

Cooperative Extension and teaching at a land-grant university: homeowner and industry perspectives and considerations of lawn and landscape extension resources and authorized crib cards in the classroom.

by

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## **Abstract**

Two pillars of public land-grant universities are providing undergraduate and graduate-level education and providing unbiased, research-based educational materials to the public through cooperative extension. Two extension-related surveys were disseminated to explore current lawn and landscape practices and cooperative extension awareness and use of homeowners and industry professionals across multiple states within the U.S. The objectives of both surveys were to attain a better understanding of the challenges in using cooperative extension resources for the lawn and landscape and which delivery methods they would be most likely to use in the future. In Chapter 1, the survey revealed that almost 50% of homeowners reported that family and friends were their primary information source for questions relating to the lawn and landscape while less than 7% reported using cooperative extension resources as their primary information source. However, over 50% of homeowners indicated that they were aware of cooperative extension resources related to the lawn and landscape at little or no cost to them. Chapter 2 revealed that 74% of horticultural industry professionals were aware of cooperative extension resources, and 43% reported that cooperative extension resources and conferences were their primary source of information for horticultural plant management topics. Both surveys revealed that homeowners and industry professionals are aware of cooperative extension resources and their most important considerations for future use were that it has to be easy to find and updated in the past five years. Homeowners and industry professionals both indicated that they would prefer to use video platforms, traditional online extension publications, social media, and emailed newsletters when compared to mailed newsletters, phone-based applications, or phone calls/chats with extension staff. Industry professionals also preferred in-person events. Chapter 3 explored the impact of crib cards on student test performance, test

anxiety, and study habits. For most students, there was a  $<2\%$  change in their average test scores when compared to traditional, non-crib card-allowed tests in the same semester. Students did report that the crib card, “help[ed] motivate me to study” and assisted in creating a “plan for what I didn’t know” while studying. Crib cards supported students with a GPA  $<2.65$  the most, while students with a GPA  $>3.1$  were sometimes hindered in performance. Overall, crib cards are another tool that students can use to help them prepare for tests and feel more confident going into the test. While they can hinder some students’ performance, there was often minimal influence on their overall course grade. Crib cards can be offered but should not be required for students to use.

# Table of Contents

|                                                                                              |      |
|----------------------------------------------------------------------------------------------|------|
| List of Figures .....                                                                        | vii  |
| List of Tables .....                                                                         | viii |
| Acknowledgements .....                                                                       | xi   |
| Dedication .....                                                                             | xii  |
| Chapter 1 - Homeowner Lawn and Landscape Practices and Use of Cooperative Extension          |      |
| Resources .....                                                                              | 1    |
| Abstract .....                                                                               | 1    |
| Introduction .....                                                                           | 2    |
| The History of Land-Grant Universities .....                                                 | 2    |
| Past Research on Cooperative Extension Use .....                                             | 4    |
| Materials and Methods .....                                                                  | 6    |
| Results and Discussion .....                                                                 | 7    |
| Respondent States .....                                                                      | 7    |
| Lawn and Landscape Maintenance Practices .....                                               | 8    |
| Extension Resource Use .....                                                                 | 12   |
| Conclusion and Recommendations .....                                                         | 15   |
| References .....                                                                             | 17   |
| Figures .....                                                                                | 20   |
| Tables .....                                                                                 | 22   |
| Chapter 2 - Current Green Industry Management Practices, Perspectives, and Considerations of |      |
| Lawn and Landscape Education Extension Resources from Land-grant Universities .....          | 47   |
| Abstract .....                                                                               | 47   |
| Introduction .....                                                                           | 48   |
| The Professional Horticulture Industry .....                                                 | 48   |
| The History of Land-Grant Universities .....                                                 | 49   |
| Materials and Methods .....                                                                  | 49   |
| Results and Discussion .....                                                                 | 51   |
| Responses .....                                                                              | 51   |
| Lawn and Landscape Contractors .....                                                         | 52   |

|                                                                                         |    |
|-----------------------------------------------------------------------------------------|----|
| Trade Organization Membership .....                                                     | 52 |
| Extension Resources .....                                                               | 53 |
| Conclusion and Recommendations.....                                                     | 56 |
| References .....                                                                        | 57 |
| Figures .....                                                                           | 58 |
| Tables.....                                                                             | 59 |
| Chapter 3 - The Influence of Authorized Crib Cards on Student Test Performance and Test |    |
| Anxiety in an Introductory Horticulture Course.....                                     | 75 |
| Abstract .....                                                                          | 75 |
| Introduction.....                                                                       | 76 |
| Materials and Methods.....                                                              | 78 |
| Results and Discussion .....                                                            | 81 |
| Pre-survey .....                                                                        | 81 |
| Test Performance .....                                                                  | 82 |
| Crib Card Usage.....                                                                    | 83 |
| Post-Survey .....                                                                       | 84 |
| Conclusion .....                                                                        | 84 |
| References .....                                                                        | 86 |
| Figures .....                                                                           | 87 |
| Tables.....                                                                             | 89 |
| Appendix.....                                                                           | 97 |
| Appendix A - Chapter 1 .....                                                            | 97 |
| Appendix B - Chapter 2 .....                                                            | 98 |
| Appendix C - Chapter 3 .....                                                            | 99 |

