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Opportunities for locally produced ingredients in Pennsylvania's craft brewing industry

Claudia Schmidt [a] *
Pennsylvania State University

Arian Moghadam [b]
Bloomsburg University

Neil Reid [c]
The University of Toledo

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Abstract

This research investigates the opportunities and challenges in sourcing locally produced ingredients within Pennsylvania's craft beer industry. While Pennsylvania ranks as the second-largest craft beer producer in the United States, sourcing core beer ingredients like hops and barley locally remains difficult because of climate and production limitations. Survey results show that the majority of brewers in our survey agree that buying local products supports economic growth and believe it benefits farmers. Several barriers to local sourcing were identified, with price, variety, and accessibility ranking as major challenges. Smaller breweries, those close to population centers, and breweries with higher taproom sales are more inclined to adopt local inputs.

Keywords

craft brewing, hops, local ingredients, malted barley, neolocalism, Pennsylvania

[a] * *Corresponding author:* Claudia Schmidt, Assistant Professor, Agricultural Economics, Department of Agricultural Economics, Sociology, and Education, Pennsylvania State University; 112A Armsby; University Park, PA 16802-5602 USA; cschmidt@psu.edu;
https://orcid.org/0000-0002-8597-7288

[b] Arian Moghadam, Professor of Economics, Department of Economics, Bloomsburg University; 400 E. 2nd Street; Bloomsburg, PA 17815 USA;
amoghada@commonwealthu.edu;
https://orcid.org/0000-0003-1846-9395

[c] Neil Reid, Professor of Geography, Department of Geography and Planning, The University of Toledo, Toledo, Ohio 43606 USA; neil.reid@utoledo.edu;
https://orcid.org/0000-0003-0520-1023

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Introduction and Literature Review

The growing number of craft breweries, small-scale wineries, and farmers markets is an indication of the increasing popularity of food and drink products that have strong connections with their local communities. All are manifestations of the broader neolocalism and maker movements whose patrons favor supporting businesses that are locally owned and are integrated into the everyday life of their communities (Rogoway, 2015; Schnell, 2013; Taylor & DiPietro, 2020; Wolf-Powers et al., 2017). While neolocalism in the craft brewing movement is strongly associated with the practice of branding (naming and labeling) of both beers and breweries (Flack, 1997; Holtkamp et al., 2016), there is recognition that the use of local ingredients is also a relevant indicator (Hayes, 2020). Indeed, the use of locally grown ingredients represents a commitment to support local agricultural producers. For example, Ikäheimo (2021) and Cappellano et al. (2023) argue that the purchase of locally grown ingredients is a neolocal practice utilized by craft breweries in Finland, while Şoica (2022) and Garavaglia (2020) present similar arguments in the case of France and Italy, respectively.

For breweries that want to engage more deeply with neolocalism, how easy is it for them to source locally grown ingredients? Most beer ingredients such as hops and other small grains, such as barley, wheat, and rye, can be produced in the U.S. In fact, the U.S. is one of the biggest hop producers in the world (Hops Growers of America, 2023), with the majority of that crop being produced in the Pacific Northwest because its growing climate is ideal for hops. Most of the ingredients are otherwise difficult to produce nationwide, because of disease pressure and low yields. However, adjuncts, like fruits and herbs, are very common in the craft beer industry and represent an opportunity for brewers to source locally and make the connection to neolocalism.

The objective of our study is to investigate the perception and willingness of craft brewers to source locally produced inputs. The focus of our study is Pennsylvania, which is the second biggest craft beer producing state in the U.S. (3,132,799 barrels in 2023; Brewers Association, 2025). This is partly due to it being the home of the nation's largest craft beer producers, like Yuengling. Pennsylvania's craft brewery numbers have expanded considerably in the past decade, from just 88 breweries in 2011 to 530 breweries in 2023 (Brewers Association, 2025). Pennsylvania had 5.4 craft breweries per capita in 2023 (Brewers Association, 2025). The state is also home to over 19 beer and craft beverage trails with participating craft breweries. Since the passing of Act 39 of 2016, a law that amended the state's liquor code, Pennsylvania is among the states with the "most advantageous direct-to-consumer brewery regulations in the nation" (Schmidt et al., 2021, p. 5). This act added new sections and changed more than 35 sections of the Liquor Code (Pennsylvania Liquor Control Board, 2016). A notable change brought about by Act 39 was its impact on collaborations among craft beverage producers. The legislation permits breweries to sell wines and spirits made by limited wineries and distilleries, and it extends the same opportunity to those wineries and distilleries to sell beer. Additionally, breweries are eligible to acquire permits to operate at farmers' markets. Another important aspect of Act 39 is the establishment of the Pennsylvania Malt and Brewed Beverages Industry Promotion Board in the Department of Agriculture, which spends up to US$1 million annually for the development and marketing of the Pennsylvania beer industry (Pennsylvania Liquor Control Board, 2023).

The paper is structured as follows: the literature review examines existing research on neolocalism and its relation to the primary ingredients of beer. The applied research methods section details the data collection and analytical framework used to assess brewers' perceptions and sourcing practices. The results and discussion section presents the findings of the survey, highlighting the factors influencing local ingredient adoption and the barriers faced by breweries. Finally, the conclusion discusses the implications for growers, brewers, and policymakers and offers recommendations for future research to further support the integration of local sourcing into the craft brewing industry.

