

Grower Preferences for High Tunnel Information Sources: Evidence from a Kentucky High Tunnel Vegetable Grower Survey

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Abstract

Despite the increase in the number of high tunnels (HTs) and education programs for HT growers in recent years, few studies have evaluated HT growers' use of information sources. Using data from a 2024 Kentucky vegetable growers' survey, we evaluated which information sources HT growers utilize. Survey results suggest that University Extension and other growers were the most used information sources. Also, respondents employing organic production practices were less likely to use Extension sources. Furthermore, survey respondents who were more dependent on farm income were more likely to rely on other growers as a source of information. It is important for University Extension to continue collaborating closely with HT growers in the creation and delivery of information to stay up-to-date and relevant. Specifically, University Extension collaboration with growers using organic production practices for HT information delivery through workshops, webinars, farm tours, and field days could increase the use of University Extension as a trustworthy information source among this segment of HT growers.

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Introduction and Problem Statement

High tunnels (HTs) are structures covered by polyethylene films that are unheated or passively heated and cooled. These structures provide many benefits, such as season extension, increased crop quality and marketable yield, and reduced weather risk related to low temperatures, precipitation, and wind (Belasco et al., 2013; Carey et al., 2009; Pierre et al., 2024).

The number of HTs has increased over time due to the relatively low cost of these structures compared to greenhouses, the multiple benefits provided by these structures, and government-funded cost-share programs that promote the adoption of HTs (Carey et al., 2009; Ernst et al., 2020; Kaiser & Ernst, 2021; Pierre et al., 2024). The U.S. Department of Agriculture (USDA) Natural Resource Conservation Service (NRCS) has invested over \$170 million in programs related to HT production. As of 2021, this investment resulted in over 26,000 HTs funded using USDA NRCS resources (Pierre et al., 2024).

Due to the increased number of HTs in the United States, the amount of HT-dedicated Extension programming and resources produced by universities and other organizations also increased (Carey et al., 2009). Despite the increase in HT-specific resources, limited information is available on which sources of information are used by HT growers in the United States (Ernst et al., 2020). Understanding HT vegetable growers' preferences for and use of information sources regarding HT management could help expand the reach of HT-dedicated Extension programs (Bruce et al., 2019). This understanding is particularly important in Kentucky, where over 1,500 HTs have been funded through NRCS programs (Rudolph et al., 2023). This is the highest number of NRCS-funded HTs among U.S. Southern states (Pierre et al., 2024; Rudolph et al., 2023).

Conceptual Framework

The choice of information sources by HT growers is situated within the context of an agricultural information system. This is a system where processes of generation, transformation, transfer, consolidation, and reception of agricultural information work simultaneously to support the use of information by agricultural producers (Mahindaratne & Min, 2018). Due to the multiple processes involved in an agricultural information system, numerous actors are involved in this system, such as farmers, researchers, and University Extension personnel. Therefore, when exploring HT grower information seeking behavior, it is important to evaluate growers' use of multiple information sources when searching for production and management information, including University Extension, crop consultants, and other growers (Edge et al., 2017; Stuart et al., 2018).

We used Mahindaratne and Min (2018) conceptual framework to outline HT grower information-seeking behavior. The information needs of HT growers would likely be determined by what Mahindaratne and Min (2018) defined as activating mechanisms or motivators, which

will not only determine the information the HT growers are searching for but also how they search for it. In this study, we focused specifically on production and technological factors as mechanisms that activate the search for HT information. Additionally, the characteristics of information sources/channels are also activating mechanisms that define the information search decisions. The characteristics of different information sources in terms of risk and rewards obtained when using each source will define HT growers' information-seeking behavior. Finally, intervening variables, which are factors that could positively or negatively affect the use of information sources, need to be considered when exploring HT growers' use of information sources. We acknowledge that there could be personal and socio-cultural factors affecting the choice of information sources. In this study, however, we do not have the capacity to evaluate these factors because we do not have data that capture them. Similar to previous studies, this study focused on the characteristics of growers and their farm businesses as variables that may influence the choice of information sources (Beethem et al., 2023; Edge et al., 2017; Jenkins et al., 2011).

Purpose

This study aims to better understand Kentucky HT vegetable grower preferences for receiving HT information that could inform Extension programming. The two main objectives of this study were to:

1. Identify information sources Kentucky HT growers use when gathering information about HTs, and their satisfaction with these sources in providing information to manage HTs.
2. Identify differences in characteristics between Kentucky HT growers based on their use of specific information sources.

Results from this study can be used by University Extension personnel to improve educational programs that better suit the needs of HT vegetable growers, help expand the reach of HT-dedicated Extension programs, or confirm that current HT educational programming efforts are maximizing educational impacts.