## **List of Figures**

|                                                                                                                                      |    |
|--------------------------------------------------------------------------------------------------------------------------------------|----|
| Figure 1.1. USDA NIFA Map of all Land-Grant Universities within the United States and its territories. ....                          | 20 |
| Figure 1.2. The number of responses from each of the 12 states surveyed. ....                                                        | 21 |
| Figure 3.1: Two crib cards collected during the study showcasing the use of color, diagrams, and sections within the card. ....      | 87 |
| Figure 3.2: Two crib cards collected during the study with little organization, no color, or other items besides text included. .... | 88 |

## List of Tables

|                                                                                                                                                                          |    |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| Table 1.1. The questions and response options presented to homeowners.....                                                                                               | 22 |
| Table 1.2. The number of homeowners surveyed from each state. ....                                                                                                       | 24 |
| Table 1.3. The reported lawn size by homeowners surveyed in 12 Great Plains and surrounding states.....                                                                  | 25 |
| Table 1.4. The reported maintenance hiring practices of homeowners in 12 Great Plains and surrounding states. ....                                                       | 26 |
| Table 1.5. The number of hours that homeowners report spending on their lawn and landscape.                                                                              | 27 |
| Table 1.6. How often homeowners report mowing their lawns.....                                                                                                           | 28 |
| Table 1.7. The mowing frequency of contractors hired by homeowners. ....                                                                                                 | 29 |
| Table 1.8. Turfgrass clipping management by homeowners and contractors hired to maintain home lawns. ....                                                                | 30 |
| Table 1.9. How homeowners are disposing of collected grass clippings. ....                                                                                               | 31 |
| Table 1.10. Turfgrass and vegetative debris management after mowing. ....                                                                                                | 32 |
| Table 1.11. The reported species within home lawns. ....                                                                                                                 | 33 |
| Table 1.12. The reported species in Montana (MT) and North Dakota (ND) home lawns. ....                                                                                  | 34 |
| Table 1.13. The reported number of times that fertilizer and other pesticides are applied to the lawn and landscape by homeowners or their hired contractors. ....       | 35 |
| Table 1.14. The reported age of homeowner in-ground irrigation systems.....                                                                                              | 36 |
| Table 1.15. The frequency of homeowners adjusting their irrigation scheduling (i.e., zone run time or start time).....                                                   | 37 |
| Table 1.16. The reported number of times that homeowner in-ground irrigation systems have been audited by a professional to evaluate system efficiency. ....             | 38 |
| Table 1.17. The reported frequency of homeowner in-ground irrigation systems being adjusted to ensure that they are only watering turfgrass and other desired areas..... | 39 |
| Table 1.18. The primary information sources for homeowners pertaining to lawn and landscape-related questions.....                                                       | 40 |
| Table 1.19. Homeowners of the Great Plains and surrounding states awareness of cooperative extension resources pertaining to the lawn and landscape.....                 | 41 |