Neolocalism through Craft Brewing

Prior research examining neolocalism in the craft brewing industry has tended to focus on the names

of beers and how these establish and reflect a brewery's connection with its local community (Flack, 1997; Gatrell et al., 2018). This practice supports the contention that neolocalism reflects "conscious efforts to signal a sense of place to locals and outsiders by leveraging community attributes" (Talmage et al., 2020, p. 140). In addition to the naming of beers, craft breweries can signal their commitment to their local community through the inclusion of local ingredients in their beer, which is the focus of this research. Beer is composed of four basic ingredients: water, hops, malted barley, and yeast. In addition, many also add adjuncts. In most craft beer, the only local ingredient is water. Hops, malted barley, and yeast are typically imported from elsewhere in the U.S. In the case of hops, 95% of American hop acreage is located in the Pacific Northwest (PNW) states of Washington, Idaho, and Oregon (Hop Growers of America, 2024), while most of the malted barley that is used in the brewing process is grown in the Great Plains states of Idaho, Montana, Wyoming, and North Dakota (Hmielowski, 2017). These regions have the ideal climates for growing hops and barley, respectively. Over the years, farmers in both regions have developed a rich knowledge base with respect to crop management practices. In addition, the necessary infrastructure (e.g., the supply chain) has evolved to support the hops and malted barley industries.

For the consumer, neolocalism represents a conscious attempt by "individuals and groups to establish, rebuild, and cultivate local ties and identities" (Schnell, 2013, p. 56). As such it is "a delayed reaction to the destruction in modern America of traditional bonds to community and family" (Shortridge, 1996, p. 10). With respect to craft breweries, Schnell and Reese suggest that they are partly a response to the "smothering homogeneity of popular, national culture" and the desire on the part of increasing numbers of people to "reestablish connections with local communities, settings, and economies" (2003, p. 46). Herz additionally notes that "many purchasers of craft beer identify with brands that are independent and local, and that align with core concepts including authenticity, community, and sustainability" (2016, para. 5). In a previous study, consumers were asked to identify their level of awareness and interest in various food and grocery topics (Nielsen, 2019). The survey identified sixteen "hot topics," with the most important of these being buying local. Researchers concluded that "it is clear that consumers are aware of the importance of buying local and continue to show a hunger for hometown, locally grown products" (Nielsen, 2019, para. 3). Local ingredients can function as an important marketing tool for craft breweries (Kell, 2019). Talmage et al. (2020) conducted a study exploring neolocalism among breweries in the Finger Lakes, New York. Based on their findings, they recommend that breweries focus foremost on local ingredients, followed by invoking local locations and local stories to enhance consumer perceptions of their beers. Craft beer consumers interviewed by Xu et al. (2023) view the use of local ingredients as an indicator of neolocalism. Talmage et al. concluded that "Neolocalism, along with a burgeoning buy local movement, may be an excellent tool for breweries" (2020, p. 155). In like manner, in examining the craft beer sector in Italy, Cipollaro et al. suggests that neolocalism "encompasses a set of strategies that producers can implement to increase consumers' appreciation of their product through its connection to an exclusive place or community" (2021, p. 2).

Major Produce Practices and Supply Chains in the Brewery Industry

In response to the growing number of craft breweries, an increasing number of initiatives have emerged in recent years to grow hops and barley outside their traditional growing regions (Dobis et al., 2019; Hmielowski, 2017; Reid et al., 2020). In 2020, hops were grown in 26 states outside the PNW (Hop Growers of America, 2024), while growing barley as an input to brewing is increasingly occurring outside the crop's Great Plains core states (Hmielowski, 2017; Isleib, 2013; Ledbetter, 2016). Of the two crops, the growing of local hops is at a more advanced stage than the growing of local barley. While surrounding states like New York and Maryland have implemented incentives for growing hops and barley locally, that is not the case in Pennsylvania (Roth et al., 2016). Nevertheless, the increasing interest in local hop production

to support the expanding craft brewing industry is evident in Pennsylvania: in 2020, 40 acres (16 hectares) of hops were harvested in Pennsylvania, up from 5 acres (2 ha) in 2015 (George, 2020, 2021).

Hops

A study by Staples et al. (2020) in Michigan suggested that craft breweries in that state are interested in purchasing locally grown hops, and realize that by doing so they are able to support the local economy. However, Michigan brewers have concerns regarding the quality of locally grown hops, and "are not willing to sacrifice the integrity of their final product for localness values if the consistency of hops does not reach their standards" (Staples et al., 2020, p. 471). When asked about the barriers to using local hops, brewers in New York identified finding the desired variety as their primary concern; in order of importance, other concerns were quality, price, and quantity (Thayer, 2017).

Turning to consumers, Atallah et al. (2021) examined how consumer perceptions differed with respect to local production of beer versus the use of local hops in producing beer. Using Indiana as a case study, they were particularly interested in estimating consumer preferences and willingness to pay (WTP) for craft beer brewed in Indiana with Indiana hops. Their findings suggest that consumers value the localness of hops and the localness of brewing differently. These differences vary according to how consumers define locally brewed beer (beer brewed in Indiana versus beer brewed in Indiana with Indiana hops) and how frequently they drink craft beer (casual versus frequent craft beer drinkers). Generally, their findings suggest that consumers are willing to pay more for craft beer brewed in Indiana than craft beer brewed elsewhere in the U.S. Willingness to pay more for craft beer made with Indiana hops is more complex. Not surprisingly, craft beer drinkers with the strictest definition of what constitutes local beer (brewed locally with Indiana hops) exhibit a higher total WTP for beer brewed in Indiana with Indiana hops.