Methods

Between January and June 2024, we surveyed Kentucky vegetable growers to assess production challenges they faced when growing vegetables in HTs and the strategies they used to overcome those challenges. The survey instrument was approved by the University of Tennessee Institutional Review Board (UTK IRB-23-07688-XM). The survey instrument is available from the authors upon request. The data reported in this paper are a subset of results from the Kentucky vegetable grower survey mentioned above. A summary of survey results is available at Velandia et al. (2025).

We included a question in the survey to assess HT growers' use of information sources to better understand grower preferences and collect ratings in terms of satisfaction with these resources in terms of their ability to help with HT issues and improve management. A 5-point Likert scale

was used to evaluate satisfaction with information sources, where 1 represents unsatisfied, and 5 represents satisfied. We also gathered information about the characteristics of growers and farm businesses, including age, education, size of the farm business in terms of gross sales and acres in vegetable production, management practices used, number of HTs in the farm operation, and number of years using HTs.

A contact list of 1,794 farm operations was built using the Kentucky Proud program, the Kentucky Department of Agriculture state-sponsored online producer directory to promote Kentucky's farms and farm products (Kentucky Proud, n.d.). The contact list contained about 83% of the 2,173 Kentucky vegetable farms reported by the 2022 Census of Agriculture (U.S. Department of Agriculture, 2024). Since a HT grower-specific contact list was not available, we identified vegetable growers in the contact list producing and marketing high-value crops commonly grown in HTs, such as tomatoes, lettuce, and other greens (Velandia et al., 2025). A total of 1,401 growers for whom we only had mailing addresses, and no e-mail addresses, received the paper version of the survey. A total of 393 vegetable growers for whom we only had e-mail addresses received the online version of the survey. This mixed-mode survey distribution strategy was used to maximize response rates and reduce errors associated with coverage and nonresponse (Dillman et al., 2009). Additionally, we advertised the survey at the 2024 Kentucky Fruit and Vegetable Conference, and through the Kentucky Vegetable Grower Association and the Center for Crop Diversification newsletters.

Responses were received from 316 of the 1,794 growers who were contacted, which represents an 18% response rate. From those 316 respondents, 253 confirmed they were growing vegetables for sale in 2023. From those 253 respondents, 122 indicated that they produced vegetables for sale in HTs in 2023. The total number of HTs owned by these respondents was 197. These HTs were spread over 60 of the 120 Kentucky counties (Velandia et al., 2025).

We evaluated differences in selected grower and farm business characteristics by the information source used. Specifically, we compared the characteristics of those respondents using University Extension as a HT information source and those not using University Extension as an information source. We also compared the characteristics of those respondents using other growers as a source and those not using other growers. Differences in characteristics captured by continuous variables were evaluated using *t*-tests, while differences in characteristics captured by dichotomous variables were evaluated using equality proportion tests (StataCorp, 2023). *T*-tests and equality proportion tests were also used to evaluate differences in the percentage use of the various information sources, as well as differences in information source ratings.

In this study, we will discuss results with *p*-values below 0.10. We employ this approach due to the exploratory nature of our study (Labovitz, 2017; Skipper et al., 1967). To our knowledge, we are the second study exploring the use of information sources by U.S. HT growers. We are not testing well-established hypotheses about the differences in characteristics between users and non-users of specific information sources. Rather, we are exploring hypotheses that could be further tested by other studies.

Findings

Survey respondents used a variety of sources for information about HT production and management. The most used information sources among survey respondents were University Extension and other growers. University Extension was used by 83% of the respondents, while 81% of the respondents indicated using other growers as an information source. The percentage of survey respondents who used consultants (21%) was significantly lower than the percentage of those respondents using University Extension and other growers (see Table 1). Other sources of information include content created by sources other than University Extension, other growers, and consultants, and found through search engines, or social media sites such as YouTube, Google, and Facebook. If the respondents mentioned University Extension websites specifically in the other source category, those responses were classified as University Extension. Other information sources used by a few survey respondents included USDA NRCS (2 respondents), or information created by other sources and delivered through books (5 respondents), and magazines (4 respondents). Survey respondents indicated using HTs for an average of nearly seven years. This could explain why USDA NRCS was mentioned as an information source by only two respondents. The High Tunnel NRCS initiative focuses mainly on providing financial assistance for the construction of HTs through NRCS Programs, but does not provide continued education or educational resources for growers once they have their HTs (U.S. Department of Agriculture – Natural Resource Conservation Service, n.d.). Therefore, NRCS might not be the top source of information after growers have already acquired or built a HT and are looking for information about managing it.

