, and the number of food hubs has increased by 288%. Also, direct sales between farmers and consumers have grown significantly from $400 million in 1992 to $2.8 billion in 2017. Similarly, CSAs are programs in which many consumers commit to sharing the risks and benefits of food production with a grower (Holcomb et al., 2013). These two examples of local food systems are commonplace in the marketing of local foods.

Import substitution is a means through which expanding local food systems can impact the economy. When consumers purchase locally produced food items, sales are more likely to accrue to residents and small businesses within the region, which will generate additional economic impacts through income and employment growth within the study area (Swenson, 2009). Existing literature has proven that locally grown foods have positive impacts on local economic activity through localization of processing activities. In response to this trend, local and federal government policy makers have shown interest in understanding how the local food system contributes to the local economy and in developing strategies that bolster local food systems (Low and Vogel, 2015).

Some studies assessed the economic impact of a specific component of the local food system. For example, Henneberry et al. (2009) estimated the impact of farmers markets on Oklahoma's economy. They showed that farmers markets generate $31.5 million in gross sales and 140 jobs. An assessment of the impact of the farmers market in West Virginia (Hughes et al., 2008) discovered that farmers markets created a total of 119 jobs, doled out $2.4 million in output, and contributed $1.5 million to the Gross State Product. Jablonski et al. (2016) also employed the opportunity cost framework to evaluate the economic impacts of food hubs on regional economies. Food hubs were found to positively impact the state of New York, with a gross output multiplier of 1.75 and an employment multiplier of 2.14.

Several of the research studies reviewed showed that the local food system significantly contributed to local economies. An assessment of Knoxville's regional foodshed system revealed that the agricultural sector's total industrial output multiplier is estimated at 1.51. In other words, for every dollar spent on food produced within Knoxville, Tennessee, an additional 51 cents in economic activity is generated throughout the region. The employment multiplier is 1.49, which means that for every job created as a result of transactions with local foods, an additional 0.49 jobs

are created in other industries throughout the region. The study found that primary agriculture in Knoxville employs 6,000 people and adds an additional $82 million to the economy (Hellwinckel et al., 2014). Also, Otto and Varner (2005) used the IMPLAN input-output model and found that farmers markets in Iowa, directly and indirectly, generated gross sales of $31.5 million. Hughes et al. (2008) used the IMPLAN model and producer surveys to show that the direct sales at farmers markets in West Virginia generate $1.7 million and an additional $2.4 million in output. Connor et al. (2008) estimated that the food system in Michigan contributes more than 18,000 jobs and an output of $200 million. Similarly, Cummings et al. (1999) estimated that farmers markets in Ontario, Canada, generated 800 additional jobs.

## Methodology

To understand the economic contribution of local foods to local economies, the IMPLAN's based input-output model was used to analyze its economic contribution**.**

*An economic contribution analysis* quantifies the effects of an existing business, industry, or sector in terms of jobs, labor income, and value-added. Economic contribution analysis is different from *economic impact analysis*. An economic impact analysis measures the changes in spending in a specified region due to a change in economic activity, such as the closing of industries or the establishments of a project or food hubs. The economic contribution of Tennessee's local food system was estimated in three different ways: direct, indirect, and induced effects.

Direct effects are the initial changes in final demand in terms of industry sales/output, employment, and labor income dollars.

Indirect effects stem from input purchases. To increase production, the local food sector must purchase more inputs—these are the first round of indirect effects. Also, the firms that supply these inputs must now purchase more of their own inputs to meet the new demand for their output—these are the additional rounds of indirect effects.

Induced effects are generated from employees of the local food sector spending their wages. When those workers spend their income, it generates the first round of induced effects. These expenditures increase demand for businesses, generating additional rounds of induced effects. Total effects are the sum of direct, indirect, and induced effects. They are the total of transactions attributable to the direct activity that this study measures (Leontief, 1987; McFadden et al., 2016). Hypothetically, in the local food systems, if a sector (Sector P) generates x amount of sales, these sales are the direct effects. Sector P will purchase more inputs from Sector Q to produce more. Sector Q will benefit from the increased business; thus, the value of the increased sales are indirect effects. When workers in Groups P and Q spend the earnings attributable to Group P's x amount of sales to buy goods, the value of these goods is the "induced" effects.

Multipliers indicate the change in economic activity due to a 1-unit direct change. They summarize the total impact, and can be expressed in terms of employment, output, or income. A total output

multiplier is a way to indicate the extent of linked economic activity within a local or regional economy. It is calculated as:

$$\frac{(\text{direct} + \text{indirect} + \text{induced effect})}{\text{direct effect}} = \text{total output multiplier}$$

There are three types of Multipliers: the Output Multiplier, Employment Multiplier, and Income Multiplier.

All of the components mentioned above are estimated using the IMPLAN's input-output model. The input-output model (IO) is an economic model that quantifies and tracks backward linkages related to economic activity between industries and institutions. It is used to track the flow of money from one entity to another. It involves large tables of data that describe the linkages among industries, households, and government entities in a region. The output of one industry will appear as the input of the others (Leontief, 1987). The IO tables for this article are based on secondary data sources, which are national averages from the U.S. Department of Agriculture Census of Agriculture, U.S. Department of Labor Statistics, and other sources contained in the IMPLAN database. These linkages take the form of an expenditure function, which specifies how different inputs are assembled to produce a unit of output.

## Results

The estimated total effects of the local food system in Tennessee is $37.5 billion (Table 1), implying a total output multiplier of 1.47. This means that every $1 spent on the Tennessee local food system generates an extra 47 cents in the economy. The total impact of $7.7 billion dollars represents the indirect effects of the local food system, which represent the input or supply transactions that support the local food production. About $4.29 billion dollars was approximated as the induced effect that stems from the workers' spending on goods and services within the region. Figure 1 also shows the direct, indirect, and induced effect of the local food system in terms of employment, labor income, and value added.

**Table 1.** Economic Contribution of Tennessee's Local Food System

| Impact | Employment | Labor Income | Value Added | Output |
|---|---|---|---|---|
| Direct | 99,689.54 | $2,691,301,805.68 | $6,123,692,219.20 | $25,556,954,934.05 |
| Indirect | 41,430.66 | $2,676,626,473.03 | $3,979,285,727.93 | $7,740,982,712.69 |
| Induced | 27,306.38 | $1,526,969,241.03 | $2,534,756,185.30 | $4,292,906,910.64 |
| Total | 168,426.57 | $6,894,897,519.75 | $12,637,734,132.42 | $37,590,844,557.37 |

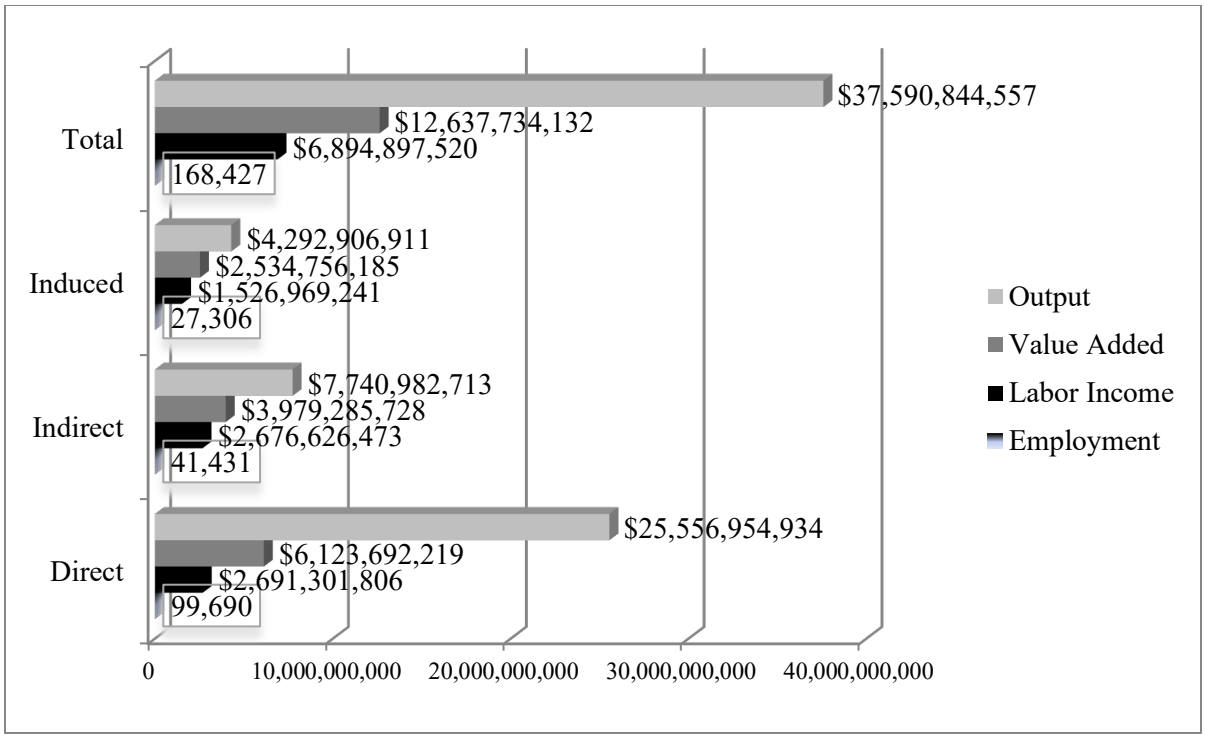


**Figure 1.** Economic Contribution of Tennessee's Local Food System

Table 2 shows the multiplier associated with each of these variables. An income multiplier of 2.56 implies that every $1 spent on local foods within the Tennessee region generates an additional $1.56 in labor income. The region's local food system directly employs more than 99,000 people and has an employment multiplier of 1.69. In other words, for every job created by the Tennessee local food system, an additional 0.69 jobs are created in other industries throughout the region. The value-added multiplier of 2.06 shows that every $1 spent on local food consumption in Tennessee will provide $1.06 additional value to products in other industries affected by local food sales (Figure 2).

**Table 2.** Tennessee's Local Food System's Income, Employment, Value-Added Multipliers

| **Multiplier** | **Value** |
|---|---|
| Output multiplier | 1.47 |
| Income multiplier | 2.56 |
| Employment multiplier | 1.69 |
| Value-added multiplier | 2.06 |

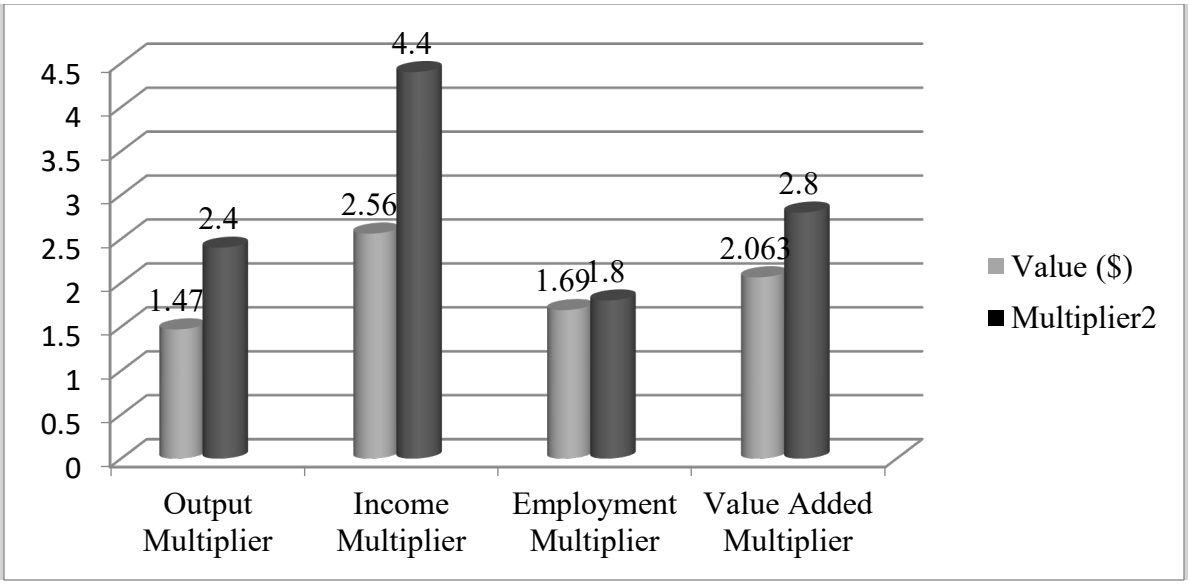


**Figure 2.** Tennessee's Local Food System's Income, Employment, and Value-added Multipliers

## Conclusion

This article shows the economic contributions of the local food system in Tennessee. Local Food System is a crucial component of Tennessee's economy, with an estimated total economic contribution of $37.5 billion. The region's local food system directly employs over 99,000 people, contributes $2.69 billion to labor income, and over $6 billion in value-added. This article also shows the extent of linked economic activity within the local economy through an economic multiplier. The total output multiplier of 1.47 indicates that for every $1 spent in the local food industry, an additional 47 cents is added to the economy. The region's local food system has an employment multiplier of 1.69. In other words, for every job created by the Tennessee local food system, an additional 0.69 jobs are created in other industries throughout the region. The value-added multiplier of 2.06 shows that every $1 spent on local food consumption in Tennessee provides $1.06 additional value to products in other industries affected by local food sales.

Since the local food system has significant positive contributions to the total state output, employment, and labor income in Tennessee, it can be a strong avenue for further economic development in the region of Tennessee. Future research should explore a unanimous and strengthened framework in evaluating the local food system to model a method that applies to several definitions and interpretations of the local food system.

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# Outreach Efforts at Standardizing Farm to Institution Reporting Metrics

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## Abstract

The National Farm to Institution Metrics Collaborative launched an outreach project to develop standardized metrics for tracking the farm impacts of farm-to-institution purchases in 2019. This report describes the project's objectives, outreach efforts, and future direction.

**Keywords:** local foods, farm to institution, farm to school

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## An Effort to Create Standard Reporting Metrics

In recent decades, practitioners have identified anchor institutions in the United States as strategically important purchasers of local foods. These institutions include K-12 schools, colleges/universities, health care facilities, workplace cafeterias, correctional facilities, food banks, and senior care facilities. While stakeholders refer to such sourcing efforts as "farm-to-institution" (FTI) programs, 1) institutions typically use intermediaries to buy local foods and 2) not all food that institutions consider "local" use ingredients from proximate farms. Standard metrics can increase the consistency and transparency in FTI program reporting. They are preferable to ad hoc approaches because they can 1) support the comparison, aggregation, and evaluation of FTI programs across sectors and regions and 2) reduce the transaction costs of distributors in tracking product attributes.

To address this issue, the National Farm to Institution Metrics Collaborative (the Collaborative) launched an initiative to develop standardized metrics for classifying the farm impacts of FTI purchases. The Collaborative consists of nearly 100 FTI organizations, institutions, and agencies from across the United States that share information on data collection efforts, emerging market trends, and evaluation techniques. The project commenced in 2019 via a cooperative agreement supported by the U.S. Department of Agriculture's Agricultural Marketing Service. The project was guided by a Pilot Steering Committee of 11 members representing government agencies, universities, and nonprofit FTI organizations with wide-reaching networks.[1]

The project's goal was to create an integrated suite of farm impact indicators that can provide greater details about local food purchases than a "local/non-local" binary indicator variable. The Committee designed the metrics so they can be applied to item-level invoice data. For each food purchase, the metrics provide insight into 1) the supplier's business type and ownership structure, 2) whether the food product used ingredients from local farms and whether they can be traced to specific farms, 3) the product type, and 4) the market channel that the institution used. The Committee did not propose standard definitions for "local food" or values-based criteria, like "good food" or "real food," so that the metrics can be used as widely as possible.

## Outreach Strategy and Next Steps

The project's first outreach presentation occurred at the 2020 National Good Food Network Conference on March 10. While attendees provided positive feedback at the workshop, the pandemic began abruptly disrupting FTI markets as the week progressed. However, despite the distress that the pandemic imposed on FTI markets, the project has remained relevant due to the

[1]The Pilot Steering Committee members include Lilian Brislen (Food Connection at the University of Kentucky), Julie Brewer (USDA Food and Nutrition Service), Ashley Chaifetz (USDA Food and Nutrition Service), Hannah Leighton (Farm to Institution New England), Colleen Matts (Michigan State University Center for Regional Food Systems), Colleen McKinney (Center for Good Food Purchasing), Jeffrey O'Hara (USDA AMS), Emma Sirois (Health Care Without Harm), Lacy Stephens (National Farm to School Network), Nora Stewart (Community Health Improvement Project), and Tina White (Real Food Generation).

continued demand of consumers for local foods and increased interest in improving traceability in the food supply chain.

To support the dissemination of the metrics, the committee created a website that includes the following: 1) two video tutorials, 2) a summary document of the metrics, 3) a question-and-answer section for background context, 4) a guide that helps institutions implement the metrics, 5) a tracking template and reporting calculator, and 6) a background report that describes how the committee developed the metrics (Brewer et al. 2020). Committee members presented the metrics at virtual workshops and webinars throughout the fall of 2020, and plan to continue doing so in 2021. USDA staff has presented the project findings to active Local Food Promotion Program grantees and also plan to do so with Farm to School grantees.

The project committee has received feedback from dining service providers expressing interest in developing standard metrics for local food purchases. So, the project committee is seeking institutions and distributors that will pilot and ground-truth the metrics in order to assess whether they can be deployed more widely. This step is important because institutions need to demonstrate a commitment to these proposed metrics before intermediaries implement tracking systems. In this vein, the metrics may assist the "Anchors in Action" national cross-sector collaboration between Health Care Without Harm, the Real Food Challenge, and Center for Good Food Purchasing. This multiyear collaboration is seeking to align standards and food tracking systems for numerous criteria across municipal governments, hospitals, schools, and universities.

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# Profitability and Financial Efficiency of Small-Scale Indigenous Chicken Egg Producers in Kenya

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## Abstract

This study examined the profitability and financial efficiency of small-scale indigenous chicken egg farmers. Farm-level data were analyzed using descriptive statistics and farm budget models. Results revealed that small-scale indigenous chicken egg enterprises were profitable, as indicated by the average net farm income and percentage profit measures. However, farmers were far from efficient in using financial resources, with the majority operating within the marginal efficiency levels. The cost structure indicated that feeds, day-old chicks, transportation, and water usage were the critical cost items accounting for more than 80% of the production cost.

**Keywords:** Indigenous chicken, egg production, financial efficiency, profitability, small-scale

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## Introduction

Poultry is the most abundant livestock species in Kenya, and indigenous chickens are the most popular, with other poultry species constituting 25% of the current total estimated population of 32 million birds (MOLD, 2015). Over the years, the poultry sector has become an essential livestock enterprise (Nyaga, 2007; Graduate Farmer, 2017). Despite the lack of defined or measurable indicators for its contribution to the Gross Domestic Product, Kenya's poultry sector has been recognized as an essential economic tool for rural poverty alleviation and household food and nutrition security (Magothe et al., 2012). The sector is constrained by various challenges, including the high cost of inputs, loss of genetic diversity; low productivity; fluctuations in production and diseases; and poorly organized marketing structures (Graduate Farmer, 2017). The focus here is to examine the profitability and financial efficiency of small-scale indigenous chicken egg farmers and provide practical tools for decision makers and farmers to apply production practices to improve the performance of small-scale indigenous chicken egg production enterprises in Kenya.

## Methods

### *Measures of Farm Profitability and Financial Efficiency*

This study investigates the profitability and financial efficiency of indigenous chicken egg farms in Kenya. The analysis assumes a small-scale farm operation with a 200-bird flock, 30-month production period (with the production of eggs starting when the birds are 23 weeks old), 80% egg-laying percentage, 20% mortality rate, 50:50 ratio of personal and borrowed capital at 7% interest rate, and utilizing family labor to manage the day-to-day farm activities. Profitability is measured using net farm income from operations and operating profit margin ratio. Following Doye (2017), financial performance is measured using net farm income from operations and a series of financial ratios, including operating profit margin, operating expense, depreciation expense, farm interest expense, net farm income from operations, and gross and fixed ratios.

### *Data and Sampling Procedure*

Data for the study are from a face-to-face survey of 303 small-scale poultry producers from nine counties: Kiambu, Kilifi, Kirinyaga, Kitui, Lamu, Machakos, Murang'a, Nakuru, and Nyandarua. Farmers were selected using a multistage sampling procedure, which involved identifying a ward in each of the nine counties, purposively selecting four communities from each ward, and, finally, using snowball sampling to select up to 58 small-scale poultry farmers from each county. Before data collection, the questionnaire was pretested in three subcounties (Kasarani, Githunguri, and Makuyu), and the results were used to fine-tune the final questionnaire. The survey, administered between May and July 2019, collected farm-level characteristics and socioeconomic and demographic data of the farm operator. Two hundred eighty-two (93.1%) small-scale farmers (out of the 303 farmers interviewed) indicated rearing indigenous chickens for egg production, and they represent the sample size. All procedures performed involving human participants received IRB

approval. Survey data were supplemented with focus group discussions that offered additional insights.