There are strategies that hop farmers outside the PNW can utilize to make their hops more attractive to local breweries. These include developing unique hop cultivars, leveraging the concept of *terroir* with respect to the aroma and flavor imparted by locally grown hops, and taking advantage of the practice of wet-hopping. Wet-hopping utilizes freshly harvested hops (Bir & Norwood, 2020; Staples et al., 2020), which imparts a "more vibrant flavor and aroma" than beer brewed with dry hop pellets (Anderson, 2015). Ideally, fresh hops should be used by the brewer within 24 hours of being harvested. This requires that fresh hops be delivered to the brewery on a just-in-time basis.[1] Due to their geographic proximity to local breweries, local hop producers have an advantage over hop producers in the Pacific Northwest. Brewers in southern California, who rely on fresh whole-cone hops transported from Washington, observed that the hops would be 48 to 72 hours old by the time they arrived in San Diego due to the time required for picking, packing and delivery (Anderson, 2015). Another concept that craft breweries can leverage in their use of locally grown hops is that of terroir. Common in the wine industry, terroir is the recognition that the physical landscape (soil, slope, microclimate, etc.) influences the grape and ultimately the taste of the wine (Demossier, 2011; Spielmann & Gélinas-Chebat, 2012). The growth of craft breweries has ignited a discussion as to whether terroir can apply to hops. Several studies have demonstrated that the growing location of hops does indeed affect the flavor, aroma, and bitterness that is imparted by hops (Green, 1997; Van Holle et al., 2017). As noted by Van Holle et al., "Amarillo hops of the Idaho terroir, in comparison to these of the Washington terroir, were characterized by lower citrusy and floral notes in combination with increased contributions from fruity, spicy and resinous odor descriptions" (2017, p. 312). This provides hop farmers outside the PNW with a potential comparative advantage. As noted by Rob Sirrine of Michigan State University Extension, "the Michigan Chinook hop is completely different than the Chinook

[1] Just-in-time is an inventory control system developed in post-war Japan. It requires material inputs to the manufacturing process to be delivered to the manufacturing plant immediately before they are incorporated into the manufacturing process (Reid, 2017).

hops in the Pacific Northwest—a completely different flavor profile. I think that's one of the things we are trying to focus on is how to differentiate ourselves from other growing regions" (Galloway, 2018, para. 9).

Growing hops in Pennsylvania is a much less profitable business than in the PNW. Hops growers in Pennsylvania must take a much more aggressive approach to managing insects and mildews. In addition to higher production costs, yields are lower. Hops grown in Pennsylvania yield an average of 1,100 lbs/acre (1,233 kg/ha), whereas hops grown in the PNW yield an average of 2,000 lbs/acre or 2,242 kg/ha (Ford et al., 2021).

Malted Barley

Most of the malting barley that is used in the brewing process is grown in the Great Plains states of Idaho, Montana, Wyoming, and North Dakota (Hmielowski, 2017). Like hops, however, there are efforts to grow malting barley to supply craft breweries outside its primary growing region. A major barrier to growing malting barley outside of the Great Plains is the climate. In much of the eastern U.S., for example, it is too hot, humid, and wet to grown barley successfully. Some growers there are experimenting with European varieties of barley, which are better suited to their region's climate, while researchers are exploring the suitability of a wide variety of breeds (Hmielowski, 2017). Growing malting barley also requires different management practices than barley grown for feed; this requires some learning on the part of farmers (Hmielowski, 2017).

Once harvested, the barley must be transferred to a malthouse for malting before it is ready to be used in the brewing process. In response to the growth of craft breweries, a number of craft-malthouses have been established (Brouwer et al., 2016). The growth of craft malting houses reflects the reality that large malting houses are operationally designed to meet the needs of large breweries. Depending upon economies of scale, large malthouses are generally incapable of handling the "smaller volumes of a larger number of varieties of barley" (Brewers Association, 2014, p. 4) demanded by craft breweries. Similar to hops, malting barley is also affected by powdery mildew in Pennsylvania. Growing organic malting barley is a risky undertaking in the mid-Atlantic because of a lack of effective organic fungicides (Roth et al., 2016).

Adjuncts

In addition to the four basic ingredients, many craft brewers add other ingredients to their beer. These additional ingredients are called adjuncts and include fruit, spices, coffee, and others. Use of adjuncts is common among craft breweries, resulting in the creation of beers such as coffee stouts, cherry porters, and grapefruit IPAs (Guest, 2019). Incorporating fruits and vegetables provides brewers with some excellent opportunities to incorporate local agricultural products into their beer recipes (Cadenas et al., 2021; Hieronymus, 2016). Utilizing starchy adjuncts, such as oats, corn, buckwheat, and sweet potatoes, is also being explored (Cadenas et al., 2021). Heritage grains are also being considered a creative adjunct and are being studied in Michigan as another craft brewing option (Flanagan, 2020).