Along with indicating the information source they used, respondents were asked to rate their satisfaction with each information source in terms of its effectiveness in providing information to manage HTs. Survey respondents indicated being somewhat satisfied with the information provided by other growers, providing an average rating of 4.09 on a scale from 1 (unsatisfied) to 5 (satisfied). University Extension followed closely with an average rating of 3.96. Consultants had the lowest rating, with an average rating of 3.88 (see Table 1). Nonetheless, ratings across these information sources were not significantly different (see Table 1). We did not provide average ratings for other sources because the variety of sources listed in this category would make it difficult to interpret an average rating.

Table 1*Number and Percentage of Survey Respondents Using Different High Tunnel (HT) Information Sources and Information Source Ratings*

Information Source	Number of HT growers	Percentages*	Ratings 1 if unsatisfied and 5 if satisfied with effectiveness in providing information that helped solve HT problems or improve HT management
Extension = 1 if used University Extension to gather information about high tunnels, zero otherwise	90	82.57 ^a	3.96 ^a
Other Growers = 1 if used other growers to gather information about high tunnels, zero otherwise	88	80.73 ^a	4.09 ^a
Consultants = 1 if used consultants to gather information about high tunnels, zero otherwise	23	21.10 ^b	3.88 ^a
Other Information Sources = 1 if used other information sources	52	47.71 ^c	-

Note. *Values in the same column followed by different letters are significantly different at the 1% level.

We also evaluated the most common combinations of information sources, including University Extension, survey respondents used when gathering information about HTs. In Table 2, we show the percentage of respondents using University Extension alone or in combination with other sources. Only 4% of the survey respondents reported using University Extension as the only source of information. The most used information source combination was University Extension and other growers, with approximately 34% of respondents using this combination. Finally, not only were consultants the least used information source for HT management information, but one that survey respondents tended to combine with other information sources. Only one of the survey respondents who indicated utilizing consultants as a resource used this information source alone. Furthermore, those respondents using consultants as a source of information were more likely to complement this information with at least two more sources of information (e.g., other growers and University Extension).

Table 2*Number of High Tunnel (HT) Growers Using Extension as an Information Source*

Information Source Combinations	Number of HT Growers	Percentage
(1) Used only University Extension sources	4	4.44
(2) Used University Extension and consultants	1	1.11
(3) Used University Extension and other growers	31	34.44
(4) Used University Extension and other sources	10	11.11
(5) Used University Extension, consultants, and other growers	8	8.89
(6) Used University Extension, consultants, and other sources	2	2.22
(7) Used University Extension, other growers, and other sources	24	26.67
(8) Used University Extension, consultants, other growers, and other sources	10	11.11
Total Extension users	90	100.00

We explored the differences in characteristics between those using University Extension and those not using it. We also evaluated the differences in characteristics between those using other growers and those not using other growers as a source of HT information (see Table 3). Only one variable was shown to be significantly different between Extension and Non-Extension users at the 5% level ($p=.05$). A larger percentage of non-users of Extension followed organic and naturally grown production practices compared to the percentage of users of Extension who used these practices. This result could be explained by the variation in Extension agent knowledge and acceptance of organic practices and other environmentally sustainable production practices, which differ from conventional production practices (Crawford et al., 2015). Some growers could have had either a good or a bad experience when searching or reaching out to University Extension sources or personnel about organic or naturally grown production practices. This variation could affect the views of growers using organic and naturally grown production practices regarding University Extension as an effective source of information in general and specifically for HT production information (Crawford et al., 2015).

Table 3

Selected Survey Respondent Characteristics Means for Users of University Extension and Non-users of Extension, and Significant Differences between Means

Characteristics	Users of University Extension	Non-users of University Extension	p-values
Average age (years)	54.01	52.33	0.63
Education- percentage of respondents with a BS degree or higher (%)	61.80	68.42	0.59
Average acres in vegetable production (acres)	1.48	2.39	0.25
Percentage of respondents with gross on-farm revenue >\$25,000 (%)	49.32	33.33	0.22
Percentage of respondents with gross revenue from crops grown in HT >\$10,000 (%)	33.77	27.78	0.63
Percentage of respondents with a percentage of taxable household income from farming above 25% (%)	46.25	42.11	0.74
Percentage of respondents that are certified organic, Certified Naturally Grown, or are using these practices (%)	36.36	61.11	0.05
Average number of HT	1.78	1.44	0.37
Average years using HT	6.96	5.11	0.15

In Table 4, we show the characteristics of respondents using and those not using other growers as a HT information source. A significantly higher percentage of growers ($p=.08$) who use other growers as an information source reported annual gross on-farm revenue greater than \$25,000 (51%) compared to only 28% of those who do not use other growers as a source reporting this level of gross on-farm revenue. Similarly, a significantly higher percentage of respondents ($p=.03$) using other growers as an information source reported annual gross revenue from crops grown in HTs above \$10,000 (38%) compared to non-users of other growers (11%). Finally, a significantly higher percentage of growers ($p=.06$) who use other growers as an information source reported a percentage of taxable household income from farming above 25% (50%) compared to non-users of other growers (26%). This result could suggest that HT growers who are more dependent on farm revenue, might be more likely to trust their peers for HT information. They may perceive that other HT growers will have more understanding of HT management because of their practical experience. Also, they might trust information from other growers, who just like them, have invested time and money growing in HTs.