## Results

*Descriptive Analysis of Survey Responses*

Socioeconomic Characteristics

Survey responses show nearly gender parity among the respondents, with a slight majority (54%) being men, and a majority (60%) of the respondents are below 40 years of age. The study found that 31% of respondents have attained basic primary education, 44.8% have a secondary school education, and 19.8% achieved tertiary education, while 2.5% reported obtaining a university education. Only a small percentage (1.9%) had no formal education. Descriptive statistics show that most of the target population is literate and can be trained on innovations. For marital status, 81.7% of the respondents were married, 16.4% were single, and 1.9% were separated. The responses suggest that the sample farmers have a good family structure that can constitute a stable workforce.

**Table 1.** Respondents' Socioeconomic Characteristics

| Variable | Description | Frequency | Percent |
|---|---|---|---|
| Age | Less than 40 years | 168 | 59.5 |
| | More than 40 Years | 114 | 40.5 |
| Gender | Male | 152 | 53.8 |
| | Female | 130 | 46.2 |
| Education | No formal education | 5 | 1.9 |
| | Primary | 87 | 31 |
| | Secondary | 126 | 44.8 |
| | Tertiary | 56 | 19.8 |
| | University | 7 | 2.5 |
| Marital status | Single | 28 | 9.8 |
| | Married | 249 | 88.3 |
| | Separated | 5 | 1.9 |
| Household head | Male | 221 | 78.2 |
| | Female | 61 | 21.8 |
| Year of experience | Less than 1 year | 13 | 4.7 |
| | 1–5 years | 49 | 17.4 |
| | 6–10 years | 18 | 6.4 |
| | 11–15 years | 188 | 66.8 |
| | Above 16 years | 13 | 4.7 |

**Table 1. (continued)**

| Variable | Description | Frequency | Percent |
|---|---|---|---|
| Years of residence | More than 1-year | 218 | 77.4 |
| | 1-year of residence | 28 | 10.1 |
| | At least 6-month | 34 | 11.9 |
| | Less than 6-month | 2 | 0.6 |
| Other sources of income | Agriculture | 212 | 75.3 |
| | Non-farm related business | 44 | 15.5 |
| | Salaried employment | 26 | 9.2 |

The study established that most households (78.2%) are male-headed compared to 21.8% female-headed. The majority (77.4%) have lived in the locality for more than one year, 11.9% lived for six months, 10% for one year, and 0.6% had lived in the locality for less than six months. These results show that most farmers in the sample have permanent residents in the study area, a factor that is favorable for poultry farming. When asked about other sources of income, 75.3% of the respondents indicated that they were involved in other agricultural-related activities besides poultry, 15.5% were involved in non-agricultural income-generating activities, and 9.2% were engaged in salaried employment. These findings imply that the majority of the respondents rely on agriculture for household income.

*Farm Production, Marketing, and Financing*

Figure 1 presents the labor provision for the small-scale indigenous chicken enterprise, indicating that indigenous chicken egg farmers rely primarily on family labor (Figure 1). During the focus group discussions, farmers indicated that the number of chicken kept and returns did not justify hiring workers. It was noted that some farmers combine hired labor for other enterprises like dairy farming to take care of indigenous chicken farming.

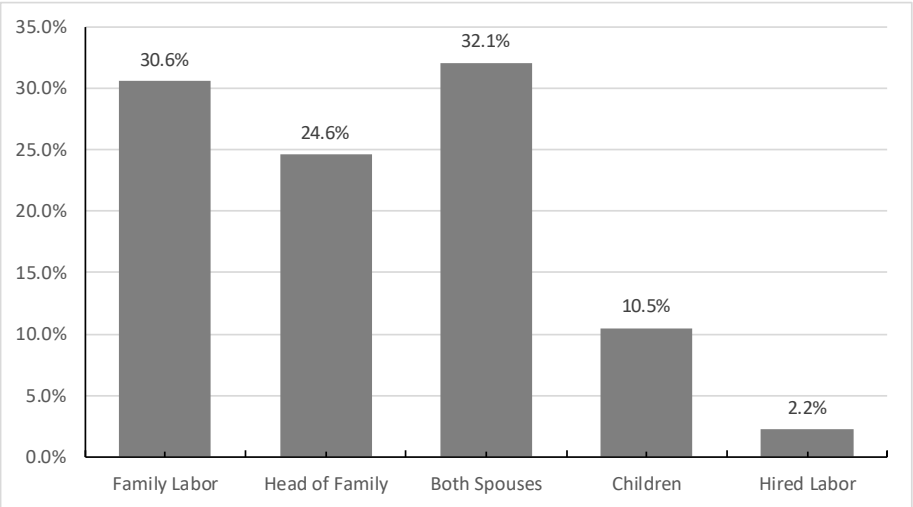


**Figure 1.** Labour Provision

Table 2 presents a cross-tabulation of the findings on flock size and method of production. Results show that most (54%) of the farmers keep a flock size of 50–100 birds. Focus group discussions indicated that the reasons for keeping chickens dictates flock size. If the reason is for commercial purposes, flock size is usually above 100 birds. However, if the reason is for household consumption, the flock size is typically small, ranging from 10–50 birds. Farmers explained that due to the small size of land, high production costs, and competitions from exotic chicken, especially broilers that mature very fast, the indigenous bird flock size keeps reducing over time.

**Table 2.** Flock Size and Method of Production

| | **Intensive Production** | **Complete Free-range** | **Semi free-range** | **Total** |
|---|---|---|---|---|
| 1–50 | 1.0% | 11.7% | 13.0% | 25.7% |
| 50–100 | 26.7% | 8.3% | 19.0% | 54.0% |
| 100–200 | 6.3% | 4.7% | 1.0% | 12.0% |
| Above 200 | 3.0% | 0.0% | 5.3% | 8.3% |
| Total | 37.0% | 24.7% | 38.3% | 100.0% |

The breakdown in Figure 2 shows that farmers use different types of feeds. Leftover food (65.3%), commercial feeds (62%), and kitchen refuse constitute the major feed types. Focus group discussions revealed that animal feed shops are the primary source (62.2%) of purchased commercial feeds and that the majority (86%) of the feeds used are concentrate. Other significant production inputs include veterinary drugs (82.6%), vaccines (63.8%), feeding equipment (57.4%), water (46.8), chemicals (28.5%), and electricity (20.6%). When asked about the survival rate at the farm level, most of the respondents (51.3%) reported rates above 50% (Figure 3).

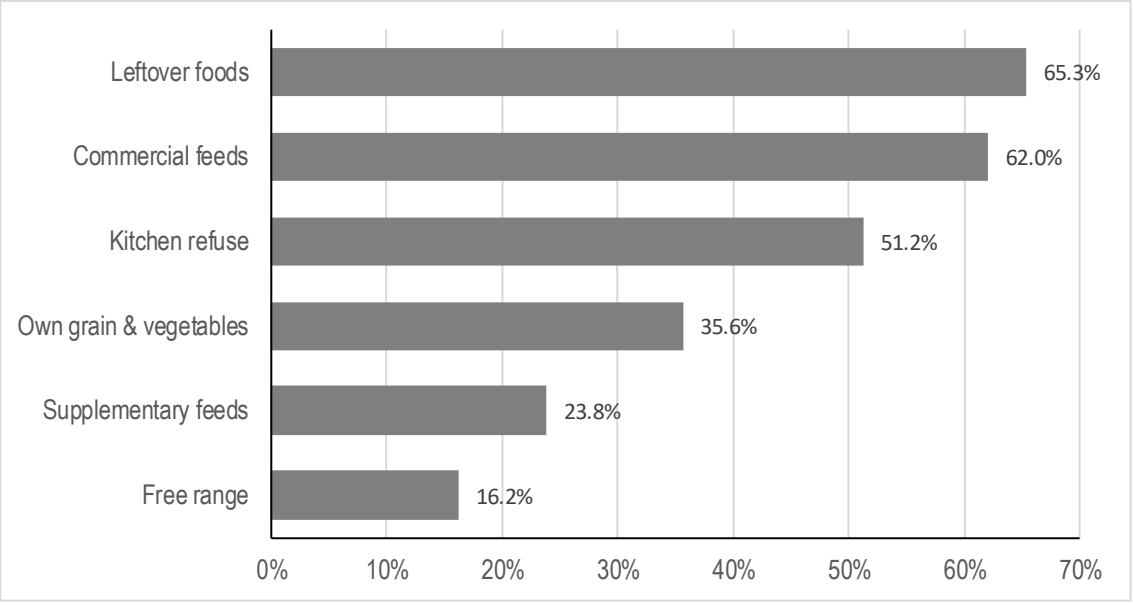


**Figure 2.** Types of Feeds

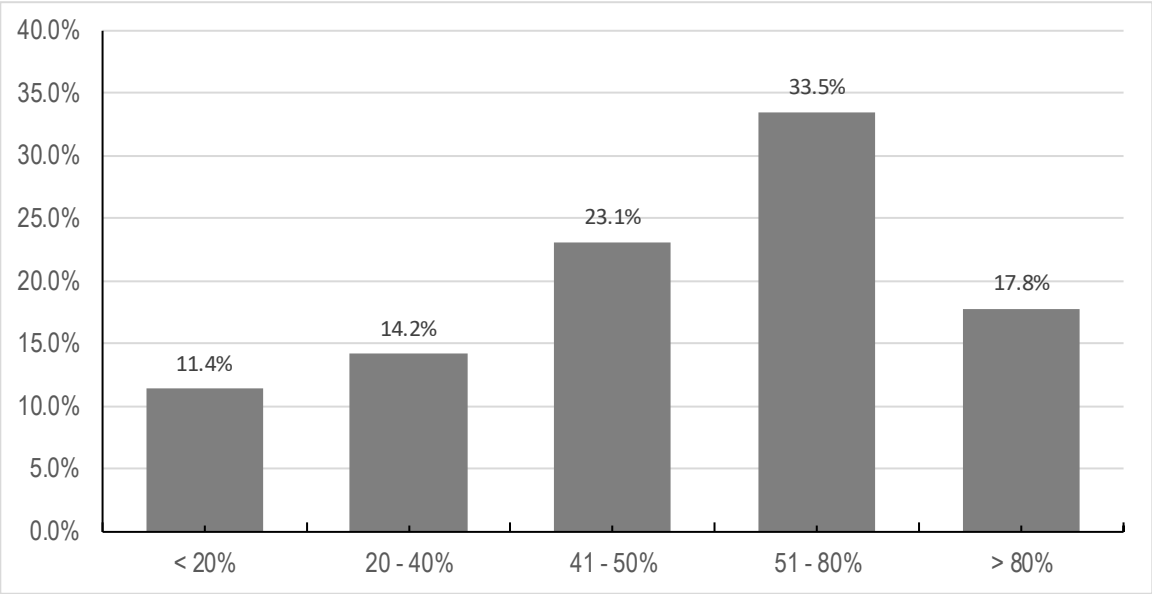


**Figure 3.** Survival Rate

**Table 3:** Production Inputs Other Than Chicken Feeds

| Variable | Frequency | Percent |
|---|---|---|
| Veterinary drugs | 233 | 82.6 |
| Vaccines | 180 | 63.8 |
| Feeding items | 162 | 57.4 |
| Water | 132 | 46.8 |
| Chemicals | 80 | 28.4 |
| Electricity | 58 | 20.6 |

The breakdown in Figure 4 shows that 92.3% of the sample farmers used personal funds to finance their enterprises, while 71.6% utilized the Table Banking/Merry-go-round scheme. Focus group discussions indicated that though they use their savings and funds from Table Banking, these resources are handily enough to fund large-scale chicken farming above 400 birds. It is worth noting that only 7.4% of the respondents sourced funds from commercial banks. The low usage of commercial banks could be attributed to the high cost of commercial loans. Farmers also confided that they avoid getting commercial loans to avoid losing their collateral in case of default. In terms of sales outlets, Figure 5 shows that eggs were sold mainly at the farm gate (65.5%) and through retail arrangements (62/4%).

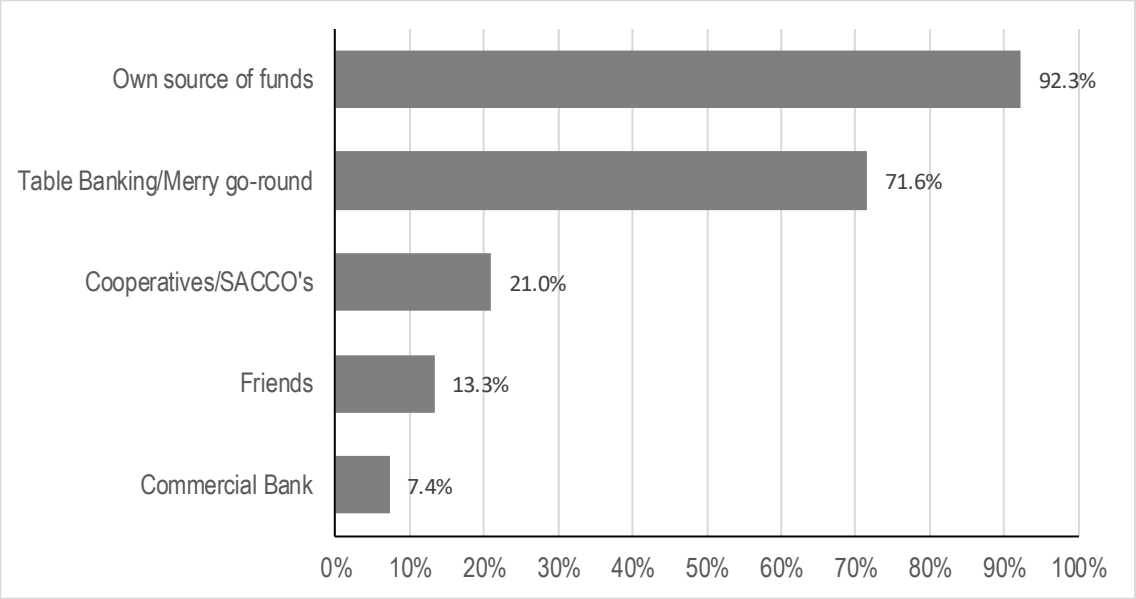


**Figure 4.** Source of Finances

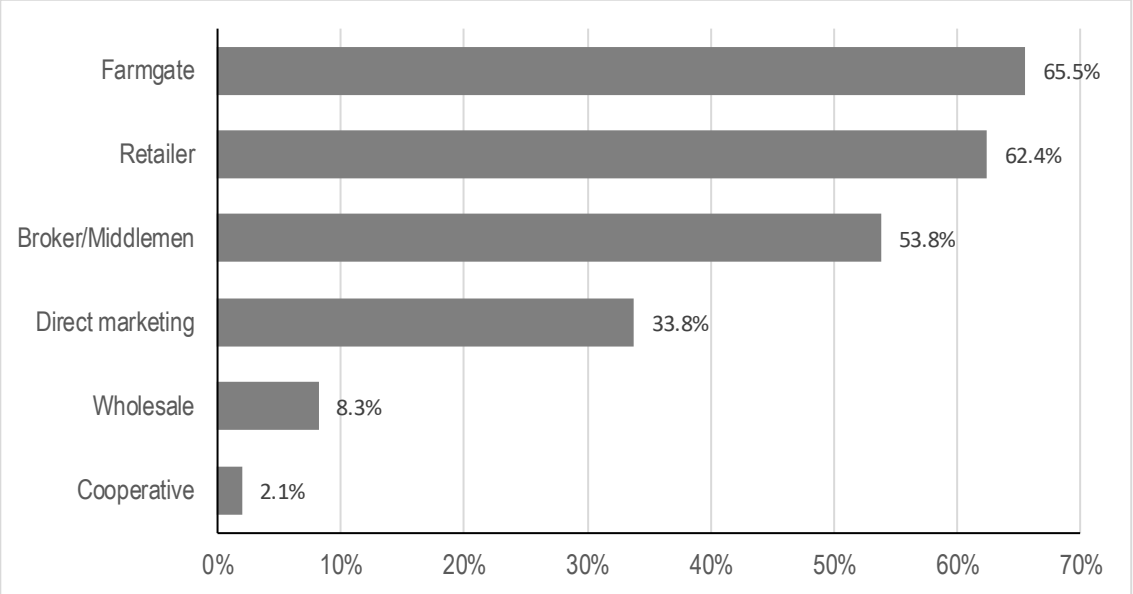


**Figure 5.** Marketing outlets

*Profitability and Financial Efficiency Results*

This section focuses on the cost associated with indigenous chicken egg farming and the revenue that accrues to the farmers. The results presented in Table 4 indicate that feed costs accounted for about 82.6% of the total production cost. This finding is not surprising given that feed costs have always been high in the poultry sector (Anang, 2013; Tanko et al., 2014; Mere, Ater, and Ezihe, 2017). As previous studies have noted, feed costs are the determinant of efficiency and profitability

as they account for a substantial portion of total production cost (Haruna and Hamidu, 2004; Kalla, 2007; Hassan et al., 2011). Overall, variable costs account for 89.6% of the total production cost. An average of KSh. 1,971,200 accrues to a farmer as revenue and KSh. 480,760 as gross margin.

**Table 4.** Cost and Returns of Small-Scale Indigenous Chicken Egg Farms in Kenya

| | **Average cost of Production** | **% Share of Cost** |
|---|---|---|
| Variable Expenses | | |
| Day-old chick | 20,000.00 | 1.20 |
| Feeds | 1,373,440.00 | 82.57 |
| Water | 50,000.00 | 3.01 |
| Brooding* | 9,000.00 | 0.54 |
| Drugs and Vaccines | 5,000.00 | 0.30 |
| Veterinary services | 3,000.00 | 0.18 |
| Transportation* | 30,000.00 | 1.80 |
| Total Variable Cost | 1,490,440.00 | 89.60 |
| | | |
| Fixed Expenses | | |
| Housing | 100,000.00 | 6.01 |
| Equipment | 6,650.00 | 0.40 |
| Interest on Loan (KSh. 833649) @ 7%* | 58,355.43 | 3.51 |
| Depreciation | 7,998.70 | 0.48 |
| Total Fixed Cost | 173,004.13 | 10.40 |
| | | |
| Total Expenditure | 1,663,444.13 | 100.00 |
| | | |
| Returns | | |
| Gross income | 1,971,200.00 | |
| Gross margin | 480,760.00 | |
| Net farm income from operations | 307,756 | |
| Operating profit margin ratio | 0.125 | |
| Production efficiency = ATR/ATC | 1.19 | |
| Percent profit | 18.50 | |
| Operating expense ratio | 0.81 | |
| Depreciation expense fatio | 0.004 | |
| Interest expense ratio | 0.030 | |
| Net farm income from operation ratio | 0.156 | |
| Gross ratio | 0.84 | |
| Fixed ratio | 0.09 | |

Note: ATR/ATC: Average total revenue/Average total cost
* represent information drawn from secondary sources

The average net farm income from operations of KSh. 307,756 and percentage profit of 18.5% show that indigenous chicken egg farming is a profitable enterprise in the study area. All things

being equal, farmers should be able to pay back loans even at a commercial bank interest rate (hypothesized at 7%) as indicated by a low-interest expense ratio of 3%. The production efficiency index indicates that returns exceed costs by 19%.

Furthermore, the operating expense ratio is estimated at 81%, which puts the average indigenous chicken egg farm within the marginal efficiency level. As noted by Doye (2017), rates in the 40% to 60% range indicate relatively efficient operations, with efficiency declining as the ratio rises. Ratios in the 60% to 75% range would reflect average efficiency, while 75% or larger rates would reflect marginal efficiency. The estimated ratio of 81% indicates that about 20% of gross farm revenue is available to replace depreciable assets, make all interest and principal payments on real assets, and provide a family living. Similarly, the computed gross ratio coefficient of 0.84 implies that 84% of the gross income offset total farm costs. The lower the gross ratio, the higher the return per Kenyan shilling (KSh.) invested. The fixed ratio coefficient is estimated at 0.09, implying that 9% of the gross income covers fixed assets, which indicates that indigenous chicken egg farmers in the study area use fixed resources efficiently. In summary, the results show that all the ratios are less than 1, implying that small-scale indigenous chicken egg farms in Kenya are profitable business enterprises.