Applied Research Methods

During the fall of 2019, we conducted an online survey to uncover what drives craft breweries in Pennsylvania to purchase locally produced inputs. We reached out to Pennsylvania-based craft breweries identified through the Brewers Association, a national not-for-profit trade association,. The breweries that responded were included in a sample of 266 active breweries and brewpubs. Prior to distribution, the survey was tested by three members of the Pennsylvania Brewers Association. Appendix A lists the questions and variables used . Additional variables, such as median housing value and median household income, were retrieved from the National Historical Geographic Information System (NHGIS) of the American Community Survey (ACS). The assessment of hop quality was based on a survey sent out by Staples et al. (2020), and the questions were adapted for other brewing ingredients. It is important to note that respondents were not required to answer all questions. Using a logistic regression model, we explore the factors influencing breweries' inclination to purchase local inputs. The model can be represented by:

$$\Pr(y_i = 1|x_i) = \Lambda(x_i'\beta) \quad (1)$$

The desire of breweries to buy local inputs is captured by the logistic cumulative distribution function, denoted by $\Lambda(.)$, where y_i indicates brewery i's desire to purchase locally produced inputs given the vector of covariates x_i that may affect its desire. The covariates are divided into four categories, encompassing characteristics of breweries and brewers, socioeconomic traits of zip codes corresponding to breweries, barriers to purchasing more local inputs, and respondents' views regarding locally produced inputs. The vector β represents the corresponding coefficients in the logistic model to be estimated.

The summary statistics for the variables used in this study are presented in Table 1. When equation (1) is employed to assess the priority of breweries to purchase locally produced inputs, the dependent variable is assigned a value of 1 if respondents indicate a strong or moderate agreement with prioritization, and 0 otherwise. Likewise, when equation (1) is used to assess the likelihood of breweries to purchase locally grown hops, barley, rye, wheat, fruits, and herbs, the dependent variable takes a value of 1 if respondents choose somewhat or extremely likely, and 0 otherwise. Our survey findings indicate that 48% of breweries pri-

Table 1. Summary Statistics

Variables	*N*	Avg.	Std. Dev.	Min.	Max.
Local ingredients (1: somewhat/strongly agree, 0: otherwise)	103	0.48	0.5	0	1
How likely are you to purchase PA-grown hops?* (1: somewhat/extremely likely, 0: otherwise)	117	0.51	0.5	0	1
How likely are you to purchase PA-grown barley? (1: somewhat/extremely likely, 0: otherwise)	116	0.66	0.48	0	1
How likely are you to purchase PA-grown rye? (1: somewhat/extremely likely, 0: otherwise)	116	0.45	0.5	0	1
How likely are you to purchase PA-grown wheat? (1: somewhat/extremely likely, 0: otherwise)	117	0.5	0.5	0	1
How likely are you to purchase PA-grown fruits? (1: somewhat/extremely likely, 0: otherwise)	115	0.75	0.44	0	1
How likely are you to purchase PA-grown herbs? (1: somewhat/extremely likely, 0: otherwise)	116	0.59	0.49	0	1
Ln (Volume - Barrels of Beer)	129	5.77	2.21	-0.69	11.51
% Sales Taproom/Pub	95	64.64	33.71	0	100
Number of years in operation	188	5.83	6.75	0	48
Age	90	41.33	9.99	25	65
Four-year college degree or more	93	0.72	0.45	0	1
Formal brewing training	92	0.22	0.41	0	1
Ln (Population)	215	9.75	1.03	3.69	11.15
Ln (Median household income) ($2017)	215	4.09	0.32	2.69	4.93
Ln (Average value of dwelling) ($2017)	215	5.18	0.44	3.59	6.34
% Population with a four-year college degree or more	215	31.82	14.53	8.04	77.29
% Population 25-44 years old	215	24.59	5.3	13.71	48.92

* PA = Pennsylvania.

oritize purchasing locally produced inputs. Notably, the likelihood of purchasing locally grown rye was found to be the lowest at 45%, while for fruits, it was the highest at 75%.

The explanatory variables in this study are grouped into four categories: characteristics of breweries and brewers, socioeconomic characteristics of breweries' zip codes, Likert scale variables measuring barriers to purchasing local inputs, and respondents' opinions on locally produced inputs and associated challenges. Summary statistics for the first two groups are presented in Table 1, while Tables 2 and 3 provide the relative cumulative frequencies of barriers to purchasing more local inputs, and the perspectives of respondents on locally produced inputs and their related challenges, respectively. Table 1 reveals that on average, over 64% of breweries' sales are generated from taprooms and pubs. During the survey period, the average duration of breweries' operation was 5.83 years, and the average age of brewers was around 41 years. Furthermore, a notable contrast can be observed when examining educational backgrounds: while only about 32%of individuals in their respective zip codes held a four-year college degree or higher, a substantial 72%of brewers possessed such qualifications. Notably, 22%of brewers had received formal training in brewing.