Table 4

Survey Respondent Characteristics Means for Users of Other Growers and Non-users of Other Growers as an Information Source, and Significant Differences between Means

Characteristics	Users of Other Growers	Non-users of Other Growers	p-values
Average age (years)	53.24	55.71	0.45
Education- percentage of respondents with a BS degree or higher (%)	62.07	66.67	0.70
Average acres in vegetable production (acres)	1.80	0.95	0.30
Percentage of respondents with annual gross on-farm revenue >\$25,000 (%)*	50.68	27.78	0.08
Percentage of respondents with gross revenue from crops grown in HT >\$10,000 (%)	37.66	11.11	0.03
Percentage of respondents with percentage of on-farm income above 25% (%)	50.00	26.32	0.06
Percentage of respondents that are USDA certified organic, Certified Naturally Grown, USDA certified organic exempt or following organic or naturally grown standards (%)	41.38	36.84	0.72
Average number of HT	1.74	1.65	0.80
Average years using HT	6.68	6.46	0.86

Conclusions, Discussion, and Recommendations

Results from a 2024 survey of Kentucky vegetable growers suggest that University Extension is the most used source of information among survey respondents, while other growers is the second most used information source among survey respondents. Also, results suggest that survey respondents combined University Extension with other information sources when searching for HT management information, with the most used combination of sources being University Extension and other growers. Results from this study suggest that it is important for University Extension to continue collaborating closely with HT growers in the delivery of information. For example, the University of Kentucky, in collaboration with other local organizations, hosts the Kentucky Fruit and Vegetable Conference every year. They involve growers in the organization of the event, but also as speakers (Martin-Gatton College of Agriculture, Food, and Environment, n.d.). According to this study's results, it would be important to replicate this strategy in the context of HT management information delivery. Additionally, University Extension could collaborate with other growers to develop videos, publications, and other online and social media content.

In contrast with previous studies evaluating the use of information sources among U.S. row crop growers for conservation information, nutrient management, and adoption of

technologies (Beethem et al., 2023; Borrelli et al., 2018; Edge et al., 2017), private sources of information such as consultants are not a commonly used source of information among HT vegetable growers included in the survey sample. Although the concept of crop consultants is not new in the context of row crop production (Borrelli et al., 2018), it may be relatively new in the context of HT production, which would explain the low use of crop consultants among HT growers. Additionally, there is likely a cost associated with accessing information through crop consultants, which could be a barrier to accessing HT information through this source.

In the context of row crop production, it seems that the use of Extension as a source of information has decreased in specific production decision contexts (Beethem et al., 2023; Edge et al., 2017; Stuart et al., 2018) compared to private sources (e.g., crop consultants). In contrast, according to this survey's results, in the context of HT vegetable production, University Extension plays an important role as a source of information for survey respondents.

Similar to previous studies (Beethem et al., 2023; Borrelli et al., 2018), other growers are commonly used sources of information, regardless of the crops grown and the production system used. The use of other growers as a trustworthy information source could also vary based on the specific information growers are seeking (Borrelli et al., 2018). Results from this study suggest that growers with a higher financial dependence on on-farm income are likely to put more trust in other growers as a source of information for HT management.

Finally, our survey results indicate that survey respondents using organic production practices may be less likely to use Extension as a source of HT information. Training Extension agents to become more familiar with environmentally sustainable practices in the context of HT production could help increase the use of University Extension as a source of HT information among growers using organic production practices. Furthermore, University Extension's collaboration with growers using organic production practices for HT information delivery could also increase the use of University Extension as a trustworthy information source among HT growers using organic production practices (Crawford et al., 2015).

In the context of HT information, several land-grant universities have dedicated programs and resources for HT information. For example, a group of universities, including Kansas State University, University of Missouri, and University of Nebraska-Lincoln created a website intended for researchers, extension specialists, professors, growers, technicians, and students to share information and experiences about HTs, including construction, management, and marketing and economics of crops grown in HTs (HighTunnels.org, n.d.). Other examples include the Tri-State High Tunnel School, organized by Michigan State University, Purdue University, and Ohio State University (Ohio State University, n.d.). Regardless of similarities in the University Extension model across land-grant universities and the HT dedicated programs and resources developed by University Extension, information needs and access to information can vary by state. Therefore, it is essential for future studies to validate the findings of this study by examining the information-seeking behavior of HT vegetable growers in other U.S. states.

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