## Conclusions

The study revealed that indigenous chicken egg enterprises are profitable, as indicated by the gross margin of KSh. 480,760 and a net farm income from the operation of KSh. 397,756. However, the farmers are far from being efficient in using financial resources, as the operating expense ratio showed that the average farm was operating within the marginal efficiency level. As highlighted by the descriptive statistics, the significant constraints include inadequate finance, long chicken maturity, and lack of markets. The cost structure indicated that feed cost, cost of day-old chicks, transportation, and water cost were the most critical cost items accounting for 89% of the production cost.

## Acknowledgment

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# The Economic Impacts of Drought on Navajo Nation

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## Abstract

Drought negatively impacts productivity in the agricultural sectors. Drought is particularly concerning in the arid Southwest, where agriculture plays an important role in the economies and traditions of Native American peoples. The objective of this study is to evaluate the impacts of drought on primary agricultural sectors for Navajo Nation, specifically cattle and hay production, applying panel data analysis, as well as the resulting total economic impacts applying supply-driven input-output analysis. Study results show that drought has a larger impact on cattle production than hay production on Navajo Nation, resulting in total economic losses of $8.2 million and $0.4 million for the cattle and hay sectors, respectively.

**Keywords:** drought, Navajo Nation, economic impacts, cattle, hay, PDSI

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## Introduction

Climate change and accompanying droughts negatively impact the productivity of agricultural sectors by causing crop losses, damage to pasture/range, and reduced plant growth (Hatfield et al., 2011; Kuwayama et al., 2019). In the United States, they are particularly concerning in the arid Southwest, where agriculture represents an important part of the economies, as well as the culture and traditions of tribal communities (Redsteer et al., 2013; Deol and Colby, 2018). As tribal communities are also plagued by poverty levels above the U.S. average (Davis, Roscigno, and Wilson, 2016; U.S. Census Bureau, 2020), they are particularly vulnerable to the negative impacts of climate change and drought.

The objective of this study is to estimate the impacts of drought on cattle and hay production, as well as the overall economy of Navajo Nation, the largest Indian reservation in the United States. Table 1 shows that poverty and unemployment rates on Navajo Nation are at least three times greater than the U.S. average, while median household income is less than half the U.S. average. At the same time, livestock contributes significantly to the economy and food security on Navajo Nation (Redsteer et al., 2013). Livestock sales represent around 21% of all agricultural sales on Navajo Nation, and cattle and calves make up roughly 19% of all livestock inventory, second to sheep and lamb (USDA-NASS, 2020a). Further, hay is the most important crop, as hay and forage represent roughly 67% of all crop acreage (USDA-NASS, 2020a). Thus, drought may have a significant impact on cattle and hay productivity, and thus, represents a serious threat to the well-being of the Navajo Nation communities.

**Table 1.** Selected Economic Indicators

| Region | Population below Poverty Level (%) | Employment in Agriculture, Forestry, Fishing/Hunting, & Mining (%) | Unemployment Rate (%) | Median Household Income ($) |
|---|---|---|---|---|
| Navajo Nation | 39.5 | 3.5 | 18.1 | 27,361 |
| United States | 11.8 | 1.8 | 5.9 | 64,324 |

*Source*: U.S. Census Bureau, 2014-2018 American Community Survey 5-Year Estimates

## Literature Review

Few studies examine the impacts of droughts on Native American tribes in the United States. Knutson, Hayes, and Svoboda (2007) found that livestock producers in the Hualapai Tribe lost approximately $1.6 million between 2001 and 2007 due to drought, as a result of reduced grazing, feed, and water availability, which led to herd reduction. Nania et al. (2014) provided examples of climate change and drought impacts on livestock production on Navajo Nation, as well as other parts of the southwestern United States. They describe how drought impacts the availability and quality of forage rangeland, water, and livestock health; what factors make this region more vulnerable to drought; and what adaptation and mitigation strategies can be implemented. Cozzetto et al. (2013) identify the impacts of climate change on ranching and agriculture to tribal communities.

Several studies examined the economic impacts of drought on agricultural sectors (Diersen and Taylor, 2003; Pérez and Hurlé, 2009; Dellal and McCarl, 2010; Bauman et al., 2013; Howitt et al., 2014). However, none examine the economic impacts of drought specifically on tribal communities; this study aims to fill this gap. We examine the severity of drought impacts on agriculture on Navajo Nation to highlight the importance of assisting tribes with preparation and response to drought, as well as addressing issues that exacerbate their vulnerability to drought.

## Methods

### *Data*

Yearly cattle inventory including calves (head) and hay yield including alfalfa (tons per acre) data were collected from the USDA National Agricultural Statistical Service (USDA-NASS, 2020b). These variables were transformed using the natural logarithm. Monthly Palmer Drought Severity Index (PDSI) data, compiled using temperature and precipitation data by the Cooperative Institute for Climate and Satellites—North Carolina (CICS-NC), were obtained from the Centers for Disease Control and Prevention (2018), and yearly averages were calculated. PDSI values can range from -10 to 10, typically from -4 to 4, where more negative/positive values represent drier/wetter conditions. Variables *DryDur* and *WetDur* were constructed as counts of consecutive years when yearly PDSI values were less than -1.9 and more than 1.9, respectively (values between -1.9 and 1.9 are considered "near normal" condition, according to the National Weather Service, Climate Prediction Center). The data span the period 1981 to 2016 ($T = 36$) and include all counties with Native American reservations in Arizona, New Mexico, Nevada, and Utah ($N = 34$). Only the reservation share of county data are used in the analysis. Table 2 provides an overview of the variables and summary statistics.

**Table 2.** Summary Statistics

| Variable | Definition (measurement) | Obs. | Mean | SD | Min | Max |
|---|---|---|---|---|---|---|
| Cattle | Cattle inventory, incl. calves (head) | 1,194 | 44,464 | 55,099 | 100 | 410,000 |
| ln Cattle | Natural log of cattle inventory | 1,194 | 10.20 | 1.09 | 4.61 | 12.92 |
| HayYield | Hay yield, incl. alfalfa (ton/acre) | 972 | 4.44 | 1.58 | 0.90 | 10.00 |
| ln HayYield | Natural log of hay yield | 972 | 1.43 | 0.35 | -0.11 | 2.30 |
| PDSI | PDSI value | 1,224 | -0.34 | 2.61 | -5.27 | 7.40 |
| DryDur | Consecutive dry years, if PDSI < -1.9 | 1,224 | 0.57 | 1.03 | 0.00 | 6.00 |
| WetDur | Consecutive wet years, if PDSI > 1.9 | 1,224 | 0.43 | 1.03 | 0.00 | 6.00 |

*Notes*: Data collected over $T = 36$ years (1981-2016) and $n = 34$ counties, reservation share only. Dry and wet duration constructed as the number of consecutive years such that PDSI < -1.9 and PDSI > 1.9, respectively.

### *Drought Impacts on Cattle Inventory and Hay Yield*

First, we apply panel data analysis to examine the direct impacts of drought on the cattle inventory and hay yields. We use current PDSI values, lagged duration of dry conditions, lagged duration of wet conditions, and trend as predictors in models for both cattle inventory and hay yields. For the cattle inventory model, we also include lagged cattle inventory (i.e., dependent variable) as a

predictor, as there is some dependency between cattle inventory in adjacent time periods since ranchers need to maintain inventory for breeding purposes and dairy production.

### *Economic Impacts of Drought*

After estimating the impacts of drought on cattle inventory and hay yields, we calculate the dollar value of the cattle and hay output losses under specified drought scenarios for Navajo Nation. These dollar values represent the direct impacts of drought on the cattle and hay sectors. Estimated direct impacts are used for the estimation of the total economic impacts of drought. Reduced production in the cattle and hay sectors due to drought will result in reduced production in other sectors, which either sell inputs to the cattle and hay sectors (e.g., feed, seeds, labor, veterinary services) or purchase outputs from these sectors (e.g., food processing). The sum of these impacts are the indirect impacts of drought. In addition, employee compensation within affected sectors will decrease and resulting reductions in household spending will affect additional sectors throughout the local economy. This effect combined with reduced tax revenues represent induced impacts. The sum of direct, indirect, and induced impacts are the total economic impacts. Indirect, induced, and total effects are estimated using supply-driven input-output analysis (Kim, 2015; Kim et al., 2017).

## Results

### *Drought Impacts on Cattle Inventory and Hay Yield*

Results of the econometric analysis confirm that drought affects cattle inventory and hay yields negatively, but differently. First, a unit decrease in PDSI (i.e., a change toward drier conditions) is associated with a 0.3% reduction in cattle inventory and 0.4% reduction in hay yields in the same year that conditions become drier. Drought also has a long-term negative effect on cattle inventory but not on hay yield. Each year of drought, such that PDSI is below -1.9, is associated with a 1.86% decrease in cattle inventory in the following year.

### *Direct and Total Economic Impacts of Drought*

Since we find that drought affects cattle and hay production differently, we defined a specific drought scenario for each. The drought scenarios and associated impacts on cattle inventory and hay yields in terms of percentage change are reported in Table 3. We used these percentage changes to calculate cattle and hay output losses on Navajo Nation and associated dollar values (i.e., direct impacts of drought on cattle and hay sectors on Navajo Nation). The direct impacts and resulting indirect, induced, and total economic impacts are reported in Table 4.

**Table 3.** Drought Scenarios and Impacts on Navajo Nation Cattle Inventory and Hay Yields

| Model | Scenario Description | Total Impact at *t* |
|---|---|---|
| Cattle | 2-year drought: PDSI decreases below -1.9 and stays the same for two years, then increases back to the pre-drought level | -3.72% |
| Hay | PDSI decreases by 2 units | -0.87% |

*Note*: Scenario impact represents change in the cattle inventory (heads) or hay yields (tons/acre) based on the results of cattle and hay models, respectively.

**Table 4.** Economic Impacts of Drought on Navajo Nation, Cattle and Hay Sectors

| | Cattle Sector (million $) | | | Hay Sector (million $) | | |
|---|---|---|---|---|---|---|
| | **Backward** | **Forward** | **Total** | **Backward** | **Forward** | **Total** |
| **Direct impact (cattle/hay sector)** | **-** | **-** | **3.502** | **-** | **-** | **0.111** |
| Impact on sectors (indirect) | 1.310 | 1.119 | 2.429 | 0.060 | 0.047 | 0.107 |
| Ag forest and hunting | 0.107 | 0.006 | 0.114 | 0.004 | 0.001 | 0.006 |
| Hay | 0.027 | 0.004 | 0.031 | - | - | - |
| Cattle ranching | - | - | - | 0.000 | 0.014 | 0.014 |
| Other livestock | 0.005 | 0.012 | 0.017 | 0.000 | 0.000 | 0.000 |
| Mining | 0.016 | 0.000 | 0.016 | 0.001 | 0.001 | 0.003 |
| Utility | 0.062 | 0.000 | 0.063 | 0.004 | 0.001 | 0.005 |
| Construction | 0.024 | 0.001 | 0.025 | 0.001 | 0.006 | 0.007 |
| Manufacturing | 0.081 | 0.018 | 0.098 | 0.002 | 0.016 | 0.018 |
| Slaughtering | 0.000 | 1.069 | 1.069 | 0.000 | 0.000 | 0.000 |
| Wholesale | 0.240 | 0.000 | 0.241 | 0.003 | 0.000 | 0.004 |
| Other retail | 0.042 | 0.000 | 0.043 | 0.003 | 0.000 | 0.004 |
| Food retail | 0.007 | 0.000 | 0.008 | 0.001 | 0.000 | 0.001 |
| Transportation | 0.110 | 0.000 | 0.111 | 0.002 | 0.000 | 0.002 |
| FIRE[1] | 0.490 | 0.000 | 0.491 | 0.033 | 0.004 | 0.037 |
| Government | 0.097 | 0.007 | 0.104 | 0.005 | 0.002 | 0.007 |
| Impact on VA (indirect) | 1.398 | 0.001 | 1.400 | 0.084 | 0.004 | 0.089 |
| Employment compensation | 0.408 | 0.000 | 0.408 | 0.062 | 0.003 | 0.065 |
| Proprietary income | 0.001 | 0.000 | 0.001 | -0.002 | 0.000 | -0.002 |
| Other property income | 0.923 | 0.000 | 0.923 | 0.021 | 0.001 | 0.022 |
| Indirect business taxes | 0.067 | 0.000 | 0.067 | 0.003 | 0.001 | 0.004 |
| Impact on HH income (induced) | 0.736 | 0.004 | 0.740 | 0.063 | 0.007 | 0.069 |
| Low income HH (up to 35k) | 0.132 | 0.002 | 0.134 | 0.011 | 0.002 | 0.013 |
| Medium income HH (35k-100k) | 0.388 | 0.001 | 0.390 | 0.036 | 0.003 | 0.039 |
| High income HH (over 100k) | 0.215 | 0.001 | 0.216 | 0.016 | 0.001 | 0.017 |
| State revenue (induced) | 0.140 | 0.001 | 0.141 | 0.007 | 0.004 | 0.012 |
| Indirect + induced impact | 3.584 | 1.126 | 4.709 | 0.214 | 0.063 | 0.276 |
| Total regional impact | | | 8.212 | | | 0.387 |

*Note*: [1]finance, insurance, real estate, and education

Two-year drought reduces output of cattle sector directly by an estimated $3.5 million on Navajo Nation. A decrease in PDSI by 2 units reduces output in the hay sector directly by $0.1 million. Total economic impacts of drought on Navajo Nation are $8.2 million and $0.4 million for the cattle and hay sectors, respectively. Estimated impacts are larger for cattle production because drought affects cattle production in the long run, and cattle production is more prominent in the region. It is also important to mention that the drought affecting cattle production also indirectly affects hay production, and vice versa. The impacts reported in Table 4 represent impacts when

these two sectors are affected by drought separately, not taking into account that they are likely affected by drought directly at the same time.

## Conclusions

This study examined the direct impacts of drought on cattle and hay production, as well as the resulting total economic impacts on Navajo Nation. Cattle inventory and hay yields decrease significantly in the same year that conditions become drier. In addition, there is a lagged effect of drought on cattle inventory, but not hay yields. Cattle producers are impacted by drought through reduced availability and/or higher feed costs, grazing, and water, which may motivate them to cull or sell cattle earlier than planned. This reduces the breeding stock and thus affects cattle inventory in the years following the drought. Although estimated disruptions in hay production due to drought are smaller, reduced hay availability may have large negative consequences for cattle production if it depends heavily on hay for feed as a result of reduced grazing efficiency. Overall, reduced cattle and hay production results in lower economic activity in related sectors and large economic losses throughout the region.

In conclusion, droughts represent a serious threat to the tribal economies, where agriculture plays an important economic role. Our results highlight the need for education and policy to improve the ability of reservations to monitor drought and mitigate drought impacts. Financial and human resources as well as collaboration with researchers, policy makers, state and local governments, and other stakeholders may be critical (Knutson, Hayes, and Svoboda, 2007; Redsteer et al., 2013; Chief, Meadow, and Whyte, 2016).

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# Understanding Profitability of Georgia Blueberry Growers Adopting a Stochastic Approach

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## Abstract

We use a stochastic approach to assess the returns from blueberry production regarding observed blueberry price and yield variability. We extend the deterministic budget to stochastic by using triangular distribution and using Monte Carlo simulations. We use net present value (NPV) to assess and compare the returns. We observed disparity in the expected NPVs from two budget systems, and the chance of getting positive NPV studied under the stochastic budget was too low (23.85%–30.24%). This result shows the need for a stochastic approach to analyze growers' profit, which helps making investment decisions. Moreover, this study is useful for farmers and farm risk analyzers.

**Keywords:** Blueberry, deterministic, simulation, stochastic

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## Introduction

Georgia started using its land along with other crops to produce blueberry after 1950 and as of 2018, blueberry production area has expanded to 13,300 acres (USDA NASS, 2019; Scherm and Krewer, 2003). Rabbiteye, southern highbush, and northern highbush are the three types of blueberries grown in Georgia and are best adapted to South Georgia and the mountain highlands, respectively. Blueberry is one of the top 10 fruits and tree nuts commodities in Georgia in terms of farm gate value with a share of 48.87%, and it contributed 2.18% of the total Georgia agricultural farm gate value in 2018 (Wolfe and Stubbs, 2019). Georgia blueberry growers face price and yield alteration due to factors such as selected cultivars used in production, area of production, aggregate productivity, market, and timing (Fonsah and Hudgins, 2007; Fonsah et al., 2007; Fonsah et al., 2011). Despite the variation in price and yield, blueberry growers in Georgia depend on a budget with single-point estimates that best describes the blueberry price and yield. Although such budgets provide farmers useful information about the profitability of blueberry farming, Awondo, Fonsah, and Gray (2017) reported that in a deterministic budget, the grower's profit is overestimated at least three times. As a result, it was imperative to also examine Georgia blueberry production using a stochastic budget system and compare the returns of both systems.

## Literature Review

The use of a probabilistic approach in budgeting can be found in numerous studies evaluating animal production (Werth et al., 1991; Gummow and Patrick, 2000; Shalloo et al., 2004; Rayburn, 2009). Evans et al. (2007) compared a pasture-raised beef production system to a conventional system using stochastic budgets. Falk (1994) evaluated a small-scale meat-packing plant in New Mexico using this approach.

However, the application of stochastic budget analysis in the fresh-food industry sector is seldom. Peacock et al. (1995) explore the economic feasibility of a New Jersey fresh tomato packing facility. Elkjaer (2000) recognizes Stochastic Budget Simulation (SBS) as a simple tool to estimate the overall farm costs that can avoid the statistical dependencies between variables. Clancy et al. (2012) used nontraditional budgeting to estimate returns from willow and miscanthus in Ireland. Similarly, Awondo, Fonsah, and Gray (2017) consider price and yield as risk-associated variables and provide the probability distribution of net present value and break-even year from producing muscadine grapes in Georgia.

The stochastic budget for blueberry production in Georgia has not been developed yet, although the University of Georgia Cooperative Extension has developed a traditional budget for southern highbush blueberry for the years 2004, 2018, and, recently, 2019. However, risk-rated budget analysis of southern highbush blueberries in Fonsah et al. (2007) and rabbiteye blueberries in Fonsah et al. (2008) and Fonsah et al. (2011) incorporated risk associated with blueberry production in Georgia to some extent. Fonsah et al. (2007) showed blueberry growers could earn profit with a chance of 92% from southern highbush blueberries. Similarly, Fonsah et al. (2011) depicted an 86% chance of earning profit from rabbiteye blueberry. These above-mentioned papers used sensitivity analysis to evaluate the effect of price and yield fluctuation incorporating risk in

blueberry production. Net returns were calculated as what-if prices and yields, which to some extent allows us to evaluate net returns in a few different price-yield scenarios. However, it does not allow us to project the whole range of net returns.

Therefore, sensitivity analysis, although a common approach to cope with the problem of agricultural production risk, can consider only one component as a variable at a time (Lien, 2003). Hence, a more sophisticated way of addressing uncertain variables is defining the distribution of the variables and interpreting them using the aprobabilistic approach.

## Methods

*Deterministic Budget*

We considered two components—costs and returns—based on an acre of fresh market southern highbush blueberries in Georgia. The budget was developed for a production system that uses a drip irrigation system and plant density of 1,210 per acres and planted distance of 12 ft within rows and 3 ft between rows. Input recommendations and prices were obtained from the University of Georgia (UGA) Extension team and agricultural vendors. Secondary data were also obtained from the UGA Agricultural Economics website and the U.S. Department of Agriculture's Economic Research Service. The total cost of production was captured by estimating the fixed and variable (pre-harvest, and post-harvest and marketing) costs (Kunwar et al., 2019). We used standardized practices recommended by the AAEA Task Force on Commodity Costs and Returns to estimate machinery and equipment costs. We assumed new machinery and equipment costs using 2020 prices and based our calculations on 10 acres since full efficiency is not obtained if used under 4 acres (Fonsah et al., 2007). However, the costs later are adjusted to 1 acre to harmonize with other costs. We estimated the price per pound and the yield per acre based on the multiple meetings and focus group discussions with growers, county agents, and economists. We used 15 years of production period for estimating costs and returns, although blueberries can be harvested from an orchard for more than 15 years with the adoption of good agricultural practices (GAP).

To appraise the investment in blueberry production in Georgia, we calculated the net present value (NPV) of cash flows of 15 years. NPVs were calculated on two discount rates of 2% and 5% to capture the variability in the personal discount rate of growers.

*Stochastic Budget*

Unlike the deterministic budget, we described the yield and price of blueberries as random components, assessed and defined the distribution of yields and prices, and used simulations to model the returns from the blueberry production system. The Monte Carlo simulation was adopted assuming both the price and the yield follow the triangular distribution. We used the single-point estimates for production costs that were estimated from the deterministic budget developed earlier. Finally, NPVs were calculated from the total costs and the simulated yields and prices, and a probabilistic approach was used to evaluate NPVs.