Table 2 presents the cumulative relative frequency, where percentages add up over each category of barriers encountered when purchasing ingredients from Pennsylvania. Similarly, Table 3 presents the cumulative relative frequency of attitudes toward locally produced inputs and the challenges associated with their purchase. Referring to Table 2, the frequencies illustrate that 75% and 71% of participants consider price and variety, respectively, to be moderate or extreme barriers to purchasing more local ingredients. Moreover, 57%, 52%, and 50% of respondents view accessibility, quality, and quantity, respectively, as moderate or extreme barriers to purchasing local ingredients. In Table 3, the results indicate that 96% of respondents somewhat or strongly agree that buying local promotes the growth of the local economy. Furthermore, 81% of participants express support for the idea that purchasing local goods leads to increased profits for local farmers. The strong agreement among respondents that buying local supports economic growth and the belief that it benefits farmers reflects the broader neolocalism movement's emphasis on fostering local ties and

Table 2. Cumulative Relative Frequency for Barriers to Purchase More Ingredients from Pennsylvania

	Accessibility	Quality	Quantity	Price	Variety
Extreme	16%	19%	15%	38%	38%
Moderate	57%	52%	50%	75%	71%
Somewhat	88%	79%	80%	90%	94%
Not a Barrier	99%	97%	98%	99%	99%
Does not apply	100%	100%	100%	100%	100%

Table 3. Cumulative Relative Frequency for Views Toward Locally Produced Inputs and the Challenges to Purchasing Them

	Good for local economy	More money for farmers	Little choice	Not clearly branded
Strongly agree	67%	42%	9%	9%
Somewhat agree	96%	81%	21%	38%
Neither agree nor disagree	99%	97%	51%	84%
Somewhat disagree	99%	98%	82%	95%
Strongly disagree	100%	100%	100%	100%

community identity. However, only 21% somewhat or strongly agree that limited availability of local ingredients is problematic, while 38% hold the same opinion about the need for clearer branding of local inputs.

Results and Discussion

This section analyzes the factors that influence breweries' priorities in sourcing locally produced inputs, focusing on brewery characteristics, socioeconomic factors, barriers to local sourcing, and brewers' perceptions.

The Priority of Breweries in Purchasing Locally Produced Inputs

Table 4 displays the results of the model representing the priority of breweries in acquiring locally produced inputs. The first four columns of the table—columns (1) through (4)—aim to provide a deeper understanding of the relationship between various groups of covariates, including the characteristics of breweries and brewers, the socioeconomic attributes of the corresponding zip codes, barriers to purchasing more local inputs, and the perceptions and challenges breweries face regarding locally produced ingredients, and their influence on this priority. The last column, column (5), represents the comprehensive aggregate model, incorporating all relevant covariates within the regression model. This approach accounts for confounding variables to provide a clearer and more precise understanding of their impact on the priorities of breweries.

The aggregate model reveals statistical significance in four of the six variables that represent characteristics of breweries and brewers. Specifically, the coefficient of the produced volume of beer displays both significance and a negative correlation, suggesting that smaller breweries tend to source local ingredients while larger ones lean toward national suppliers. High-volume breweries may favor national suppliers due to cost savings resulting from economies of scale, reduced supply-chain volatilities, consistent quality for a wide range of ingredients, and contractual obligations and agreements. Furthermore, the coefficient for the percentage of sales from drafts at taprooms and pubs indicates that breweries situated closer to their customers are more likely to purchase local ingredients. This may enable them to cater to consumer preferences and adapt swiftly to any changes by offering seasonal, limited-release beers.

Even though local ingredients might be more expensive, they could prove to be more cost-effective for agile breweries that primarily sell through taprooms and pubs. This is mainly because of the potential complexities and costs associated with seasonal contracts and sourcing new varieties from national suppliers to meet fluctuating consumer demand. Additionally, these breweries can save on distribution and packaging expenses, allowing them to allocate resources more effectively. The positive correlation between a brewery's length of operation and the likelihood of purchasing locally produced ingredients is indicated by the coefficient for the number of years in operation. Initially, breweries depend on national supply chains to ensure product quality and quantity. However, as time goes on, they may be inclined to shift toward local suppliers and cultivate personal connections with them. This practice helps foster stronger ties with the local community and sets their products apart from larger breweries, responding to consumer preferences. The coefficient for age reveals that younger brewers show a greater inclination toward procuring local inputs, and this tendency diminishes with age. The coefficients representing the socioeconomic characteristics of breweries' zip codes did not exhibit any statistical significance. This outcome was anticipated, as the selected geographical area for analyzing demand-related factors must accurately reflect the market scope of the entity under investigation. Nevertheless, the appropriate market area for each brewery remains elusive. Consequently, the findings regarding the socioeconomic characteristics of zip codes indicate an absence of discernible correlation with the probability of purchasing local ingredients.

The results also reveal interesting insights into the barriers breweries face when purchasing locally produced inputs. Specifically, two of the four variables examined exhibit statistically significant coefficients. The first noteworthy coefficient pertains to the accessibility barrier, which indicates that as this barrier increases, there is a decrease in the likelihood of breweries procuring local ingredients. This

Table 4. Logistic Regression for the Priority of Breweries in Purchasing Locally Produced Ingredients
Survey Question: I make it a priority to buy PA-produced inputs – 1: somewhat/strongly agree, 0: otherwise

	(1)	(2)	(3)	(4)	(5)
Ln (Volume - Barrels of Beer)	−0.318**				−0.573**
	(0.040)				(0.014)
% Sales Taproom/Pub	0.0161*				0.0358*
	(0.059)				(0.070)
Number of years in operation	0.0500				0.254**
	(0.462)				(0.018)
Age	−0.0429				−0.106**
	(0.106)				(0.031)
Four-year college degree or more	0.0815				1.062
	(0.890)				(0.263)
Formal brewing training	−0.294				1.269
	(0.574)				(0.224)
Ln (Population)		−0.210			−0.0704
		(0.215)			(0.825)
Ln (Median household income)		−0.460			2.286
		(0.763)			(0.506)
Ln (Average value of dwelling)		−0.591			−1.543
		(0.574)			(0.511)
% Population with a four-year college degree or more		0.0201			−0.0581
		(0.399)			(0.160)
% Population 25-44 years old		0.00545			−0.0919
		(0.887)			(0.262)
Barrier to buy more local - Accessibility			−0.550**		−1.470*
			(0.037)		(0.050)
Barrier to buy more local - Quality			−0.175		−0.0652
			(0.459)		(0.887)
Barrier to buy more local - Quantity			0.0793		0.0970
			(0.763)		(0.880)
Barrier to buy more local - Price			−0.668***		−2.227**
			(0.006)		(0.012)
Barrier to buy more local - Variety			−0.0516		−0.383
			(0.844)		(0.550)
Buying local is good for local economy				1.597***	2.977**
				(0.009)	(0.014)
Buying local means more money for farmers				1.842***	2.204
				(0.000)	(0.113)
I have little choice in buying local				−0.896***	−1.349***
				(0.001)	(0.006)
I buy more local if inputs were clearly branded local				0.408	1.107**
				(0.143)	(0.046)
Constant	2.290*	6.080	5.175***	−14.50***	−1.009
	(0.093)	(0.220)	(0.002)	(0.000)	(0.932)
Observations	81	102	102	103	80
Pseudo R^2	0.084	0.018	0.101	0.422	0.594
Log-likelihood	−51.41	−69.25	−63.46	−41.20	−22.50
Chi2	7.919	2.837	11.84	34.20	29.25

p-values in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

finding fosters the inference that local suppliers might encounter challenges in meeting breweries' demand consistently, face hurdles in maintaining uniform quality standards, have a limited assortment of ingredients due to regional constraints or smaller scale of operation, or lack the means for proper storage to ensure a year-round supply. A similar trend emerges with regard to the price of locally produced inputs, suggesting that these ingredients, at times, can be more expensive than those sourced from large, national suppliers, due to economies of scale. Consequently, for breweries operating on slim margins in a crowded market, this factor can diminish the appeal of local ingredients. Improving accessibility to local suppliers and ensuring the competitive pricing of their offerings could incentivize breweries to purchase locally. Of the four variables representing brewers' perception of locally produced inputs and their purchasing challenges, three exhibit statistically significant coefficients. The coefficient associated with supporting the local economy demonstrates a positive relation to the likelihood of purchasing local inputs, while disagreement with this notion indicates a negative relation. The coefficient for supporting farmers displays a similar relationship, although its statistical significance diminishes in the presence of other variables. Notably, the absence of the option to purchase local ingredients suggests that breweries would be more inclined to choose local inputs if given the opportunity. Additionally, the coefficient for the ease of purchasing local ingredients highlights the importance of branding, as breweries are more likely to opt for local inputs that are well-branded.

The Likelihood of Breweries in Purchasing Locally Grown Agricultural Products (Hops, Barley, Rye, Wheat, Fruits, and Herbs)

In this section, we explore the purchasing preferences and practices of breweries when it comes to locally sourced hops, barley, rye, wheat, fruits, and herbs. Table 5 provides insights into the likelihood of breweries purchasing these ingredients. The coefficients of the variables representing breweries and breweries' characteristics reveal that smaller breweries are more inclined to buy fruits and herbs grown in Pennsylvania. Furthermore, breweries with a higher percentage of sales from drafts at taprooms and pubs are more likely to purchase Pennsylvania-grown hops, fruits, and herbs.

While earlier findings show a positive correlation between a brewery's tenure and the likelihood of purchasing local ingredients, the results here indicate a different trend for hops and fruits. These findings imply that breweries with longer operation periods may procure local ingredients possibly due to established relationships, commitment to the local economy, and the desire for product quality and consistency. However, they might be less inclined to purchase local hops due to possible factors such as supply volume, quality, consistency, variety, and contractual obligations. In addition, even though Pennsylvania is renowned for apple production and also produces significant amounts of peaches, grapes, and cherries, breweries often utilize various fruits, including citrus fruits, berries, and tropical and stone fruits, which may not be native to Pennsylvania or consistently available in the required volume. Furthermore, breweries may encounter processing needs such as fruit purees or concentrates, as well as cost considerations, which can discourage them from using local fruits. To summarize, while breweries show a preference for local ingredients, results show the decision-making process is complex and influenced by a variety of factors.

The coefficients of the variables representing barriers to purchasing locally produced ingredients reveals a mix of results. With the exception of accessibility, which shows the expected sign for local hops, most of the other barriers seem to have no impact on the purchase of these ingredients locally. However, this finding is contrary to our previous results, which indicated that brewers consider accessibility and price as significant barriers to purchasing local ingredients. Moreover, we also find a significant positive correlation between quality as a barrier and the purchase of locally produced rye, wheat, and herbs. We also discovered a moderate correlation between quantity and the purchase of locally produced hops. These results add further nuance to our analysis. Furthermore, when examining the coefficients of the variables representing brewers' views on locally produced inputs and associated challenges, interesting patterns emerge. It is evident that brewers who believe that buying

local benefits the local economy are more inclined to purchase PA-grown wheat. In addition, those who feel limited in their options for buying local are less likely to purchase PA-grown barley. Lastly, brewers expressing an interest in purchasing more local inputs if they were branded as local are also more likely to purchase PA-grown hops, barley, wheat, fruits, and herbs.