## Results

*Deterministic Budget*

The total variable costs in the first three establishment years were estimated at $6,947.26/acre, $4,833.65/acre, and $9,379/acre, respectively. For each of the full productive years, the total variable costs were estimated at $15,544.24/acre. The reason for the observed decrease in the total variable costs in the 2nd year from the 1st year is that there is no cost for land preparation, planting, and planting materials. Similarly, the total fixed costs estimated for years 1, 2, 3 and 4 -15 were $2,849.46/acre, $2,026.11/acre, 2,022.92/acre, and $2,054.23/acre, respectively which included a fixed machinery cost of $1,521.3/acre every year.

Table 1 shows the cash flows for the 15-year production period and the calculated NPVs at 2% and 5% discount rates. The investment in blueberry production begins to yield positive returns after the third year and covers the original cost of the investment in the ninth year. The net present value at both discount rates was positive, making the investment attractive for blueberry growers.

**Table 1.** Cash Flows and NPVs of Blueberry Production in Georgia, 2020

| Year | Yield | Price | Return | Variable Cost | Return over Variable Cost | Total Cost | Return over Total Cost (Net Cash Flow) |
|---|---|---|---|---|---|---|---|
| 1 | 0 | 3 | 0 | 6,947.26 | -6,947.26 | 9,796.72 | -9,796.72 |
| 2 | 1,615 | 3 | 4,845 | 4,833.65 | 11.35 | 6,859.77 | -2,014.77 |
| 3 | 3,800 | 3 | 11,400 | 9,379.00 | 2,021.00 | 11,401.92 | -1.92 |
| 4 | 6,650 | 3 | 19,950 | 15,544.24 | 4,405.76 | 17,598.47 | 2351.53 |
| 5 | 6,650 | 3 | 19,950 | 15,544.24 | 4,405.76 | 17,598.47 | 2,351.53 |
| 6 | 6,650 | 3 | 19,950 | 15,544.24 | 4,405.76 | 17,598.47 | 2,351.53 |
| 7 | 6,650 | 3 | 19,950 | 15,544.24 | 4,405.76 | 17,598.47 | 2,351.53 |
| 8 | 6,650 | 3 | 19,950 | 15,544.24 | 4,405.76 | 17,598.47 | 2,351.53 |
| 9 | 6,650 | 3 | 19,950 | 15,544.24 | 4,405.76 | 17,598.47 | 2,351.53 |
| 10 | 6,650 | 3 | 19,950 | 15,544.24 | 4,405.76 | 17,598.47 | 2,351.53 |
| 11 | 6,650 | 3 | 19,950 | 15,544.24 | 4,405.76 | 17,598.47 | 2,351.53 |
| 12 | 6,650 | 3 | 19,950 | 15,544.24 | 4,405.76 | 17,598.47 | 2,351.53 |
| 13 | 6,650 | 3 | 19,950 | 15,544.24 | 4,405.76 | 17,598.47 | 2,351.53 |
| 14 | 6,650 | 3 | 19,950 | 15,544.24 | 4,405.76 | 17,598.47 | 2,351.53 |
| 15 | 6,650 | 3 | 19,950 | 15,544.24 | 4,405.76 | 17,598.47 | 2,351.53 |

Note: NPV at discount rate of 2% (NPV@2%) = 12,128.70
NPV at discount rate of 5% (NPV@5%) = 7,187.17
Measurement Note:
Yield in pounds per acre.
Price in dollars per pound.
Return, variable cost, and total cost in dollars per acre.

*Stochastic Budget*

Figures 1 and 2 give the probability density function and cumulative distribution function of NPV at two discount rates. The probability of getting positive NPV was very low— 30% and 24% at 2% and 5% discount rates, respectively. The expected NPV was -$8,157/acre at a 2% discount rate and -$9,174/acre at a 5% discount rate. As the chances of a positive NPV are below 50%, the investment in blueberry production does not seem favorable in Georgia.

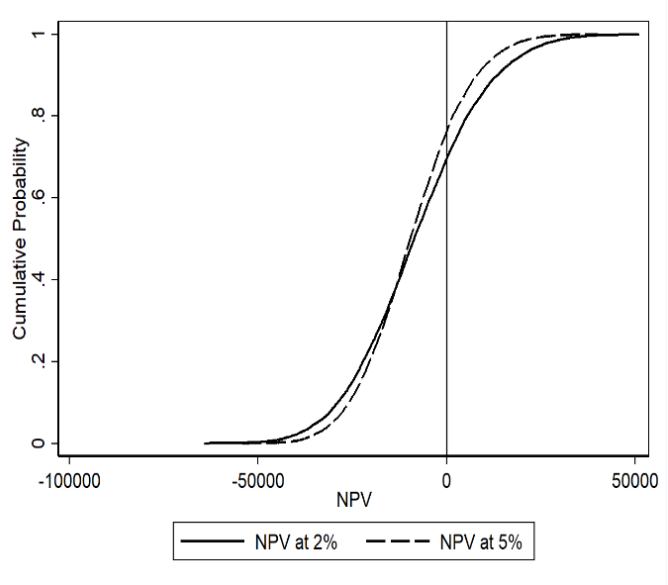


**Figure 1.** CDF of NPV of Blueberry Production in Georgia

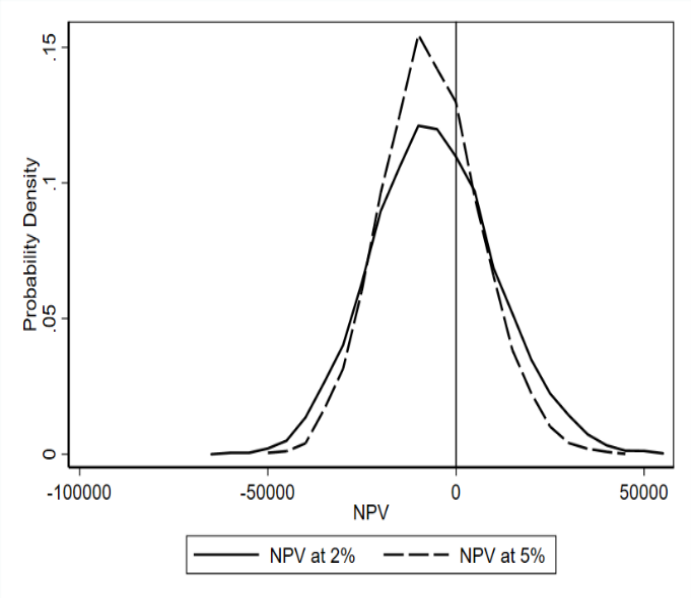


**Figure 2.** PDF of NPV of Blueberry Production in Georgia

The expected NPV in the deterministic budget is 248.70% more than the expected NPV in the stochastic budget at a 2% discount rate and 178.34% at a 5% discount rate. This shows that the result from the traditional budget is unrealistic and unjustifiably optimistic. The findings here are in line with Awondo, Fonsah, and Gray (2017), which depicted that the chance of getting a positive NPV from the non-stochastic budget is three to four times greater than that from the stochastic budget.

## Conclusion

The findings of our research show that blueberry production in Georgia is not as attractive as portrayed by the deterministic budget. Since the components of the production are random, the output variable, such as the NPV in our model, with 100% certainty does not account for the real-world agricultural production process. Thus, the probabilistic approach along with the deterministic approach helps growers to analyze and compare their profitable scenarios and boost confidence in investing in agricultural business. With direct implications for growers, this study can also be useful in the formulation and implementation of agricultural policies. This study does not consider costs (input prices) as stochastic variables. The consideration of input prices as random variables will improve the findings of the study; thus, this consideration could be a possible extension of our work.

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# The Consumer Choice of Market for Fresh Fruits: A Study of Attitudinal Factors and Market Attributes

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## Abstract

This study proposes that market attributes and consumer attitudes drive the decision to choose the main marketplace to purchase fresh fruits, defined as the first step in the consumer purchasing behavior. From a survey of 1,658 Americans, we categorized respondents as those purchasing most fresh fruits at chain stores (66%), club/warehouse stores (5%), independent grocery stores (18%), and DTC markets (11%). Results from a multinomial logit regression showed fresh fruit prices was the main attribute of purchasing at chain stores, and a major barrier for independent stores. Atmosphere and access to local fruits was the main attribute for farmers markets.

**Keywords:** fresh fruit, marketing, product differentiation, attitudinal factors, market channel

## Introduction

The growing consumption of produce, motivated by increasing demand for healthy and environmentally friendly foods, has impacted the U.S. supply chain of fresh fruits. Farmers, food retailers, and grocery stores have adopted various product differentiation strategies to appeal to fresh fruit consumers (Brunori et al., 2016). One example of these strategies is the use of food labels (Turnwald and Crum, 2019) that convey nutrition, origin, and production attributes (Torres, 2020), as well as procedures adding value to fresh fruits (Low et al., 2020).

Changes in lifestyle and consumption patterns make consumers increasingly diverse and less predictable (Freire and Rudkin, 2019). To address changes in consumer demand, several researchers have investigated the attributes influencing buying behavior and consumption of fresh fruits. Fresh fruit purchases can be driven by search (e.g., price), experience (e.g., sweetness), and credence attributes (e.g., local) (Torres, Langenhoven, and Behe, 2020). The boost in fresh fruit sales, the proliferation of food labels, and the increasing number of market channels drive the need to further investigate consumer decision making when buying fresh fruits (Lenk et al., 2018).

While most research has focused on product attributes' importance in the purchase of fresh fruits, more recently, researchers have linked marketplace selection as a first step in the consumer decision-making process. Gindi et al. (2018) proposed that fresh fruit purchases follow a hierarchical process in which the selection of a marketplace is the first decision to determine purchasing behavior. Thus, we expect that before a consumer chooses what and how much fruit to buy, they first decide where to make the purchase. In this study, we propose that different market attributes and consumer attitudes can drive the decision to choose the main marketplace to purchase fresh fruits.

This study takes a step back from the product attribute and labeling literature to understand how marketplace attributes and consumers' attitudinal factors influence the choice of market for fresh fruit purchases. Market attributes include the market availability, the availability of desirable fresh fruits, prices, market proximity, fresh fruits selection, friendliness of market, convenience, the supply of locally grown fruits, the supply of organic fruits, access of seasonal fruits, and variety of fresh fruits.

Attitudes play a key role in consumer choice (Roininen et al., 2001; Verneau et al., 2016). Torres, Langenhoven, and Behe (2020) reported on the consumer attitudes guiding fresh fruit consumption. They used four widely used attitudinal scales to understand consumer choices for fresh fruits: general health interest (GHI), craving for sweet foods (CSF), food pleasure (FP), and variety-seeking foods (VSF) scales. The GHI scale indicates consumer preferences for health-related attributes (Roininen et al., 2001). Consumers relate sweetness (CSF) as a desirable fresh fruit attribute (Saba et al., 2019). The food pleasure scale has been associated with a better nutritional status or a greater food intake (Davidenko et al., 2015). Finally, the search for variety in foods (VSF) has been correlated with an increase in fruit consumption (Van Trijp and Steenkamp, 1992; Nakagawa and Kotani, 2017).

The objective of this study is to investigate how market attributes and four attitudinal scales influence consumers' choice of the main marketplace for fresh fruits. Marketplaces included national chain stores, club stores or warehouses, independent or local grocery stores, and direct-to-consumer (DTC) markets. Chain stores included large traditional grocery stores, such as Walmart, Payless, and Meijer. Club stores included wholesale warehouses selling products in bulk quantities, such as Costco and Sam's Club. Independent grocery stores included independent, ethnic, and natural grocery stores. Lastly, DTC markets included farmers markets, roadside stands, on-farm, and community-supported agriculture (CSAs).

## Data and Methodology

We used a web-based survey of fresh fruit purchasers to obtain data for this study. The survey was distributed by LightSpeed GMI (Bridgewater, NJ) in late summer and early fall 2018, and was to be representative of the U.S. population on age, gender, and pretax income (based on 2017 census estimates). The study sample was composed of 1,658 valid respondents. To better understand the choice of marketplace for fresh fruits, we categorized respondents into four groups: those purchasing most fruit at chain stores (66%; $N$ = 1,095), club/warehouse stores (5%; $N$ = 85), independent grocery stores (18%; $N$ = 304), and DTC markets (11%; $N$ = 174).

We asked respondents to identify the importance they placed on market attributes when purchasing fresh fruits. Market attributes were measured on a scale varying from 0 to 100 from "not at all important" to "extremely important." Attitudes were measured by attitudinal scales, including the GHI, FP, CSF, and VSF on a 5-point Likert scale varying from "strongly disagree" (1) to "strongly agree" (5). To uncover the most salient attitudinal factors influencing market choice, researchers conducted a principal component analyses (PCA) on the scales using the MEANS, FACTOR, and CORR procedures available in SAS (SAS Institute Inc., 2017).

The questionnaire asked for demographic characteristics, including gender, age, marital status, educational attainment, annual household income, geographic location, household size, number of children, and ethnicity. Researchers also asked questions regarding purchasing and consumption behavior, including the number of miles traveled to the marketplace, monthly expenditures on fresh fruits, and the person responsible for purchasing most fruits in the household. Respondents were geographically grouped according to categorization from the Bureau of Labor Statistics into Northeast, South, Midwest, and West regions.

Researchers computed multiple mean comparisons using analysis of variance (ANOVA) tests and Tukey's honestly significant difference method at the 10% significance level. Given the unordered and discrete nature of the marketplace categories and the attitudinal factors, a robust multinomial logit regression was performed to understand what factors influence the choice of marketplace among fresh fruit consumers. The multinomial logit model describes a consumer's choice when they are faced with a variety of markets; yet, the markets are likely to be highly differentiated by an individual's attitudinal scales and market attributes. Analyses were conducted using Stata (StataCorp, 2019).

## Results and Discussion

Table 1 describes the explanatory variables and mean differences for all the variables, by marketplace type. The two most valued market attributes were fresh fruit selection (74% of importance) and the market price (70% of importance). Other markets' attributes were seasonal fruits availability (65% of importance), closeness to home (62% of importance), friendliness of atmosphere (58% of importance), availability of local fruits (55% of importance), only place offering the fresh fruits consumers want (49% of importance), and availability of organic fruits (44% of importance). Related to the consumers' attitudinal scale, those purchasing at club and independent stores rated higher on the FP scale in comparison to those purchasing fresh fruits at chain stores and DTC markets ($P < 0.1$).

**Table 1.** Descriptive Statistics of the Demographic, Purchase Characteristics, Market Attributes, and Attitudinal Scales Variables for the Four Market Channels of 1,658 U.S. Respondents Participating in an Online Survey about the Choice of Marketplace

| | Mean (SD) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **Full Sample** | **Chain** | | **Club** | | **Independent** | | **DTC** | |
| **Variable** | ***N* = 1,658** | ***N* = 1,095** | | ***N* = 85** | | ***N* = 304** | | ***N* = 174** | |
| Female | 0,47 | 0,47 | AB | 0,35 | B | 0,54 | A | 0,38 | B |
| | (0,50) | (0,50) | | (0,48) | | (0,50) | | (0,49) | |
| Single | 0,38 | 0,37 | | 0,37 | | 0,36 | | 0,45 | |
| | (0,48) | (0,48) | | (0,49) | | (0,48) | | (0,50) | |
| College | 0,56 | 0,56 | | 0,66 | | 0,43 | | 0,41 | |
| | (0,50) | (0,50) | | (0,48) | | (0,50) | | (0,49) | |
| Income | 5,59 | 5,51 | B | 6,33 | A | 5,65 | AB | 5,69 | AB |
| | (2,33) | (2,32) | | (2,39) | | (2,23) | | (2,43) | |
| Age | 45,35 | 45,76 | | 42,93 | | 45,81 | | 43,14 | |
| | (16,78) | (16,74) | | (16,36) | | (17,26) | | (16,20) | |
| Live in rural area | 0,22 | 0,22 | A | 0,09 | B | 0,25 | A | 0,25 | A |
| | (0,42) | (0,42) | | (0,29) | | (0,43) | | (0,44) | |
| Household size | 4,28 | 4,27 | AB | 4,62 | A | 4,28 | AB | 4,14 | B |
| | (1,45) | (1,43) | | (1,68) | | (1,47) | | (1,41) | |
| Number children in household | 1,50 | 1,51 | AB | 1,71 | A | 1,41 | B | 1,49 | AB |
| | (0,92) | (0,92) | | (1,20) | | (0,89) | | (0,83) | |
| Live in Midwest | 0,23 | 0,23 | B | 0,18 | BC | 0,30 | A | 0,15 | C |
| | (0,42) | (0,42) | | (0,38) | | (0,46) | | (0,36) | |
| Live in West | 0,18 | 0,17 | B | 0,35 | A | 0,18 | B | 0,12 | B |
| | (0,38) | (0,38) | | (0,48) | | (0,39) | | (0,33) | |
| Live in South | 0,38 | 0,41 | A | 0,34 | AB | 0,26 | B | 0,44 | A |
| | (0,49) | (0,49) | | (0,48) | | (0,44) | | (0,50) | |
| Live in Northeast | 0,21 | 0,19 | B | 0,13 | B | 0,26 | A | 0,29 | A |
| | (0,41) | (0,39) | | (0,34) | | (0,44) | | (0,46) | |

**Table 1. (continued)**

| | Mean (SD) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **Full Sample** | **Chain** | | **Club** | | **Independent** | | **DTC** | |
| **Variable** | ***N* = 1,658** | ***N* = 1,095** | | ***N* = 85** | | ***N* = 304** | | ***N* = 174** | |
| Asian | 0,04 | 0,03 | C | 0,15` | A | 0,06 | B | 0,06 | BC |
| | (0,20) | (0,16) | | (0,36) | | (0,23) | | (0,23) | |
| Black | 0,08 | 0,08 | | 0,07 | | 0,08 | | 0,09 | |
| | (0,28) | (0,28) | | (0,26) | | (0,28) | | (0,28) | |
| White | 0,77 | 0,79 | A | 0,62 | B | 0,76 | A | 0,74 | AB |
| | (0,42) | (0,41) | | (0,49) | | (0,43) | | (0,44) | |
| Hispanic | 0,04 | 0,04 | B | 0,09 | A | 0,03 | B | 0,03 | B |
| | (0,20) | (0,19) | | (0,29) | | (0,18) | | (0,18) | |
| Miles traveled | 6,05 | 5,78 | BC | 8,20 | A | 5,32 | C | 7,99 | AB |
| | (9,69) | (9,28) | | (12,46) | | (9,11) | | (11,24) | |
| Responsible to purchase FF | 0,83 | 0,84 | A | 0,73 | B | 0,80 | AB | 0,85 | A |
| | (0,37) | (0,36) | | (0,45) | | (0,40) | | (0,36) | |
| Monthly spend on FF | 30,14 | 27,08 | B | 46,43 | A | 28,64 | B | 44,02 | A |
| | (54,37) | (36,03) | | (73,74) | | (37,59) | | (120,82) | |
| Only place offering desirable FF [z] | 48,90 | 46,90 | B | 47,35 | B | 49,21 | B | 61,96 | A |
| | (30,76) | (30,81) | | (33,03) | | (29,53) | | (28,28) | |
| Market price[z] | 70,53 | 72,01 | A | 69,14 | AB | 69,04 | AB | 64,32 | B |
| | (23,90) | (23,27) | | (25,58) | | (23,94) | | (25,89) | |
| Closeness to consumers home[z] | 62,19 | 63,43 | A | 56,69 | AB | 62,77 | A | 55,95 | B |
| | (27,74) | (27,26) | | (29,26) | | (27,47) | | (29,53) | |
| Market availability[z] | 35,48 | 35,01 | | 32,40 | | 36,44 | | 38,32 | |
| | (31,63) | (31,67) | | (32,23) | | (31,02) | | (32,19) | |
| FF selection[z] | 73,65 | 72,90 | BC | 67,75 | C | 74,60 | AB | 79,81 | A |
| | (23,75) | (23,91) | | (26,79) | | (22,59) | | (21,90) | |
| Friendliness of atmosphere[z] | 58,31 | 56,16 | B | 58,06 | B | 59,16 | B | 70,72 | A |
| | (29,20) | (29,36) | | (30,52) | | (28,16) | | (26,23) | |

**Table 1. (continued)**

| | Mean (SD) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **Full Sample** | **Chain** | | **Club** | | **Independent** | | **DTC** | |
| **Variable** | ***N* = 1,658** | ***N* = 1,095** | | ***N* = 85** | | ***N* = 304** | | ***N* = 174** | |
| Convenience[z] | 71,31 | 72,03 | | 68,52 | | 70,19 | | 70,04 | |
| | (24,05) | (23,84) | | (26,13) | | (23,56) | | (25,17) | |
| Locally-grown FF offer[z] | 54,98 | 51,56 | B | 52,79 | B | 54,88 | B | 78,17 | A |
| | (30,42) | (29,96) | | (32,95) | | (29,21) | | (23,39) | |
| Organic FF offer[z] | 43,60 | 40,38 | C | 51,34 | B | 42,93 | BC | 61,48 | A |
| | (33,47) | (32,99) | | (34,34) | | (31,63) | | (33,29) | |
| Seasonal FF offer[z] | 64,90 | 63,23 | B | 61,07 | B | 65,93 | B | 75,74 | A |
| | (27,88) | (28,38) | | (29,75) | | (26,52) | | (23,25) | |
| FF diversity[z] | 56,13 | 55,22 | | 58,66 | | 56,51 | | 60,04 | |
| | (30,86) | (30,78) | | (32,19) | | (29,90) | | (32,23) | |
| General health interest | 0,00 | 0,01 | | 0,07 | | -0,02 | | -0,01 | |
| | (1,00) | (1,00) | | (1,09) | | (1,01) | | (1,00) | |
| Cravings for sweet food | 0,00 | 0,00 | | 0,19 | | -0,04 | | 0,01 | |
| | (1,00) | (0,99) | | (1,05) | | (1,01) | | (1,02) | |
| Food pleasure | 0,01 | 0,00 | B | 0,28 | A | 0,02 | AB | -0,11 | B |
| | (1,00) | (1,00) | | (0,93) | | (0,99) | | (1,02) | |
| Variety seeking in food | 0,00 | 0,01 | | -0,02 | | 0,00 | | -0,06 | |
| | (1,00) | (1,00) | | (1,12) | | (1,00) | | (0,95) | |

Note: [z]The mean is the percentage of respondents with that attribute. Different letters across columns indicate significant differences of means at $P < 0.1$ using Tukey's significant different test. FF = fresh fruits

Table 2 displays the marginal effects of the multinomial logit regression. Shoppers rating high on CSF were more likely to choose club stores (1%, $P < 0.05$) and DTC markets (1%, $P < 0.1$) for fresh fruits. These results suggest the importance of highlighting fruit sweetness in fruit labels, as well as through their social media. Club stores and local markets can provide samples of fresh fruits for tasting because they allows consumers to verify experience attributes, which may motivate consumers to buy more fresh fruits. This is especially true as most purchase decision making is made at the place of purchase (Nair and Shams, 2020). Shoppers rating high in VSF were less likely to shop for fresh fruits at club stores (1%, $P < 0.05$). Consistent with Ailawadi, Ma, and Grewa (2018), we suggest that consumers seeking a variety of fresh fruits may be enticed to purchase more at club stores if they have access to big bundles containing different fruit types.