Table 5. Logistic Regression for How Likely the Breweries are to Purchase Pennsylvania-Grown (1) Hops, (2) Barley, (3) Rye, (4) Wheat, (5) Fruits/Vegetables, and (6) Herbs
(1: Somewhat/Extremely Likely, 0: Otherwise)

	(1)	(2)	(3)	(4)	(5)	(6)
	Hops	Barley	Rye	Wheat	Fruits	Herbs
Ln (Volume - Barrels of Beer)	−0.0684 (0.694)	0.231 (0.113)	0.0577 (0.714)	0.0860 (0.565)	−0.314* (0.074)	−0.431** (0.018)
% Sales Taproom/Pub	0.0231** (0.047)	0.00519 (0.673)	0.0132 (0.178)	0.0116 (0.300)	0.0237* (0.065)	0.0223* (0.050)
Number of years in operation	−0.159** (0.011)	−0.00790 (0.888)	0.0656 (0.252)	0.0181 (0.785)	−0.163** (0.020)	−0.0511 (0.501)
Age	−0.00872 (0.782)	−0.00662 (0.831)	−0.0232 (0.399)	−0.00218 (0.942)	0.00589 (0.889)	0.0122 (0.685)
Four-year college degree or more	−0.566 (0.484)	0.598 (0.373)	−0.429 (0.506)	−0.446 (0.510)	0.456 (0.575)	0.343 (0.662)
Formal brewing training	0.0117 (0.988)	−0.0332 (0.968)	0.937 (0.235)	1.443 (0.113)	−0.708 (0.410)	0.845 (0.264)
Barrier to buy more local - Accessibility	−0.866* (0.094)	−0.189 (0.644)	0.0345 (0.924)	−0.220 (0.608)	−0.223 (0.644)	−0.153 (0.720)
Barrier to buy more local - Quality	0.264 (0.400)	0.0834 (0.832)	0.650** (0.037)	0.744** (0.030)	0.507 (0.229)	0.923*** (0.001)
Barrier to buy more local - Quantity	0.974* (0.061)	−0.0699 (0.869)	−0.0478 (0.893)	−0.0804 (0.812)	−0.0238 (0.949)	0.401 (0.291)
Barrier to buy more local - Price	−0.00323 (0.993)	−0.190 (0.595)	−0.199 (0.544)	−0.127 (0.725)	−0.623 (0.116)	−0.351 (0.380)
Barrier to buy more local - Variety	−0.412 (0.284)	0.0207 (0.963)	−0.196 (0.599)	−0.139 (0.739)	−0.140 (0.772)	0.0876 (0.823)
Buying local is good for local economy	0.782 (0.254)	0.837 (0.188)	1.087 (0.101)	1.407** (0.026)	−0.272 (0.602)	0.575 (0.344)
Buying local means more money for farmers	−0.309 (0.588)	0.0512 (0.909)	0.569 (0.211)	0.178 (0.675)	0.297 (0.632)	−0.0686 (0.899)
I have little choice in buying local	−0.381 (0.137)	−0.619* (0.060)	0.0966 (0.673)	−0.146 (0.544)	0.445 (0.310)	0.440 (0.109)
I buy more local if inputs were clearly branded local	0.972*** (0.007)	0.848** (0.016)	0.512 (0.118)	0.957** (0.019)	0.693* (0.061)	0.687* (0.091)
Constant	−2.945 (0.555)	−4.616 (0.199)	−10.70** (0.017)	−11.51*** (0.005)	1.183 (0.809)	−7.988** (0.040)
Observations	80	80	79	80	79	79
Pseudo R^2	0.286	0.231	0.210	0.253	0.287	0.260
Log-likelihood	−39.28	−38.18	−43.00	−41.35	−31.06	−39.94
Chi2	27.57	16.99	19.05	22.21	25.46	29.06

p-values in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Conclusions

The findings of this study underscore the complex decision-making process breweries face when sourcing local ingredients. While the surveyed brewers generally recognize the economic and community benefits of local inputs (96% agree that buying locally supports economic growth), significant barriers such as price, variety, accessibility, quality, and quantity persist. These challenges align with prior research (e.g., Staples et al., 2020) and underscore the need for targeted interventions. Smaller breweries, those with a higher percentage of sales from taprooms, and those located closer to population centers are more likely to source locally, highlighting the importance of proximity and scale in influencing purchasing decisions. Additionally, branding is critical, as well-branded local ingredients are more likely to attract buyers. These findings also underscore the integral role of neolocalism in Pennsylvania's craft brewing industry as breweries strive to balance community-oriented values with practical challenges. Neolocalism, as reflected in the preference for local ingredients and the emphasis on supporting local economies, can be a key driver of sourcing decisions. However, the above-mentioned barriers limit the widespread adoption of local inputs.

These findings hold several implications for growers, craft brewers, policy-makers, and applied researchers. For input growers, our research shows that targeting smaller breweries near urban or tourist areas and focusing on the competitive pricing and branding of local ingredients may be practical strategies to increase adoption. In order to facilitate input sourcing and grower connections with processing capacities and local brewers, some hop-growing states outside the PNW have formed state and regional hop-growing associations or guilds. At the time of writing, Pennsylvania does not have a hops growers association. Establishing state or regional hop-growing associations, as seen in other states like Ohio, Minnesota, New York, or Wisconsin, could help connect growers with brewers and address supply-chain challenges.

For policy actors such as the Pennsylvania Malt and Brewed Beverages Industry Promotion Board, additional research that supports improving the accessibility and viability of local beer ingredients in Pennsylvania's growing environment could address some of the barriers that have been identified and expand local sourcing. Production research should investigate innovative strategies to overcome accessibility and cost barriers. Future policy research should also examine how regulatory support can further enhance the use of local ingredients and investigate the long-term effects of Act 39 on the sourcing habits of Pennsylvania breweries.

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Appendix A. List of Variables and Their Description

Local ingredients	To what extent do you agree/disagree with the following statements? (Please note that local refers to Pennsylvania) — I make it a priority to buy locally produced inputs. (Strongly disagree, somewhat disagree, neither agree nor disagree, somewhat agree, strongly agree)
How likely are you to purchase PA-grown hops	How likely are you to purchase Pennsylvania-grown ingredients for your beer production over the next 12 months? — Hops (Extremely unlikely, somewhat unlikely, neither likely nor unlikely, somewhat likely, extremely likely)
How likely are you to purchase PA-grown barley	How likely are you to purchase Pennsylvania-grown ingredients for your beer production over the next 12 months? — Barley (Extremely unlikely, somewhat unlikely, neither likely nor unlikely, somewhat likely, extremely likely)
How likely are you to purchase PA-grown rye	How likely are you to purchase Pennsylvania-grown ingredients for your beer production over the next 12 months? — Rye (Extremely unlikely, somewhat unlikely, neither likely nor unlikely, somewhat likely, extremely likely)
How likely are you to purchase PA-grown wheat	How likely are you to purchase Pennsylvania-grown ingredients for your beer production over the next 12 months? — Wheat (Extremely unlikely, somewhat unlikely, neither likely nor unlikely, somewhat likely, extremely likely)
How likely are you to purchase PA-grown fruits	How likely are you to purchase Pennsylvania-grown ingredients for your beer production over the next 12 months? — Fruits & Veggies (Extremely unlikely, somewhat unlikely, neither likely nor unlikely, somewhat likely, extremely likely)
How likely to purchase PA-grown herbs	How likely are you to purchase Pennsylvania-grown ingredients for your beer production over the next 12 months? — Herbs (Extremely unlikely, somewhat unlikely, neither likely nor unlikely, somewhat likely, extremely likely)
Volume (Barrels of Beer)	How much fermented beverage did you produce in 2018 (in barrels)? — Beer — Barrels of Beverage
% Sales Taproom/Pub	Approximately what percentage of your sales come from each of the following marketing channels? — Drafts at your Taproom/Brewpub
Number of years in operation	How many years has your brewery business been in operation?
Age	What is your age? (21–29, 30–39, 40–49, 50–59, 60 or older)
Four-year college degree or more	Please check your highest level of formal education (High school graduate or less, technical degree or 2-year college, some college, 4-year college degree, postgraduate studies)
Formal brewing training	Are you participating in a formal brewing training program? (No, no plans to attend a formal training program; No, but planning to attend a certificate program; No, but planning to attend a degree program; Yes, currently attending a certificate program; Yes, completed a certificate program; Yes, completed a degree program)
Barrier to buy more local – Accessibility	How significant are the following barriers to purchasing more of your ingredients from Pennsylvania? — Accessibility of local products (Does not apply, not a barrier, somewhat of a barrier, moderate barrier, extreme Barrier)
Barrier to buy more local – Quantity	How significant are the following barriers to purchasing more of your ingredients from Pennsylvania? — Quantity (Does not apply, not a barrier, somewhat of a barrier, moderate barrier, extreme Barrier)
Barrier to buy more local – Price	How significant are the following barriers to purchasing more of your ingredients from Pennsylvania? — Price (Does not apply, not a barrier, somewhat of a barrier, moderate barrier, extreme Barrier)
Barrier to buy more local - Variety	How significant are the following barriers to purchasing more of your ingredients from Pennsylvania? — Lack of desired varieties available (Does not apply, not a barrier, somewhat of a barrier, moderate barrier, extreme Barrier)

Buying local is good for local economy	To what extent do you agree/disagree with the following statements? (please note that local refers to Pennsylvania) — Buying locally grown inputs is good for the local economy. (Strongly disagree, somewhat disagree, neither agree nor disagree, somewhat agree, strongly agree)
Buying local means more money for farmers	To what extent do you agree/disagree with the following statements? (please note that local refers to Pennsylvania) — Buying locally grown inputs means more money goes to the farmer. (Strongly disagree, somewhat disagree, neither agree nor disagree, somewhat agree, strongly agree)
I have little choice in buying local	To what extent do you agree/disagree with the following statements? (please note that local refers to Pennsylvania) — I have little choice over whether the inputs I buy are locally grown. (Strongly disagree, somewhat disagree, neither agree nor disagree, somewhat agree, strongly agree)
Buy more local if inputs were clearly branded local	To what extent do you agree/disagree with the following statements? (please note that local refers to Pennsylvania) — I would buy more locally grown inputs if the inputs were clearly branded as such. (Strongly disagree, somewhat disagree, neither agree nor disagree, somewhat agree, strongly agree)
Population	Zip code's total population 2017
Median household income	Zip code's median household income in US$, 2017
Average value of dwelling	Zip code's average value of dwelling in US$, 2017
% Population with a four-year college degree or more	Zip code's percentage of population with a four-year college degree or more
% Population 25–44 years old	Zip code's percentage of population 25–44 years old