**Table 2.** Marginal Effects from the Multinomial Logit Regression of Variables Influencing or Not the Marketplace Choice

| | **Chain** ***N* = 1,095** | | **Club** ***N* = 85** | | **Independent** ***N* = 304** | | **DTC** ***N* = 174** | |
|---|---|---|---|---|---|---|---|---|
| Female | -4,18 | * | -0,50 | | 6,20 | *** | -1,52 | |
| Age | 0,07 | | 0,00 | | -0,06 | | -0,01 | |
| Single | -1,17 | | 0,45 | | -1,58 | | 2,30 | * |
| College | 1,09 | | 0,09 | | -1,75 | | 0,57 | |
| Income | 0,00 | | 0,00 | ** | 0,00 | | 0,00 | |
| Live in rural area | -2,60 | | -2,41 | * | 4,34 | | 0,67 | |
| Household size | -0,67 | | 0,44 | | 1,14 | | -0,91 | * |
| Number children in household | 2,35 | | 0,15 | | -3,14 | * | 0,64 | |
| Live in Midwest | 3,38 | | 1,69 | | -1,79 | | -3,28 | ** |
| Live in West | 5,12 | | 3,33 | ** | -4,39 | | -4,06 | ** |
| Live in South | 11,13 | *** | 1,73 | | -12,43 | *** | -0,43 | |
| Asian | -17,90 | *** | 4,71 | *** | 8,74 | * | 4,45 | ** |
| Black | -2,36 | | -0,39 | | 3,53 | | -0,78 | |
| Hispanic | -1,58 | | 2,58 | * | 2,42 | | -3,41 | |
| Miles traveled | 0,06 | | 0,07 | ** | -0,18 | | 0,05 | |
| Responsible to purchase FF | 6,55 | ** | -1,96 | ** | -4,93 | * | 0,33 | |
| Monthly spend on FF | -0,03 | | 0,01 | ** | 0,01 | | 0,01 | |
| Only place offering desirable FF | -8,47 | * | -0,31 | | 1,45 | | 7,33 | *** |
| Market price | 11,56 | ** | 1,52 | | -8,22 | * | -4,86 | ** |
| Closeness to consumers home | 6,50 | | -2,77 | | 4,55 | | -8,28 | *** |
| Market availability | 3,32 | | -2,82 | | 2,51 | | -3,00 | * |
| FF selection | 5,17 | | -5,16 | ** | 4,87 | | -4,89 | * |
| Friendliness of atmosphere | -17,51 | *** | 2,61 | | 7,69 | | 7,21 | ** |
| Convenience | 17,70 | ** | -0,87 | | -12,85 | ** | -3,97 | |
| Locally grown FF offer | -15,74 | ** | -1,17 | | -1,82 | | 18,73 | *** |

**Table 2. (continued)**

| | Chain *N* = 1,095 | Club *N* = 85 | | Independent *N* = 304 | DTC *N* = 174 | |
|---|---|---|---|---|---|---|
| Organic FF offer | -5,25 | 4,65 | ** | -1,73 | 2,33 | |
| Seasonal FF offer | -1,55 | -3,30 | | 5,23 | -0,37 | |
| FF diversity | 5,00 | 2,94 | | -2,65 | -5,29 | ** |
| General health interest | 0,05 | 0,26 | | -0,13 | -0,18 | |
| Cravings for sweet food | -0,68 | 0,90 | ** | -1,14 | 0,92 | * |
| Food pleasure | -1,27 | 0,68 | | 1,26 | -0,68 | |
| Variety seeking in food | 1,31 | -0,82 | ** | -0,27 | -0,22 | |
| Prob > $Chi^2$ | | | | | | 0.00 |
| Pseudo $R^2$ | | | | | | 0.13 |

Note: Marginal effects are expressed in per cent points. *** *P < 0.01,* ** *P < 0.05,* * *P < 0.1*

Market attributes driving fruit buyers to purchase at chain stores included convenience of market (18%, $P < 0.05$) and prices (12%, $P < 0.05$). In contrast, friendliness of atmosphere (18%, $P < 0.01$*)* and access to locally grown fruits (16%, $P < 0.05$) deterred shoppers from choosing chain stores. These findings suggest that improving customer service and the supply of local fruits may influence customers to purchase at chain stores. It seems that consumers purchasing fresh fruits at chain stores care more about prices and one-stop convenience.

The only market attribute driving customers to choose club stores was access to organic fruits (5%, $P < 0.05$), while fruit selection (5%, $P < 0.05$) was a major barrier to purchasing fruits at these stores. This finding has important implications for club stores and warehouses. For example, managers of club stores could boost sales by offering more organic fruits and improving offline and online organic produce advertising.

Shoppers at independent stores were less likely to be driven by prices (8%, $P < 0.1$) or market convenience (13%, $P < 0.05$). Cho and Volpe (2017) reported that buyers choosing independent stores tend to be driven by specific fresh fruit attributes, including freshness and access to ethnic fruits. Our results also suggest that those purchasing at independent grocery stores are willing to pay premium prices as long as they have access to specialty fresh fruits.

Market attributes driving fruit buyers to purchase at local markets were availability of locally grown fruits (19%, $P < 0.01$), the only place they can find fruits they want (7%, $P < 0.01$), and friendly atmosphere (7%, $P < 0.05$). These attributes were consistent with previous studies reporting the drivers to purchase local produce (Pinto and Torres, 2017; Low et al., 2020). In contrast, distance to the market (8%, $P < 0.01$), prices (5%, $P < 0.05$), diversity of fruits (5%, $P < 0.05$), and fresh fruit selection (5%, $P < 0.1$) were major barriers to purchasing fresh fruits at DTC markets. Our findings suggest local buyers do not consider price as a determinant factor when selecting the marketplace for fresh fruits. Local market consumers seem to place more value on knowing more about their food, where it comes from, and the health, nutrition, and safety characteristics when buying from local markets.

## Conclusions

The marketplace choice for fresh fruit purchase is influenced by different marketplace attributes and consumers' attitudes. Focusing on four types of markets (e.g., chain stores, club stores, independent stores, and local markets) and four attitudinal scales, this study provides a better understanding of what guides consumers to purchase fresh fruits at a specific market, as well as the barriers when choosing a marketplace. Our findings have several implications. Creating a friendly atmosphere with creative displays and promoting consumer-sellers interaction seems to be driving consumers to choose the marketplace for fresh fruit purchases. Fresh fruit retailers can use our findings to develop marketing campaigns that emphasize sweetness, "localness," and diversity of fruits. Future research should focus on motivations influencing fresh fruit consumers through in-depth research interviews or new qualitative methods relying on cognitive sciences.

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# Fruit and Vegetable Consumption Among a Selected Group of Undergraduate and Graduate Students

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## Abstract

Students who consumed 1½-2 cups of fruits daily were more likely to be juniors; to live in households with income levels above $50,000; to be married or divorced; or to be employed. Consumption was not influenced by residence, household size, race, or gender. Forty-six percent of respondents did not eat vegetables daily; 48% ate 2-3 cups daily; and 6% consumed more than 3 cups daily. Students who worked were more likely to eat 2-3 cups of vegetables daily. Based on the 2015-2020 *Dietary Guidelines for Americans*, a majority of the participants met the minimum daily recommendations for fruits and vegetables.

**Keywords:** fruits, vegetables, undergraduate and graduate students, African Americans, ChooseMyPlate, Dietary Guidelines for Americans

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## Introduction

One of the messages included in the ChooseMyPlate toolkit developed by the United States Department of Agriculture encourages Americans to include dark-green, starchy, red, and orange vegetables, beans and peas, and other vegetables in their daily diets (U.S. Department of Agriculture, 2021a). Additional messages expand on the nutritional and health themes by emphasizing that fruits and vegetables have many desirable health benefits and, therefore, should become an integral part of a healthy diet (U.S. Department of Agriculture, 2021b). The researchers also suggested that by incorporating a variety of fruits and vegetables in our daily diets, Americans would get vitally important nutrients, such as potassium, dietary fiber, and vitamins A and C, and would lower the risks of developing chronic illnesses, such as heart disease and stroke, some types of cancers, high blood cholesterol, and high blood pressure, among others. They also mentioned that vegetables did not have cholesterol and that they were naturally low in fat and calories. Therefore, eating lower calorie vegetables such as beans, peas, or lentils instead of other higher calorie foods could impact weight gain and, ultimately, lower the trajectory of U.S. overweight and obesity rates (U.S. Department of Agriculture, 2021a). Researchers at the Harvard T. C. Chan School of Public Health (2020) indicated that although fruits and vegetables provided many desirable health benefits, no single fruit or vegetable contained all the nutrients needed for a healthy diet. Therefore, consumers should choose variety over quantity when incorporating fruits and vegetables into their diets. They suggested further that a diet rich in fruits and vegetables could lower blood pressure, control blood sugar levels, suppress appetite, and also lower the risks of developing heart disease, stroke, eye problems, and digestive problems. Thus, nonstarchy fruits and vegetables, such as apples, pears, and green leafy vegetables, should be a part of a healthy diet because of their weight-lowering potential.

## Problem Statement

Despite the overwhelming evidence of the benefits of incorporating a variety of fruits and vegetables in daily diets, many Americans do not eat fruits and vegetables daily, which may be one of the contributing factors to the rising overweight and obesity rates and rates of health-related diseases in the United States. The 2015-2020 *Dietary Guidelines for Americans* (U.S. Department of Health and Human Services, 2021)) recommend that to maintain good health and well-being, adults should eat at least 1½-2 cups of fruits and 2-3 cups of vegetables daily, among others. However, the diets of many American adults, including college students, do not meet these daily dietary recommendations. Given these realities, researchers at many colleges and universities have been studying students' dietary patterns for several years and have been encouraging students to adopt healthier eating habits whenever deficiencies are uncovered. Our study continues this trend by measuring fruit and vegetable consumption among a random sample of students to determine eating frequencies and factors associated with consumption of these food products.

## Objectives

The study's objectives are (1) to describe daily consumption of fruits and vegetables by a randomly selected group of students, and (2) to determine the extent to which selected sociodemographic

characteristics, such as academic classifications, household size, household income levels, residence, marital status, employment status, race, and gender, affect daily consumption levels of fruits and vegetables.

## Literature Review

Hoy et al. (2020) alluded to the dietary benefits of fruit and vegetable intake and concluded that total intake increased when wider varieties of fruits and vegetables were consumed, and the converse. Further, respondents who consumed salads had better nutrient intakes than those who did not, and that greater variety also led to higher overall consumption. They suggested that intake could be boosted by snacking on fruits and vegetables or adding them to main or side dishes. Martin et al. (2019) assessed how demographic characteristics affected consumption of a variety of fruits and vegetables by adults in the 2013-2016 National Health and Nutrition Examination Survey. Their findings suggested that demographic characteristics affected intake and that respondents aged 60 years or above compared to 20-29 years old, Asians, non-Hispanic blacks, and those with higher educational levels consumed greater varieties of fruits and vegetables. Their findings also suggested that only 25% of adults in the United States met the *Dietary Guidelines* for fruits and vegetables.

Berg et al. (2014) referred to some of the chronic diseases, such as cancer, heart disease, and stroke, that emanated from poor nutrition and lack of physical activity and suggested that these behaviors in adolescent and early adult years should be addressed because of their potential adverse effects on health and well-being later in life. Consequently, their study focused on fruit and vegetable intake based on the *Dietary Guidelines*, physical activity, and overweight/obesity rates among Black and White females attending two and four-year colleges. Their findings suggested that fruit and vegetable intake among White females was associated with greater extraversion, greater conscientiousness, limiting dietary fat intake, and higher level of physical activity. In the case of Black females, intake was associated with self-reported weight, actions toward weight management, limiting dietary fat intake, greater level of physical activity, and lower body mass indices. The study by Sa et al. (2016) found higher levels of overweight or obesity rates among a selected group of students at a historically Black university in Maryland than for the U.S. overall college student population. They also found that physical inactivity was higher among women and overweight or obese students. The authors concluded that historically Black colleges and universities should increase their efforts to promote healthier lifestyles among their student body to combat the prevalence of overweight and obesity on these campuses.

Ramsay et al. (2017) compared college students' reported fruit and vegetable preferences and intake from childhood to adulthood among a selected group of students and observed that females liked fruits and vegetables more than their male counterparts and, as a result, had a higher intake of these foods. Further, upperclassmen liked vegetables more than underclassmen. They also concluded that behavioral strategies were needed to increase fruit and vegetable intake among college students.

As argued previously, many American adults, including college students, do not meet the *Dietary Guidelines* for daily consumption levels for fruits and vegetables. In fact, many college students have very unhealthy eating habits and high levels of physical inactivity, which put them at increased risks for chronic diseases in adulthood. Thus, it is imperative for researchers to continue to study students' eating habits and to help them make healthier food choices when deficiencies are found. By examining college students' daily consumption of fruits and vegetables and factors associated with consumption, we will be able to help them make better food choices if deficiencies are found.

## Methods and Procedures

The study's data were compiled from a survey of 132 randomly selected university students in February and March 2020. The survey questions were designed to ascertain nutritional knowledge, fruit and vegetable consumption, and sociodemographic characteristics. Fruit and vegetable consumption was measured by asking participants how many cups of fresh or processed fruit (Fruit) they ate per day. The response categories were none, 1½ to 2 cups, or greater than 2 cups. Vegetable consumption was assessed by asking participants how many cups of fresh or processed vegetables (Vegetab) they consumed daily. The response categories were none, 2 to 3 cups, or greater than 3 cups. Data also were collected on academic classifications (Class); the number of persons living at participants' permanent addresses (Hsize); assessments of their families' total annual household income levels (Income); whether participants lived on or off campus (Live); participants' marital status (Marital status); work status (Work status); race (Race); and gender (Gender).

Descriptive statistics and the Chi-square tests for independence were used to address the two objectives. Percentages and the median were used in the first objective and Chi-square tests for independence were used for the second objective. The chi-square tests allow us to examine whether the two-response variables, fruit and vegetab, are independent of or dependent on the selected sociodemographic characteristics.

## Empirical Results and Discussion

Table 1 shows the descriptive statistics of the variables used in the study. The results revealed that 39% of the sampled students reported no consumption of fruits, while 61% reported eating 1½ -2 cups (54%) or more than two cups (7%) per day. A higher percentage of students (46%) reported no vegetable consumption on a daily basis; 48% indicated that they consumed 2-3 cups of vegetables daily; and 6% reported that they ate more than three cups of vegetables daily. The results also suggested that sophomores (47%) comprised the largest group of respondents, followed by juniors and graduate students (19%), freshmen (11%), and seniors. The median household size was three persons, and the median household income level ranged from $35,000–$49,999. The sample was dominated by students who lived off campus (61%), unmarried students (86%), students who worked (66%), African Americans (86%), and female students (77%).

**Table 1.** Descriptive Statistics for Consumption and Selected Sociodemographic Characteristics

| Variables | Summary Statistics |
|---|---|
| Fruit | |
| None | 39% |
| 1 ½-2 Cups | 54% |
| < 2 Cups | 7% |
| Vegetab | |
| None | 46% |
| 2-3 Cups | 48% |
| < 3 Cups | 6% |
| Class | |
| Freshmen | 11% |
| Sophomores | 47% |
| Juniors | 19% |
| Seniors | 4% |
| Graduate Students | 19% |
| Hsize | |
| Median | 3 |
| Income | |
| Median | $35,000-$49,999 |
| Live | |
| Off campus | 61% |
| Marital status | |
| Single | 86% |
| Work status | |
| Work | 66% |
| Race | |
| African Americans | 89% |
| Gender | |
| Female | 77% |

The results presented in Table 2 represent cross-tabulations between fruit consumption levels and students' sociodemographic characteristics. Based on the results, fruit consumption is closely

associated with academic classifications, income levels, marital status, and employment status but is independent of household size, area of residence, race, and gender. The results also indicate that freshmen are least likely to have eaten fruits and that juniors are more likely to eat the daily recommended amount of fruits. Students who reported a household income level between $15,000 and $34,999 are more likely to report that they do not eat fruits daily. Students whose household incomes exceed $50,000 are more likely to consume between 1½-2 cups of fruits daily. Married or divorced students and those who worked are more likely to consume the lower range for fruits on a daily basis compared to their corresponding counterparts.

**Table 2.** Factors Associated with Daily Fruit Consumption

| Variables | None | 1½ -2 Cups Percentages | < 2 Cups | $\chi^2$ | *p*-Value |
|---|---|---|---|---|---|
| Class | | | | | |
| Freshmen | 71.4 | 21.4 | 7.1 | | |
| Sophomores | 45.2 | 48.4 | 6.5 | | |
| Juniors | 16.0 | 76.0 | 8.0 | | |
| Seniors | 66.7 | 33.3 | 0.0 | | |
| Graduate Students | 24.0 | 68.0 | 8.0 | 17.567** | 0.025 |
| Hsize | | | | | |
| 3 ≤ | 39.6 | 54.7 | 5.7 | | |
| < 3 | 39.7 | 52.6 | 7.7 | 0.217 | 0.897 |
| Income | | | | | |
| > $15,000 | 47.4 | 42.1 | 10.5 | | |
| $15,000-$34,999 | 63.0 | 33.3 | 3.7 | | |
| $35,000-$49,999 | 42.1 | 50.0 | 7.9 | | |
| ≤ $50,000 | 20.8 | 72.9 | 6.2 | 15.186** | 0.019 |
| Live | | | | | |
| Off Campus | 43.8 | 51.2 | 5.0 | | |
| On Campus | 32.7 | 57.7 | 9.6 | 2.206 | 0.332 |
| Marital status | | | | | |
| Single | 43.0 | 50.0 | 7.0 | | |
| Other | 16.7 | 77.8 | 5.6 | 5.012* | 0.082 |
| Work status | | | | | |
| No | 33.3 | 53.3 | 13.3 | | |
| Yes | 42.5 | 54.0 | 3.4 | 4.890* | 0.087 |

**Table 2. (continued)**

| Variables | None | 1½ -2 Cups Percentages | < 2 Cups | $\chi^2$ | *p*-Value |
|---|---|---|---|---|---|
| Race | | | | | |
| African Americans | 39.8 | 53.4 | 57.1 | | |
| Other | 35.7 | 57.1 | 7.1 | 0.089 | 0.956 |
| Gender | | | | | |
| Female | 38.2 | 52.9 | 8.8 | | |
| Male | 43.3 | 56.7 | 0.0 | 2.860 | 0.239 |
| Total | 39.0 | 54.0 | 7.0 | | |

Note: Single and double asterisks (*,**) indicate statistical significance at the 10% and 5% levels, respectively.

Vegetable consumption is lower than fruit consumption, and only one of the selected sociodemographic characteristics is statistically significant at the 5% level (Table 3). The results also suggest that students who worked are more likely to eat 2-3 cups of vegetables daily and that those without jobs are more likely to consume more than 3 cups of vegetables per day. Vegetable consumption is independent of academic classifications, household size, income levels, where students lived, marital status, race, or gender.

**Table 3.** Factors Associated with Daily Vegetable Consumption

| Variables | None | 2 -3 Cups Percentages | < 3 Cups | $\chi^2$ | *p*-Value |
|---|---|---|---|---|---|
| Class | | | | | |
| Freshmen | 57.1 | 35.7 | 7.1 | | |
| Sophomores | 54.8 | 38.7 | 6.5 | | |
| Juniors | 36.0 | 60.0 | 4.0 | | |
| Seniors | 66.7 | 33.3 | 0.0 | | |
| Graduate Students | 24.0 | 68.0 | 8.0 | 10.555 | 0.228 |
| Hsize | | | | | |
| 3 ≤ | 52.8 | 39.6 | 7.5 | | |
| < 3 | 41.0 | 53.8 | 5.1 | 2.590 | 0.274 |
| Income | | | | | |
| > $15,000 | 42.1 | 57.9 | 0.0 | | |
| $15,000-$34,999 | 66.7 | 25.9 | 7.4 | | |
| $35,000-$49,999 | 50.0 | 44.7 | 5.3 | | |
| ≤ $50,000 | 33.3 | 58.3 | 8.3 | 10.339 | 0.111 |

**Table 3. (continued)**

| Variables | None | 2 -3 Cups Percentages | < 3 Cups | $\chi^2$ | *p*-Value |
|---|---|---|---|---|---|
| Live | | | | | |
| Off campus | 41.2 | 51.2 | 7.5 | | |
| On campus | 53.8 | 42.3 | 3.8 | 2.304 | 0.316 |
| Marital status | | | | | |
| Single | 48.2 | 45.6 | 6.1 | | |
| Other | 33.3 | 61.1 | 5.6 | 1.539 | 0.463 |
| Work status | | | | | |
| No | 51.1 | 35.6 | 13.3 | | |
| Yes | 43.7 | 54.0 | 2.3 | 8.433** | 0.015 |
| Race | | | | | |
| African Americans | 45.8 | 48.3 | 5.9 | | |
| Other | 50.0 | 42.9 | 7.1 | 0.157 | 0.925 |
| Gender | | | | | |
| Female | 48.0 | 46.1 | 5.9 | | |
| Male | 40.0 | 53.3 | 6.7 | 0.603 | 0.740 |
| Total | 46.0 | 48.0 | 6.0 | | |

Note: Double asterisk (**) indicates statistical significance at the 5% level.

## Summary and Conclusions

The study's main objectives were to describe daily fruit and vegetable consumption among a selected group of university students and factors associated with consumption levels. The results suggested that juniors, those from households with income levels in excess of $50,000, married or divorced students, and those who were employed were more likely to consume the minimum recommended daily intake for fruits compared to their corresponding counterparts. Vegetable consumers were more likely to be employed compared to those without jobs. Academic classifications, household size, income levels, residence, marital status, race, and gender had no association with vegetable consumption.

Despite the health benefits of eating fruits and vegetables, many Americans, including college students, often fall short of the daily recommendations for these foods. The shortfall may be because fruits and vegetables are more costly than many high-calorie foods, or that many Americans live in food deserts, and therefore, do not have easy access to fresh fruits and vegetables. To the extent that deserts exist, every effort must be made to ensure that more Americans can have access to high-quality produce at reasonable prices. At the university level, we can also expose

students to the benefits of consuming fruits and vegetables alluded to in the introduction and encourage them to adopt healthier eating styles for long-term health and wellbeing.

The study's data were collected prior to the explosion of COVID-19 in the United States, ensuing lockdown, and disruptions in the food supply. Hopefully, the food supply chain will be able to respond more readily to future external shocks and suppliers of fresh fruits and vegetables will be able to seamlessly meet consumer demand and not jeopardize healthy eating habits.

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# A Survey of Shopping Changes under COVID-19

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## Abstract

Before COVID-19, less than 7% of annual American grocery sales took place online. We hypothesize that during the COVID-19 pandemic, shoppers have decreased in-person shopping and increased online shopping. We conducted a survey of 780 grocery shoppers in five Northeastern states in May 2020. The percent of groceries purchased online increased from 8.4% pre-COVID-19 to 21.1% during COVID-19, whereas the percent of purchases from physical stores declined from 85.3% to 72.4%. Increases in online purchases resulted from 1) an increase in the number of online users, and 2) an increase in the amount purchased online by pre-COVID-19 online users.

**Keywords:** online, shopping behaviors, supermarkets, COVID-19

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## Introduction

Shopping for groceries and preparing food are common activities in American households. During the current COVID-19 pandemic, we hypothesize that those activities have changed. The current situation that has resulted from COVID-19 is unprecedented. People have lived under stay-at-home orders; restaurants, schools, and other places where consumers obtain foods have closed; and food supply chains, processing plants, and farms have all been disrupted due to COVID-19 outbreaks among workers. And nowhere, at the time of the study, was the pandemic having a greater impact than in our study region, which includes Connecticut, Massachusetts, New Jersey, New York, and Pennsylvania.

On March 21, the study region started implementing statewide stay-at-home orders (Ballotpedia, 2020). When the survey launched May 21, consumers had been living under the orders for approximately two months.

Before the pandemic, online grocery sales were increasing quickly. Nielsen's Brandbank reported average 2019 online sales as being 4% of total grocery sales (Dunning 2020). Online sales increased throughout the year, and in December 2019, Brick Meets Click, a consulting group that studies digital effects on the grocery sector, reported that online grocery sales accounted for 6.3% of the total amount spent on groceries in the United States (Melton, 2019). They predicted online sales would increase to approximately 7.0% of the market in 2020.

In March 2020, society changed. Although grocery stores remained open as essential businesses, the emergence of the pandemic, stay-at-home orders, and food service shutdowns caused online grocery sales to accelerate sharply. Many consumers were concerned for their safety and shopped in the shelter of their homes while retailers fast-tracked emerging online shopping operations to meet the demand (Redman, 2020).

## Methods

We surveyed shoppers in Connecticut, Massachusetts, New Jersey, New York, and Pennsylvania, the region most heavily affected by COVID-19 at the time of the survey. A survey panel was recruited by Qualtrics, and survey data were collected May 21-26, 2020. Shoppers in New York state provided 41% of the survey responses, which is a slightly higher proportion than the state represents in the survey region's total population.

Respondents self-described the type of area in which they lived as being rural, urban, or suburban, with 26.7% indicating that they lived in a rural area, 37.2% from a suburban area, and 36.2% from an urban area (Table 2). Using the Census Bureau definitions for urban and rural areas, 87.3% of the population in the five-state region surveyed lives in urban areas and 12.7% in rural areas (Iowa State University). Therefore, our survey overrepresents the rural population in the region.

Responses to the demographic questions in the survey are presented in Table 1. One psychographic question was included in an effort to provide additional strength to the analyses. This question

asked respondents about how much information or news they follow about COVID-19. The purpose of the question was to describe to what degree respondents were worried about the disease, and, therefore, how they might be changing their normal shopping habits.

**Table 1.** Respondent Demographics

| Variable | Description | % of Respondents |
|---|---|---|
| Current employment | I am still employed at the rate of employment prior to the COVID-19 crisis. | 37.2 |
| | I am still working but not as much as prior to the COVID-19 crisis. | 13.9 |
| | I am currently furloughed. | 7.8 |
| | I became unemployed after the COVID-19 crisis hit and am not receiving unemployment. | 4.7 |
| | I am currently on unemployment due to the COVID-19 crisis. | 7.2 |
| | I am currently retired. | 18.5 |
| | Other, please describe. | 10.7 |
| News regarding COVID-19 | I follow as much information about COVID-19 as I can. | 29.4 |
| | I follow information about COVID-19 every day. | 44.2 |
| | I follow information about COVID-19 on occasion | 23.3 |
| | None, I do not follow information about COVID-19. | 2.8 |
| Marital status | Single | 38.9 |
| | Married | 55.1 |
| | Other | 6.0 |
| Children | Number of children under 18 (number) | 0.55 |
| Education | Less than high school | 1.0 |
| | High school/GED | 20.4 |
| | Some college | 16.7 |
| | 2-year college degree | 9.5 |
| | 4-year college degree | 30.1 |
| | Graduate/professional degree | 22.3 |
| Household income in 2019 before taxes | I prefer not to say | 3.6 |
| | Less than $20,000 | 10.6 |
| | $20,000–$39,999 | 15.4 |
| | $40,000–$59,999 | 15.1 |

**Table 1. (continued)**

| Variable | Description | % of Respondents |
|---|---|---|
| Household income in 2019 before taxes | $60,000–$79,999 | 17.2 |
| | $80,000–$99,999 | 10.8 |
| | $100,000–$119,999 | 6.3 |
| | $120,000–$139,999 | 5.1 |
| | $140,000–$159,999 | 5.1 |
| | $160,000–$179,999 | 2.3 |
| | $180,000–$199,999 | 2.9 |
| | $200,000 or greater | 5.5 |

## Results

Respondents reported a large increase in the percent of groceries purchased online "normally," from pre-COVID-19 to "currently," from 8.4% to 21.1% (Table 2), an increase of 152%. This increase is counterbalanced by the decrease in the proportion of in-store grocery purchases from 85.3% to 72.4%. Other shopping methods, such as direct from farm, remained essentially unchanged.

**Table 2.** Percent of Groceries Purchased from Different Retail Types, Normally and Currently

| | A physical store[1] | Ordered online and either picked up or delivered[2] | Farmer direct[3] | Other |
|---|---|---|---|---|
| Normally, before COVID-19 | 85.3% | 8.4% | 4.3% | 1.9% |
| Currently | 72.4 | 21.1 | 4.1 | 2.5 |

Note: [1]Such as a supermarket or other grocery store
[2]Such as Kroger, Walmart, Instacart, Shipt, AmazonFresh, Fresh Direct, Peapod, etc.
[3]Such as farm stand, farmers market, CSA, online farm store, etc.

The total increase in online grocery purchases resulted from 1) an increase in the amount purchased online by pre-COVID-19 online users (59.2% of those who previously purchased online increased their online grocery purchases), and 2) an increase in total online users, from 30.8% of respondents to 45.5%.

Respondents from our five-state region reported 8.4% of their groceries were purchased online prior to COVID-19. This number is between the figure reported by Bricks and Clicks and that reported by FMI, and we feel the responses from our survey of the region are valid.

We used OLS (ordinary least squares) to examine which consumers were normally associated with greater purchasing online pre-COVID-19 (regression estimates and *p*-values shown in Table 3). Before COVID-19, those who were likely to have purchased more groceries online were urban,

male, younger than 65, and respondents with children under 18. Income[1] was not significant in explaining greater online grocery purchases pre-COVID-19.

**Table 3.** Regression Estimates for Percent of Groceries Ordered Online, Pre-COVID-19

| Variable | Estimate | Std. Error | *t*-ratio |
|---|---|---|---|
| Intercept | 6.788*** | 1.761 | 3.854 |
| Higher educated | 0.275 | 1.277 | 0.216 |
| Income | 1.876 | 1.260 | 1.489 |
| Rural | -0.947 | 1.466 | -0.646 |
| Urban | 5.696*** | 1.349 | 4.224 |
| Female | -5.312*** | 1.168 | -4.546 |
| 18–34 years old | -0.398 | 1.448 | -0.275 |
| 65 years old or older | -3.243* | 1.509 | -2.148 |
| Child(ren) | 5.314*** | 1.334 | 3.983 |
| Married | 0.059 | 1.326 | 0.044 |
| R-squared | 0.136 | | |

Note: Single, double, and triple asterisks (*, **, ***) indicate significance at a 10%, 5%, and 1% level.

As reported earlier, 59.2% of those who purchased online pre-COVID-19 increased their online grocery purchases during the pandemic. Those respondents who increased their purchases online were more likely to be those with four years or more of college, urban, those who consume information about COVID-19 daily,[2] and those with children under 18 (Table 4).

**Table 4.** Coefficients for Those Who Increased Their Percent of Groceries Ordered Online

| Variable | Estimate | Std. Error | *t*-ratio |
|---|---|---|---|
| Intercept | -2.263*** | 0.388 | -5.826 |
| Higher educated | 0.504** | 0.186 | 2.707 |
| Income | 0.301 | 0.179 | 1.681 |
| Rural | 0.204 | 0.217 | 0.940 |
| Urban | 0.562** | 0.192 | 2.922 |
| Female | -0.129 | 0.168 | -0.768 |
| 18–34 years old | 0.265 | 0.208 | 1.274 |
| 65 years old or older | -0.009 | 0.276 | -0.033 |
| Employed | 0.136 | 0.297 | 0.457 |
| Unemployed | 0.312 | 0.324 | 0.965 |
| Retired | 0.017 | 0.386 | 0.043 |
| COVID-19 information | 0.494* | 0.194 | 2.542 |
| Child(ren) | 0.452* | 0.189 | 2.393 |
| Married | 0.331 | 0.194 | 1.711 |
| Log-likelihood value | -449.122 | | |

Note: Single, double, and triple asterisks (*, **, ***) indicate significance at a 10%, 5%, and 1% level.

[1] For the regression models, we convert each income category to a numeric value by assuming each observation lies at the mean of its associated category.

[2] This variable was not included in the question about shopping pre-COVID-19, because it would not have been a logical option.

As reported earlier, more people started online shopping after COVID-19 struck and stay-at-home orders were issued. Were these additional consumers in the same demographic group as previous users, or did the pandemic provide incentive to consumers in different demographic groups to use online grocery shopping?

A logit model was used to analyze which respondents started shopping online during the pandemic in spring 2020 (regression estimates and *p*-values are shown in Table 5). Respondents new to online grocery shopping during the COVID-19 pandemic in the spring were very different from those who shopped online prior to COVID-19, and were more likely to have completed four years or more of college and be female and married.

**Table 5.** Regression Estimates for New Online Grocery Shoppers during COVID-19

| Variable | Estimate | Std. Error | *t*-ratio |
|---|---|---|---|
| Intercept | -2.774*** | 0.481 | -5.770 |
| Higher educated | 0.582* | 0.234 | 2.483 |
| Income | -0.242 | 0.231 | -1.048 |
| Rural | 0.226 | 0.260 | 0.869 |
| Urban | -0.022 | 0.243 | -0.090 |
| Female | 0.815*** | 0.222 | 3.662 |
| 18–34 years old | 0.257 | 0.258 | 0.995 |
| 65 years old or older | -0.207 | 0.344 | -0.602 |
| Employed | -0.034 | 0.349 | -0.097 |
| Unemployed | 0.114 | 0.382 | 0.298 |
| Retired | 0.249 | 0.450 | 0.554 |
| COVID-19 information | 0.071 | 0.235 | 0.304 |
| Child(ren) | 0.129 | 0.238 | 0.541 |
| Married | 0.524* | 0.242 | 2.169 |
| Log-likelihood value | -324.088 | | |

Note: Single, double, and triple asterisks (*, **, ***) indicate significance at a 10%, 5%, and 1% level.

## Conclusions

The disruptions caused by the changes in grocery purchasing patterns have been extensive, and researchers and industry need to understand the extent of the changes.

We feel shoppers in the five-state region of the United States hardest hit by COVID-19 in the spring of 2020 acted as a bellwether for how shoppers reacted in the rest of the United States as the pandemic unfolded. With COVID-19 still prevalent, online grocery shopping is expected to remain higher than pre-COVID-19 levels, even though industry sources indicate that the growth is slowing.

We examined the demographics of those respondents who had been shopping online. We then looked at which respondents were more likely to have increased their online shopping and which respondents were more likely to have started shopping online during the pandemic. The respondents who increased their online shopping during the pandemic shared demographic descriptors, with a larger set of those who had already been shopping online pre-COVID-19.

The respondents who started shopping online appear to be different demographically and were more likely to have more than four years of college, be female, and be married.

Opportunities to expand the online shopper base continue to exist, especially during the pandemic and as online shopping becomes even more available to the vast majority of consumers. Demographics to target in the future include females and those older than 65.

Beyond targeting specific demographics, retailers can encourage larger online shopping baskets and/or more frequent use of online shopping. According to our survey, of those respondents currently shopping online, only 46.4% of their groceries are being purchased online. Therefore, they are still shopping in store for 55.4% of their groceries. Given that shoppers are limiting the number of visits to and reducing the amount of time spent in grocery stores, retailers might want to investigate why online shoppers are not purchasing more of their groceries in this way.

The Food Marketing Institute has suggested ways in which retailers can improve their online shopping (Markenson, 2020). These operations include better product selection, faster delivery, easier-to-use websites, more and better product information, and more accurate search functionality

Some factors may decrease or stall online shopping. Many retailers and online shopping services charge for picking, handling, or delivery and may place a surcharge on the products themselves. These generally higher costs of online shopping could dampen sales if the country enters a recession.

Can retailers keep their new online shoppers? Most industry experts believe online shopping will remain higher than pre-COVID-19 levels, although it may drop after the pandemic is over (Bitter 2020).

If retailers want to continue or expand their current online presence, they will need to be prepared to manage their online shopping programs innovatively and effectively to maintain sales and customers.

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# U.S. Consumers' Intake of Food at Home (FAH) and Food Away from Home (FAFH) As a Complex Economic System

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## Abstract

Americans spend billions of dollars in personal consumption expenditures each year. The percentage of FAH expenditures in the United States has been dwindling, while the percentage of FAFH expenditures has increased. Many factors might be causing this trend. Complex interactions of such factors determining the U.S. consumer's intake of FAH and FAFH expenditures were studied using machine learning and Directed Acyclic Graphical approaches. Employment and education status are common causes of both FAH and FAFH expenditures. Body mass index, marital status, race and sex have mixed effects. Findings will be useful for policy makers to implement social support programs.

**Keywords:** food at home, food away from home, TETRAD, directed acyclic graphs, machine learning

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## Introduction

Americans spend 9.7% of their disposable income on food each year, and food expenditures are the third largest in the U.S. economy (Saksena et al., 2018; USDA, 2019). In 2018, Americans spent on average $7,923 on food (Bureau of Labor Statistics, 2019). These expenditures are commonly separated into two categories—food at home (FAH) and food away from home (FAFH). Over the last three decades, consumers' food expenditure patterns have shifted, as food away from home expenditures increased. surpassing food at home in 2009 for the first time. Many possible factors could be influencing this shift, including market shifts, micro and macroeconomic variables, socioeconomic status, and consumer tastes and preferences.

As of 2018, less than 50% of food expenditures were used to purchase FAH. According to the Economic Research Service (ERS) of the U.S. Department of Agriculture, food at home is all food purchased from supermarkets, retailers, smaller grocery stores, or supercenters (Saksena et al., 2018). It can include prepared or semiprepared items that are consumed off premise or at home (Saksena et al., 2018). Most of consumers' food expenditures were used for food at home until 2009. In fact, before the twentieth century, most FAFH meals were only for special events or celebrations, and these meals were normally brought from someone else's home (Saksena et al., 2018). FAFH did not begin to rise until the industrialization period at the end of the nineteenth century. The changing times, urbanization, and the creation of automobiles can be credited for changing the food market and the increasing FAFH expenditures (Saksena et al., 2018). Food away from home is defined as food obtained from restaurants (full service and fast food), school lunches, and an "other" category (vending machines, someone else) (Saksena et al., 2018). The rise of FAFH began at the end of the nineteenth century but did not become dominant until the end of the twentieth century. The creation of the automobile resulted in more workers traveling, thus increasing demand for taverns and cafeterias. However, the eating establishments were visited only if necessary, and most preferred food cooked at home (Saksena et al., 2018). As disposable income increased, more women entered the workforce, and restaurants began to increase in quality and quantity, food-away-from-home expenditures started to climb. However, most of these restaurants still catered to workers looking for a quick meal. It was not until the 1930s that restaurants began to focus on family dining (Saksena et al., 2018). This time also brought an increase in chain restaurants. In the 1960s, the number of restaurants began to increase, and by the 1980s the number had grown by 100% (Saksena et al., 2018). The changing food and work environments have caused more and more food expenditures to be spent on convenience food. Currently, FAFH expenditures account for over 50% of food expenditures (Saksena et al., 2018).

The growing complexity of the food environment and the variables that impact consumers' food expenditures have created complex interactions and have made it difficult to single out variables, specifically in assessing or creating various government policies. Factors that are causing Americans to consume food at home or away from home might be causing some other factors that are determining such consumption patterns. This interaction among variables makes the food purchase patterns a complex economic system. This study uses novel approaches in causality modeling developed using artificial intelligence and machine learning (such as directed acyclic graphs [DAGs]) to study U.S. consumers' intake of FAH and FAFH expenditures. Mapping these

complex interactions of variables creating the intake of FAH and FAFH expenditures can create useful information for policy makers to create viable support programs. In light of this, the main objective of this study is to discover factors that influence consumption of food at home and food away from home and, subsequently, to discover possible interactions among them.

## Literature Review

Literature suggests that factors such as income, time constraints, the relative price of food and non-food items, and household demographic composition are important factors determining the U.S. consumer's food expenditures.

Income plays a large role in the demand for food products. Kamakura and Du (2012) found that the Engel curve (relationship between household income and expenditure on food) for FAFH is upward sloping or a normal good. In contrast, FAH was found to be downward sloping or an inferior good. This relationship was found by an empirical study of expenditures of 30 major commodities over two decades in which the United States faced three recessions. However, during recessionary times FAH expenditures increase and FAFH expenditures decrease (Kamakura and Du, 2012; Saksena et al., 2018).

Time constraints, according to Rahkovsky and Young (2018), can lead to changes in consumers' intakes. This study used the Exact Affine Stone Index (EASI) implicit Marshallian demand model with data from the National Household Food Acquisition and Purchase Survey (FoodAPS) to determine how time constraints influence food demands. As income increases, a higher percentage of expenditures move to more full-service restaurants or more convenient food options. This move can be a costly choice, both in dollars and in nutrition. Food away from home tends to be higher in both categories (Young and Rahkovsky, 2018). Employment can affect consumption patterns as well. Households in which all adults were employed spent more at restaurants. However, if the primary shopper was unemployed, they spent only 36% of their food budget on FAFH (Young and Rahkovsky, 2018). Household demographics, such as age, household size, and structure of the household, could play a large role in food purchases due to stricter time constraints.

## Data and Methodology

Data from the USDA Food Acquisition and Purchase Survey (FoodAPS) was used in this study. This survey is a national panel of 4,826 U.S. households and contains information about individual's purchases (USDA-ERS, 2017). Included in this data were FAH and FAFH purchases among a host of other variables. The group sample varies, from those who participate in nutrition assistance programs, low-income households not participating in these programs, and households with higher incomes. FoodAPS participants collected data in seven-day periods between April 2012 and January 2013. They collected all information about purchases at and away from home. These households were instructed to save receipts, scan barcodes, and record other information in food journals (Senia, 2017). The information includes "the quantities, prices, and expenditures for all at home and away from home foods and beverages purchased or acquired by all household members, eating occasions by household members" (Senia, 2017). Other factors were collected

such as income, program participation, food security, health status, and distance to local supermarkets. Data from this survey were also broken down into individual results of the 14,317 members of the household. This analysis allowed us to use the individual level variables, such as Body mass index (BMI), in this study. Because BMI is only available for individuals older than 2 years old, we removed all children under 2 years from this study. This is due to the inaccuracy of BMI for children under 2 as stated by the committee on childhood obesity (Senia, 2017). We also restricted the dataset for those over the age of 21. The exclusion of individuals under the age of 21 was due to a lack of data, which can be explained by the participant receiving meals from outside sources, such as schools. Another possible reason would be the lack of these individuals' purchasing power. If they did make food purchases, they were most likely recorded in their guardian's purchases. In the end, data from 9,152 individuals were used in the study.

Table 1 gives description and summary statistics for all variables used in this study. The average age is around 46 years, and 54% of the sample is female. The racial breakdown is as follows: 69% White, 14% Black, 5% Asian, 1% American Indian, and the remainder identify as another race or multiple races. Around 22% of the sample claim Hispanic ethnicity, 46% are married, 6% are widowed, 14% are divorced, 4% are separated, 30% have never been married, and 51% are employed. This study investigates how socioeconomic and individuals' characteristics affect and interact in consumer expenditure patterns in the United States. Patterns are developed using causality structures identified through cutting-edge machine learning algorithms. Some variables are set to be exogenous (such as race, age, sex) in this study. These causality structures are developed using Directed Acyclic Graphs (Pearl, 2009).

Using the Greedy Equivalence Search (GES) machine-learning algorithm, a graphical causal structure among variables was developed by searching over Markov equivalence classes (Meek, 1997; Chickering, 2002; Senia, 2017). Dharmasena et al. (2016) used these techniques to develop causality models on U.S. food environment factors. GES is run using the TETRAD statistical program. This algorithm finds the optimal causal structures that minimize Bayesian Information Criteria (BIC). The BIC approximation is explained in Chickering (2002) from the Schwarz Loss Function, and it underlines the assumptions of GES. The assumptions are causal sufficiency condition, causal faithfulness condition, and causal Markov condition (Dharmasena et al., 2016). Causal sufficiency condition assumes that the variables identified are sufficient to be in the model to develop the DAG of food expenditure patterns. Causal faithfulness condition shows that the edge removal is solely dependent on the correlation and conditional correlations between variables and not due to deep parameter cancellations between the nodes. Causal Markov condition assumes that the joint probability distribution of the variables under consideration is determined by the product of marginal probabilities of each variable and the conditional probability of a given variable, only conditioned on the preceding parent variable. More discussion on these is found in Dharmasena et al. (2016).

**Table 1.** Descriptions of Variables and Descriptive Statistics

| Variable Name | Variable Description | Mean | Std. Dev | Min | Max |
|---|---|---|---|---|---|
| FAH | Money spent on Food at Home ($/person/week) | 52.06 | 84.67 | 0 | 1,810.05 |
| FAFH | Money spent on Food Away from Home ($/person/week) | 17.87 | 35.42 | 0 | 646.78 |
| BMI | Individual's calculated Body Mass Index | 28.28 | 6.93 | 0.81 | 160.15 |
| **Variable Name** | **Variable Description** | **Percentage** | | | |
| Sex | Female | 54 | | | |
| | Male | 46 | | | |
| Hispanic | Hispanic | 22 | | | |
| | Non-Hispanic | 78 | | | |
| Race | White | 69 | | | |
| | Black | 14 | | | |
| | American Indian | 1 | | | |
| | Asian | 5 | | | |
| | Other | 9 | | | |
| | Multiple race | 13 | | | |
| Education | Less than $10^{th}$ grade | 13 | | | |
| | High school, no diploma | 6 | | | |
| | High school, diploma | 32 | | | |
| | Some college | 29 | | | |
| | Bachelor's degree | 13 | | | |
| | Master's degree or doctorate | 6 | | | |
| | No education | < 1 | | | |
| Marital | Married | 46 | | | |
| | Widowed | 6 | | | |

**Table 1. (continued)**

| Variable Name | Variable Description | Percentage |
|---|---|---|
| Marital (continued) | Divorced | 14 |
| | Separated | 4 |
| | Never married | 30 |
| Employment | Employed | 51 |
| | Unemployed | 49 |

## Results

Figure 1 shows the Directed Acyclic Graph (causality structures) developed for consumer expenditures and various variables. The edges with direction dictate the predictor and the predicted variables in the regression model (Kim and Dharmasena, 2018). "Each number on an edge is the estimated slope coefficient of the predictor variable when the arrow-received variable (dependent variable) is regressed on every causing variable (independent variable)" (Kim and Dharmasena, 2018). Table 2 provides the estimated coefficients for all edges (marginal effects), as well as the *p*-values. All the variables are significant at a 1% level or lower.

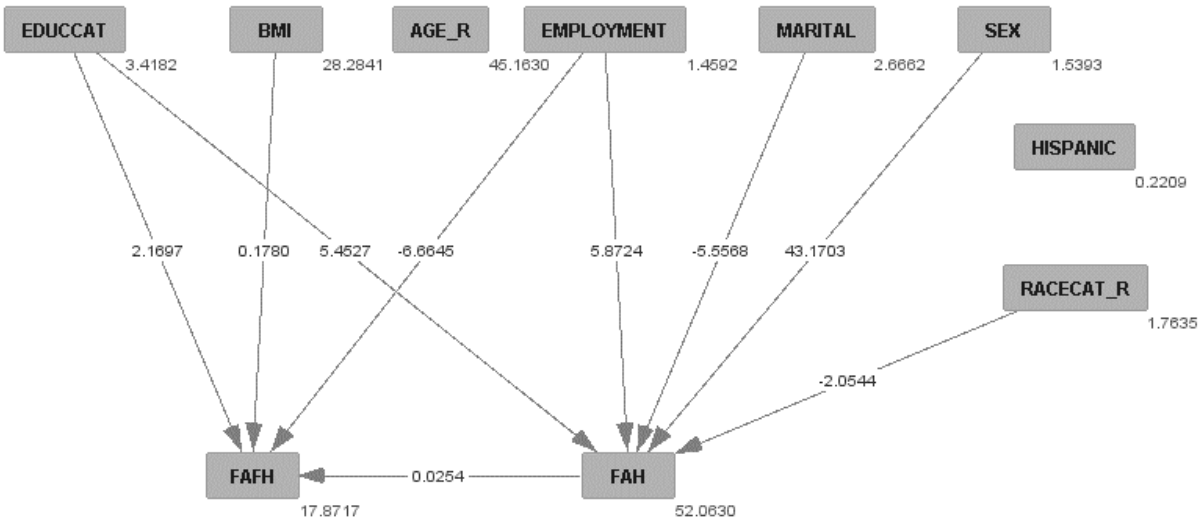


**Figure 1.** Directed Acyclic Graph (DAG) of Consumer Expenditures on FAH and FAFH

Note: Marginal effects are the numbers shown on arrows. The numbers by the boxes are means for each variable.

First, there is a contemporaneous causality relationship between food at home and food away from home expenditures, meaning more food at home purchased leads to an increase in food away from home purchases. However, this is a weak effect and can be explained by other factors. Sex was found to have the largest impact on FAH, with women purchasing more than their male counterparts. Marital status and race have a negative impact on FAH. Employment effects both FAH and FAFH but has differing signs as it negatively impacts food away from home and positively impacts food at home. Education has a positive effect on both FAFH and FAH. BMI has a positive effect on FAFH. This model found that age and ethnicity are not determining factors of FAH and FAFH expenditures.

**Table 2.** Parameter Estimates for Each Edge

| From | To | Edge Coefficient* | *p*-Value |
|---|---|---|---|
| FAH | FAFH | 0.0254 | <0.0000 |
| BMI | FAFH | 0.1780 | 0.0008 |
| Education | FAFH | 2.1697 | <0.0000 |
| Employment | FAFH | -6.6645 | <0.0000 |
| | | | |
| Race | FAH | -2.0544 | 0.0008 |
| Employment | FAH | 5.8724 | 0.0007 |
| Marital | FAH | -5.5568 | <0.0000 |
| Sex | FAH | 43.1703 | <0.0000 |
| Education | FAH | 5.4527 | <0.0000 |

Note: Significance level considered is *p*-value 0.01; *Edge Coefficient is the partial effect of the variables.

## Conclusions

Factors affecting FAFH expenditures are an individual's education status, body mass index, and employment status. Food-at-home expenditures are determined by the individual's education status, employment status, marital status, gender, and race. The resulting knowledge of direct and indirect causal relationships among consumer expenditures and other factors will be useful in food marketing, as well as for government policy makers to design appropriate food assistance programs.

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# Potential of Grow-out of Softshell Blue Crabs in Ponds Stocked with Juvenile Crabs

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## Abstract

Economic simulations were performed to guide the planning and managing of additional pilot experiments in softshell blue crab grow-out to maximize harvests and improve profitability. The potential costs and benefits are weighed in advance before implementing any planned changes. In making these simulations, the current information on softshell blue crab production is used. Simulations initially considered the cost of juvenile crabs as produced by private hatcheries and nurseries. Additional simulations cover the impacts of increasing survival rates and stocking density. Finally, simulations of discounted net annual cash inflows incorporated the wholesale prices of blue softshell crabs in the Mid-Atlantic markets.

**Keywords:** economic feasibility, pond culture, soft blue crabs, brackish water

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## Introduction

This research project is a collaborative effort of several research, teaching, and outreach institutions in Mississippi and North Carolina (Perry et al., 2018). The University of Southern Mississippi, Gulf Coast Research Laboratory, in Ocean Springs, Mississippi, developed and shared its blue crab hatchery and nursery and pond grow-out research results (Perry et al., 2010; Ciurcza, 2019; Waycott, 2019; University of Southern Mississippi, 2020). The North Carolina Sea Grant Program coordinated the blue crab project with a community college aquaculture program. The Carteret Community College in Moorehead, North Carolina, conducted the blue crab hatchery and nursery, pond grow-out research activities (Schneider, 2019). The Thomas Seafood of Carteret Company in Beaufort, North Carolina, hosted the pond grow-out, shedding facility, storage, and marketing activities. The Mississippi State University, Coastal Research and Extension Center, in Biloxi, Mississippi, provided expertise in aquaculture economics and marketing to assess the economic viability of the soft blue crab pond grow-out system (Basher, 2019).

The U.S. commercial softshell blue crab landings have drastically declined since 2000. This decline in commercial softshell blue crab landings radically altered the domestic market situation for blue softshell crabs (Franze and Lively, 2018; Peveto, 2018; Brasher, 2019). The ex-vessel prices of blue softshell crab have been persistently increasing over the years, with a marked increase during the last five years after the recession and the Gulf of Mexico oil spill.

Indoor blue crab hatchery and nursery technologies have been developed over the years at the University of Southern Mississippi, Gulf Coast Research Laboratory (Perry et al., 2020). Several years of pond grow-out trials were conducted to evaluate the feasibility of growing softshell blue crabs in low salinity ponds in Lyman, Mississippi (Perry, et al., 2010; Mississippi Department of Marine Resources, 2012). A collaborative project was funded by the National Sea Grant Program to test these pond production technologies in brackish water ponds in Beaufort, North Carolina (Perry et al., 2018). Two years of pond trials produced initial results for evaluating the economic feasibility of these production technologies.

This economic analysis' overall objective is to estimate the costs of producing blue softshell crabs in brackishwater ponds. Specifically, it aims to achieve the following objectives: 1) to evaluate the operating costs of producing blue softshell crabs in a pond grow-out production system, and 2) to develop optimal economic models of softshell blue crab production systems subject to supply and technological constraints.

## Methods

To produce these simulations, the North Carolina model in pond design, construction, and preparation and the Mississippi data on stocking and survival were combined to create a hypothetical blue crab farm (Table 1). The key assumptions include three crops per year and 4 quarter-acres of ponds. The stocking density is first set at 4,000 juvenile crabs per pond and then raised to 6,000 juveniles per pond. Survival rates are initially pegged at 50%.

In the initial stages of industry development, critical state and federal assistance are provided to enable the emerging industry to launch. Additional simulations cover the impacts of increasing survival rates. Finally, simulation results of production costs are compared to long-term variability in the wholesale prices of blue softshell crabs in the Mid-Atlantic U.S. wholesale markets.

**Table 1.** Technical Parameters for Softshell Blue Crab Farm Pond Production System

| Item | Description | Benchmark |
|---|---|---|
| Stocking density | # of juveniles per pond | 6,000 |
| Growth rate | g/day | 1.50 |
| Survival rate | % | 50 |
| Stocking weight | g | 0.25 |
| Stocking length | mm | 17.00 |
| Juvenile crabs cost | $/crab | 0.00 |
| Average production | doz of crabs per pond per crop | 250 |
| Average production | # of crabs per pond per crop | 3,000 |
| Target wholesale price | $/doz | $17 |
| Number of crops | # of crops per yr | 3 |
| Number of ponds | # of ponds per farm | 4 |
| Total harvest | lbs of crab per pond per crop | 597 |
| Total amount of feed | lbs of feed per pond per crop | 1,406 |
| Feed conversion ratio | lbs of feed per lb of crab | 2.36 |
| Percent of feed costs to total variable costs | % | 26 |
| Annual net returns | $/yr | 4,511 |
| Average cost | $/doz | $16 |

## Results

The main challenges in aquaculture involved increasing efficiency in the production process, emphasizing minimizing losses by cannibalism in larviculture techniques, nutrition of larvae and juvenile, reducing impacts caused by viral diseases, and technological development of the cultivation systems themselves (Hungria et al., 2017). These observations adequately summarized the experimental trials in softshell blue crab production in ponds. Higher softshell blue crab production was achieved with higher stocking densities and higher survival rates. However, survival rates were limited due to rampant cannibalism in nursery tanks where juvenile crabs are kept for some time before stocking them in ponds.

At a lower stocking density of 4,000 juvenile crabs per pond, the average costs of production ranged from $20 to $60 per dozen of softshell blue crabs (Figure 1). As survival rate increased, the average costs of production subsequently decreased. The wholesale market prices in the Mid-Atlantic markets averaged $17 per dozen of hotel size (4-4.5 in or 2.5 oz) softshell blue crabs (Urner Barry Comtell, 2020). The net present value and internal rate of return of this simulation resulted in a rejection of this particular production system.

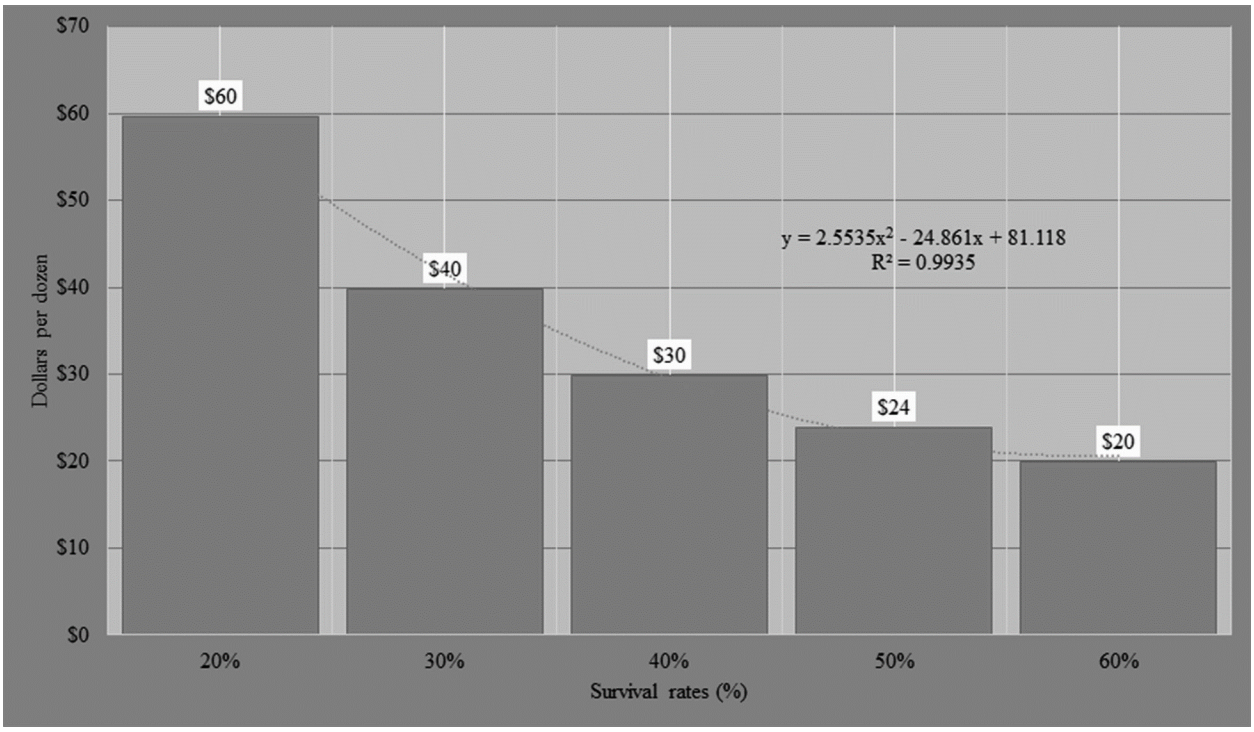


**Figure 1**. Sensitivity of Average Cost to Survival Rate at Stocking = 4,000 Juvenile Crabs per Pond and Growth Rate = 1.5 gram.

With a higher stocking density of 6,000 juvenile crabs per pond, the average costs of production when the survival rate is 50% was $16 per dozen of softshell blue crabs (Table 1). The wholesale market prices in the Mid-Atlantic markets averaged $17 per dozen of hotel size (4-4.5 in or 2.5 oz) softshell blue crabs (Urner Barry Comtell, 2020). The net present value and internal rate of return of this simulation led to the acceptance of this specific production system.

## Summary and Implications

Simulation results at a stocking density of at least 6,000 juvenile crabs per pond and hotel-sized softshell blue crabs (4 in or 2.5 oz) at a wholesale price of at least $17 per dozen indicated that softshell blue crab grow-out in brackish water ponds could be economically feasible. Currently, alternative options are rather constrained, because the holding capacity of each pond is limited by its natural productivity, availability of local and cheaper feed, prevalence of cannibalism, and efficient harvesting methods. Other production strategies are being evaluated, such as stocking ponds with megalopae instead of juvenile crabs.

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# The Adoption of Drying Added-Value Technologies in the Specialty Crop Industry

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## Abstract

Value-added technologies can benefit specialty crops growers by leading to an increase profitability and improving access to markets. This study categorized and explored the main characteristics of farmers on the spectrum of adoption of drying value-added technologies. Farmers were categorized as 1) considering drying, 2) currently drying, 3) stopped drying, or 4) never dried. There were more women and minority farmers drying specialty crops than farmers with genders and races/ethnicities. There was a greater proportion of diversified operations, those selling through local markets, and those using food labels among farmers using drying technologies to add value to their products.

**Keywords:** market differentiation, agricultural diversification, minority farmers, value-added, food crops, specialty crops, drying foods, food labels.

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## Introduction

Consumers are looking for more distinct value-added (VA) products, and healthy local foods have been the niche that provides the answer for many demand trends. Changes in consumer preferences for agricultural products are encouraging markets to evolve and supply more convenient presentations of fruits and vegetables (Pollack, 2001). For instance, an increase in the number of direct and intermediate markets helps facilitate farmer access to more diverse markets. In addition, the proliferation of food labels conveying nutrition, origin, and production of foods is an example of how farmers, food handlers, and retailers have responded to changes in consumer demand (Torres, 2020).

To support new market trends, federal and local governments have developed interventions and incentives that aim to increase the consumption and supply of fresh whole foods (List and Samek, 2015). For example, the Value-Added Producer Grant (VAPG) by the U.S. Department of Agriculture supports farmers' adoption of new technologies with funding of up to $75,000 for planning grants and $250,000 for working capital projects. This funding helps farmers adopt activities that support expenses related to producing and marketing value-added agricultural products.

The adoption of technological innovations is considered a key farm strategy in helping farmers increase market access and manage risk (Sunding and Zilberman, 2001). This strategy is especially important for high-value specialty crops as they are perishable in nature, and greater coordination is needed on how these products are produced, processed, and marketed (Swinnen and Maertens, 2007). Through agricultural innovations, farmers are able to supply innovative VA final products, reduce costs, enhance product quality, and protect human health and environment.

In a survey of Indiana specialty crops farmers, Fulton, Pritchett, and Pederson (2003) found that specialty crops tend to receive higher price premiums, but they also generate additional production costs than non-specialty crops. Demand and supply trends provide evidence of new economic opportunities for specialty crop farmers by adding value to locally grown products and meeting off-season demand for dried fruits, vegetables, and herbs. Drying technologies can lead to a reduction in postharvest losses, which can increase food availability and protect the environment (Kader, 2003). VA technologies, such as drying, can benefit specialty crop growers by increasing farm profitability, improving access to markets, promoting greater competition among middlemen, and increasing their bargaining power (Mittal, 2007).

While most of the literature regarding innovations in VA technologies is focused on U.S. commodity agriculture or developing countries (Chen, 2020), this study focuses on the adoption of VA technologies among U.S. specialty crop farmers. Drawing from the VAPG, we defined value-added as 1) changes in the physical state, 2) value-enhancing, or 3) physical segregation resulting in differentiation of agricultural products. Specifically, we focused on the adoption of drying technologies as VA innovations. Drying of fruits and vegetables can create market opportunities for small- and medium-scale farmers, so they can deliver value to perishable crops while accessing new markets and generate off-season income.

The objective of this study is twofold. First, we categorized and explored the main characteristics of farmers on the spectrum of adoption of drying VA technologies. Farmers were categorized as 1) considering drying, 2) currently drying, 3) stopped drying, or 4) never dried. Second, using an ordered probit model, we investigated the drivers and barriers of adopting drying VA technologies, including solar, electric, freeze, and open-sun drying.

## Data and Methodology

Data for this study came from a 2019 web-based survey of specialty crop growers located in 32 states.[1] Growers' email addresses were obtained from lists of grower associations and the Food Industry MarketMaker database. We compiled a list of 3,557 unique email addresses that was screened to eliminate duplicate entries. These databases facilitated access to operations growing fruits, vegetables, and herbs. Our data included farmers selling in direct-to-consumer (DTC) market channels, intermediate markets, and wholesale outlets. DTC markets were defined as those where the farmer sells directly to consumers, such as farmers markets, while intermediate markets were those where the farmer sells to local restaurants or retailers (Torres et al., 2017). Lastly, wholesale outlets were those where the farmer sells to processors, distributors, and wholesalers (Woods et al., 2013).

The web-based survey was conducted using Qualtrics software. To increase participation rate, we included a $10 gift card as an incentive to the first 1,000 farmers who completed the survey. A total of 766 farmers completed the survey, for a response rate of 21.5%, which is considered an acceptable response rate for this type of survey (Dillman, Smyth, and Christian, 2014). The questionnaire included questions related to farmers' demographics (i.e., educational attainment, gender, farming experience), farm characteristics (i.e., crops, markets, and growing technologies), as well as farmers' networks and perceptions of their farm. The questionnaire was approved by the corresponding Institutional Review Board for compliance with ethical standards for human subjects.

The subsample for this study included 580 specialty crop operations that reported their status on the process of drying technologies. We categorized farmers as *never dried* ($N$ = 334; 58%), *considering drying* ($N$ = 95; 16%), *drying* ($N$ = 88; 15%), and *stopped drying* ($N$ = 63; 11%). We analyzed farmers' categories using a one-way analysis of variance (ANOVA) comparison of means. Using an ordered probit regression, we estimated the influence of farmer and farm characteristics, as well as perceptions and networks, on the probability of considering, adopting, or stopping drying specialty crops. The ordered probit regression is an appropriate approach to model ordinal survey responses where the observed dependent variable has an ordinal scale (Greene, 2003). All analyses were conducted using Stata (StataCorp, 2019).

[1] Alabama, Arizona, Arkansas, California, Colorado, Florida, Georgia, Idaho, Illinois, Indiana, Iowa, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Montana, New Mexico, New York, North Carolina, North Dakota, Oklahoma, Oregon, Rhode Island, Tennessee, Virginia, West Virginia, Wisconsin, and Wyoming.

## Results and Discussion

This study investigated the major factors affecting the adoption of drying VA technologies. Table 1 displays the covariates used in the study, as well as the means and standard deviations for the continuous and categorical variables of the study. Table 1 illustrates that farmer demographics, farm characteristics, and perceptions differ among farmers' categories. Results showed that there were more women and minority farmers drying specialty crops than other genders and races/ethnicities ($P < 0.05$). There was a bigger proportion of diversified operations, those selling primarily through local markets, and those using food labels among farmers using drying technologies to add value to their products ($P < 0.05$). Having support networks (i.e. other farmers supporting adoption of technologies) was less common for farmers who never used drying technologies ($P < 0.05$). It is likely that having support from other farmers adopting VA technologies is influencing farmers in our study to dry their specialty crops. Table 1 illustrates that the proportion of farmers perceiving barriers to drying was higher among those drying produce ($P < 0.05$).

Table 2 displays the marginal effects associated with the ordered probit regression. Table 2 shows that race/ethnicity was correlated with the adoption of drying VA technologies. Minority farmers were 7% more likely to dry their crops ($P < 0.10$), which may be helping them access new markets and develop business networks. The fact that minority farmers were also 5% more likely to stop drying is interesting ($P < 0.10$), as this result may be showing that the barriers faced by minority farmers investing in VA technologies remain even after drying and selling value-added products.

**Table 1.** Comparison of Explanatory Variables for Specialty Crop Operations Categorized as Never Dried ($N$ = 334), Considering Drying ($N$ = 95), Drying ($N$ = 88), and Stopped Drying ($N$ = 63)

| | Never Dried[z] | | | Considering | | | Drying | | | Stopped | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Mean** | **SD** | | **Mean** | **SD** | | **Mean** | **SD** | | **Mean** | **SD** | |
| College[y] | 0.67 | 0.47 | | 0.61 | 0.49 | | 0.67 | 0.47 | | 0.71 | 0.46 | |
| Female[y] | 0.28 | 0.45 | BC | 0.27 | 0.45 | C | 0.49 | 0.50 | A | 0.46 | 0.50 | AB |
| Nowhite[y] | 0.05 | 0.21 | B | 0.06 | 0.24 | B | 0.05 | 0.21 | B | 0.14 | 0.35 | A |
| Midwest[y] | 0.55 | 0.50 | | 0.51 | 0.50 | | 0.44 | 0.50 | | 0.47 | 0.50 | |
| Northeast[y] | 0.05 | 0.21 | | 0.04 | 0.21 | | 0.06 | 0.24 | | 0.02 | 0.13 | |
| West[y] | 0.22 | 0.41 | | 0.27 | 0.45 | | 0.25 | 0.44 | | 0.33 | 0.48 | |
| South[y] | 0.18 | 0.39 | | 0.16 | 0.37 | | 0.24 | 0.43 | | 0.14 | 0.35 | |
| Number crops | 9.99 | 11.83 | B | 17.83 | 15.35 | A | 23.02 | 16.29 | A | 20.17 | 16.56 | A |
| Experience | 24.27 | 15.79 | | 21.90 | 16.00 | | 20.15 | 12.86 | | 26.48 | 16.85 | |
| Percentage income | 71.45 | 34.35 | | 69.31 | 32.43 | | 69.99 | 32.22 | | 61.52 | 36.19 | |
| Only dtc[y] | 0.22 | 0.42 | B | 0.27 | 0.45 | AB | 0.34 | 0.48 | AB | 0.44 | 0.50 | A |
| Only wholesale[y] | 0.26 | 0.44 | A | 0.16 | 0.37 | AB | 0.07 | 0.25 | B | 0.16 | 0.37 | AB |
| Mixed[y] | 0.25 | 0.43 | B | 0.44 | 0.50 | A | 0.44 | 0.50 | A | 0.29 | 0.46 | AB |
| Distance | 18.66 | 24.42 | | 24.66 | 27.63 | | 24.50 | 25.59 | | 20.98 | 25.82 | |
| Label[y] | 0.37 | 0.48 | B | 0.52 | 0.50 | AB | 0.61 | 0.49 | A | 0.66 | 0.48 | A |
| Employees | 26.28 | 58.79 | | 24.06 | 67.51 | | 14.78 | 45.71 | | 9.86 | 18.94 | |
| Totalland | 349.55 | 948.95 | | 251.88 | 625.40 | | 231.68 | 1011.45 | | 94.44 | 204.85 | |
| Sole[y] | 0.40 | 0.49 | | 0.41 | 0.49 | | 0.40 | 0.49 | | 0.41 | 0.50 | |
| Partime[y] | 0.34 | 0.47 | | 0.29 | 0.46 | | 0.28 | 0.45 | | 0.38 | 0.49 | |
| Small[y] | 0.51 | 0.50 | | 0.51 | 0.50 | | 0.65 | 0.48 | | 0.63 | 0.49 | |
| Medium[y] | 0.12 | 0.33 | | 0.18 | 0.39 | | 0.09 | 0.29 | | 0.08 | 0.27 | |
| Large[y] | 0.26 | 0.44 | | 0.27 | 0.45 | | 0.16 | 0.37 | | 0.13 | 0.34 | |
| Change sales | 1.98 | 0.64 | | 1.97 | 0.65 | | 2.04 | 0.71 | | 2.05 | 0.66 | |

**Table 1 (continued).**

| | Never Dried | | | Considering | | | Drying | | | Stopped | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Mean** | **SD** | | **Mean** | **SD** | | **Mean** | **SD** | | **Mean** | **SD** | |
| Change labor | 2.08 | 0.74 | | 2.24 | 0.73 | | 2.19 | 0.80 | | 2.22 | 0.77 | |
| Networks[y] | 0.17 | 0.38 | B | 0.36 | 0.48 | A | 0.45 | 0.50 | A | 0.38 | 0.49 | A |
| Info industry[y] | 0.69 | 0.46 | | 0.72 | 0.45 | | 0.64 | 0.48 | | 0.62 | 0.49 | |
| Info farmers[y] | 0.85 | 0.36 | B | 0.96 | 0.21 | A | 0.90 | 0.30 | AB | 0.81 | 0.40 | B |
| Info extension[y] | 0.83 | 0.38 | | 0.82 | 0.39 | | 0.85 | 0.36 | | 0.78 | 0.42 | |
| Successfully | 0.47 | 0.50 | | 0.51 | 0.50 | | 0.56 | 0.50 | | 0.53 | 0.50 | |
| Barriers dry | 2.07 | 0.76 | B | 2.08 | 0.49 | B | 2.35 | 0.49 | A | 2.09 | 0.55 | B |
| Financial assist[y] | 0.49 | 0.50 | B | 0.56 | 0.50 | AB | 0.65 | 0.48 | A | 0.58 | 0.50 | AB |

[z]Upper case letters show statistically significant differences across clusters at the $P < 0.1$ using Tukey's significant difference test.
[y]The mean is the percentage of respondents with that attribute.

**Table 2.** Marginal Effects Results from Ordered Probit for the Adoption of Drying Value-Added Technologies among Specialty Crop Operations

| | Never Dried | | Considering | | Drying | | Stopped | |
|---|---|---|---|---|---|---|---|---|
| College | 0.98 | | -0.27 | | -0.42 | | -0.29 | |
| Female | -2.92 | | 0.79 | | 1.26 | | 0.87 | |
| Nowhite | -15.11 | * | 4.10 | * | 6.51 | * | 4.50 | * |
| Midwest | 6.10 | | -1.66 | | -2.63 | | -1.82 | |
| West | -0.19 | | 0.05 | | 0.08 | | 0.06 | |
| South | 0.90 | | -0.24 | | -0.39 | | -0.27 | |
| Number crops | -0.79 | *** | 0.21 | *** | 0.34 | *** | 0.23 | *** |
| Experience | -0.20 | | 0.06 | | 0.09 | | 0.06 | |
| Percentage income | 0.26 | *** | -0.07 | *** | -0.11 | *** | -0.08 | *** |
| Only wholesale | 5.74 | | -1.56 | | -2.47 | | -1.71 | |
| Mixed | 2.88 | | -0.78 | | -1.24 | | -0.86 | |
| Distance | -0.10 | | 0.03 | | 0.05 | | 0.03 | |
| Label | -21.01 | *** | 5.70 | *** | 9.05 | *** | 6.26 | *** |
| Employees | 0.03 | | -0.01 | | -0.01 | | -0.01 | |
| Total land | 0.00 | | 0.00 | | 0.00 | | 0.00 | |
| Sole | 6.43 | | -1.75 | | -2.77 | | -1.91 | |
| Partime | -0.76 | | 0.21 | | 0.33 | | 0.23 | |
| Small | -12.13 | * | 3.29 | * | 5.22 | * | 3.61 | * |
| Large | 4.28 | | -1.16 | | -1.84 | | -1.27 | |
| Change sales | -6.90 | ** | 1.87 | ** | 2.97 | ** | 2.05 | ** |
| Change labor | -0.99 | | 0.27 | | 0.43 | | 0.30 | |
| Networks | -15.98 | *** | 4.34 | *** | 6.89 | *** | 4.76 | *** |
| Info industry | 6.48 | | -1.76 | | -2.79 | | -1.93 | |
| Info farmer | -9.86 | | 2.68 | | 4.25 | | 2.94 | |
| Info Extension | -2.93 | | 0.79 | | 1.26 | | 0.87 | |
| Successful | -5.10 | | 1.38 | | 2.20 | | 1.52 | |
| Barriers dry | -11.91 | *** | 3.23 | *** | 5.13 | *** | 3.54 | *** |
| Financial assist | -5.22 | | 1.42 | | 2.25 | | 1.56 | |
| Observations | | | | | | | 486.00 | |
| Prob > $Chi^2$ | | | | | | | 0.00 | |
| Pseudo $R^2$ | | | | | | | 0.13 | |

Note: Marginal effects are expressed in percent points.
***$P < 0.01$, **$P < 0.05$, *$P < 0.1$

Other drivers of adoption of VA technologies included having a diversified crop mix ($P < 0.01$). The fact that horizontal diversification (number crops grown) and vertical diversification (adding value to crops) are positively correlated is interesting. It seems that farmers are looking for strategies to develop and maintain a competitive advantage by investing in diversifying product

offerings and innovation strategies (i.e., VA technologies). We expect that pursuing vertical and horizontal diversification can help farmers increase market penetration and market access. It is likely that the adoption of these strategies may be driven by the rapid changes among consumers toward local, authentic, traceable, transparent, and ethical foods.

Results from the ordered probit regression show that using marketing labels on products ($P < 0.01$) increases the likelihood of considering drying and then drying specialty crops. The distance between the consumer and producer in today's food system represents obstacles for effective communication and the establishment of trusting relationships. In most cases, consumers cannot directly observe the food production process, which implies that they have asymmetric information regarding products and farming practices (Messer, Costanigro, and Kaiser, 2017). Farmers using labels can help improve consumers' trust and build long-term relationships. Moreover, farmers using marketing labels may want to communicate the drying process or other VA technology used in their operation.

Interestingly, the likelihood of considering drying and drying agricultural products was higher for smaller operations ($P < 0.10$). This result may inform us about the strategies implemented by small producers to reach new markets and that drying technologies are accessible for them. Consistent with Maertens and Barrett (2013), our results show social networks are important in the technology adoption process. Results from the ordered probit regression suggest that having support networks with experience in VA technologies increases the likelihood of adopting drying VA technologies. Moreover, farmers perceiving important barriers to the drying process were more likely to adopt drying technologies. An explanation of this finding may be that farmers adopting these technologies are the ones facing and reporting barriers to dry specialty crops. Yet, these barriers seem to also be driving farmers to stop using drying VA technologies. Lastly, a major deterrent of drying value-added was the increasing percentage of farmers' income derived from specialty crops ($P < 0.01$).

## Conclusions

The adoption of drying VA technologies is influenced by farmer demographics, farm characteristics, access to support networks, and farmer perceptions. Our findings can be used by researchers, policy makers, and industry stakeholders. They can help tailor incentives, Extension programs, and market strategies to improve the supply and demand of local dried agricultural products. Future research should consider the impact of drying technologies on farm economic performance and improve understanding of farmers' adoption of drying VA technologies.

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# Colorado Producers during COVID-19: A Closer Look at the Potato Supply Chain[1]

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## Abstract

Media headlines during the COVID-19 pandemic have told two different stories about sales of agricultural products. On the one hand, many large establishments whose customer base consists of restaurants and food service lost sales (Yaffe-Bellany and Corkery, 2020). On the other hand, establishments whose primary customers are in retail or direct-to-consumer markets (e.g., farmers markets, roadside stands) have seen increased demand for their products (Robey, 2020). In short, the reality of COVID-19 is affecting farm establishments differently, depending on many factors including their market channel. In turn, farmers are responding to the pandemic with a variety of strategies, which affect actors farther down the supply chain (Blevins, 2020; Ehrlich, Sullins, and Jablonski 2020; Love, Thilmany, and Jablonski 2020).

We interviewed potato farmers from the San Luis Valley, Colorado, and compiled their strategies for adjusting farm operations and product marketing during the pandemic. Their strategies range from short-term solutions, such as repackaging their products, to longer-term solutions, such as building new customer relationships or diversifying their crop rotations. For farmers, hearing how others are creatively handling an unusual situation may spark innovation, and, for policy makers,

[1]The original writing was published on the Colorado State University Food Systems website for reference by agricultural producers, businesses, extension staff, and researchers.

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it may provide clarity on how they can best support agriculture with effective policy. For food processors, distributors, and retailers, knowledge of on-farm strategies can help them prepare to increase the versatility of their operations to keep pace with swift changes in market dynamics in the future. During this time of transition, it is important to reflect on priorities, management practices, and the industry's evolvement to be better positioned for the future.

**Keywords:** Colorado, potatoes, COVID-19, adaptation strategy, farm diversification, supply chain

## Original Publications

Ehrlich, S., M. Sullins, and B. Jablonski. 2020. *Colorado Producers during COVID-19: A Closer Look at the Potato Supply Chain*. Available online: https://foodsystems.colostate.edu/wp-content/uploads/2020/06/COVID19-Potato-overview_final2-2.pdf.

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