|                                                                                                                                                                                                    |    |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| Table 1.20. How many times homeowners aware of cooperative extension resources have used extension education resources in the past year. ....                                                      | 42 |
| Table 1.21. The most used extension education delivery methods by homeowners. ....                                                                                                                 | 43 |
| Table 1.22. Homeowner challenges in using and obtaining resources and information from cooperative extension.....                                                                                  | 44 |
| Table 1.23. The most important considerations for homeowners when using cooperative extension resources. ....                                                                                      | 45 |
| Table 1.24. Cooperative Extension resources and tools that homeowners would be most likely to use in the future.....                                                                               | 46 |
| Table 2.1. The survey questions presented to industry practitioners.....                                                                                                                           | 59 |
| Table 2.2. The university and cooperative extension associated collaborators and all cooperative extension-associated field days, workshops, or conferences where the survey was distributed. .... | 62 |
| Table 2.3. The number of responses ( <i>n</i> ) by state that industry practitioners work in.....                                                                                                  | 63 |
| Table 2.4. The breakdown of industry affiliation of practitioners at cooperative extension led in-person workshops.....                                                                            | 64 |
| Table 2.5. The education level of horticultural industry practitioners surveyed. ....                                                                                                              | 65 |
| Table 2.6. The number of employees in businesses surveyed, including seasonal workers.....                                                                                                         | 66 |
| Table 2.7. The most common additional services <sup>a</sup> offered by lawn care and landscape companies. ....                                                                                     | 67 |
| Table 2.8. The most used customer relationship managers by lawn care and landscaping companies surveyed. ....                                                                                      | 68 |
| Table 2.9. Trade organization membership <sup>a</sup> . ....                                                                                                                                       | 69 |
| Table 2.10. The primary and secondary information sources for practitioners surveyed relating to horticultural plant management and plant health management. ....                                  | 70 |
| Table 2.11. Practitioner awareness of cooperative extension resources. ....                                                                                                                        | 71 |
| Table 2.12. The primary reason or challenges in using cooperative extension resources by practitioners.....                                                                                        | 72 |
| Table 2.13. The considerations by practitioners when using cooperative extension resources relating to plant health care and maintenance. ....                                                     | 73 |

|                                                                                                                                                                                     |    |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| Table 2.14. The mediums that practitioners would be most likely to use for future cooperative extension educational materials pertaining to plant health care and maintenance. .... | 74 |
| Table 3.1: Description of when crib cards were allowed for Basic Turfgrass Culture (HORT 515) tests during spring 2023 and 2024 semesters at Kansas State University. ....          | 89 |
| Table 3.2: Demographics of HORT 515 students in the spring 2023 and spring 2024 semesters. ....                                                                                     | 90 |
| Table 3.3: The pre-survey results on students perceptions on how they will use crib cards during the semester (2023 and 2024 data was combined).....                                | 91 |
| Table 3.4: The <i>T</i> -test results of HORT 515 tests from spring 2023 and spring 2024. ....                                                                                      | 92 |
| Table 3.5. The mean test results of HORT 515 students in the spring of 2023.....                                                                                                    | 93 |
| Table 3.6. The mean test results of HORT 515 students in the spring of 2024.....                                                                                                    | 94 |
| Table 3.7. The linear regression results of student crib card use in HORT 515 by students in both 2023 and 2024.....                                                                | 95 |
| Table 3.8. The post-survey results on students perceptions on how they will use crib cards during the semester (2023 and 2024 data was combined).....                               | 96 |

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# **Chapter 1 - Homeowner Lawn and Landscape Practices and Use of Cooperative Extension Resources**

## **Abstract**

Cooperative Extension is one of the most public-facing aspects of land-grant universities providing research-based informative materials focusing on assorted topics relating to agriculture, horticulture, and other aspects of home life. This experiment explored current lawn and landscape maintenance practices of homeowners across 12 states in the U.S., their awareness and use of Cooperative Extension resources, and their largest challenges in using those Cooperative Extension resources. A 50-question survey was created at Kansas State University in Qualtrics and distributed through Amazon Mechanical Turk from 16 June 2023 to 30 Mar. 2024. Most homeowners did indicate that they maintain the lawn and landscape areas of their property, including fertilizer and pesticide applications. Nearly 50% of homeowners reported that family and friends were their primary information source for lawn and landscape questions. Less than 7% of homeowners used Cooperative Extension as their primary source even though >50% indicated they were aware of Cooperative Extension resources being available to them at little or no cost. Homeowners who were aware of Cooperative Extension resources indicated that their most important consideration for using extension material in the future is that it must be easy to find and updated within the past five years. They would be more likely to continue using traditional online extension publications; however, they would also be likely to use video-based publications, interact with social media posts, and read blogs from extension professionals. Results from this survey provide insights into the current lawn and landscape practices by homeowners and help guide extension programming efforts at land-grant universities.

## **Introduction**

### **The History of Land-Grant Universities**

In every state and most territories within the U.S., there are one to six land-grant colleges and universities that are supported by local, state, and federal funding (USDA-NIFA, 2024b, Figure 1.1). Land-grant universities fall into three categories and are often referred to by the year that their Morrill Act was passed: public universities (1862), historically black colleges and universities (1890), or tribal colleges and universities (1994). These higher education institutions have been designated through three legislative acts to support their communities and stakeholders through teaching, innovating, and disseminating research. In 2022, the United States Department of Agriculture (USDA) reported there are 112 designated universities and colleges with land-grant status in the U.S. and its territories (USDA-NIFA, 2024b).

The original federal act that formed land-grant universities was the Morrill Act of 1862. Intended to help educate American citizens and residents at the state level and provide affordable higher education opportunities focusing on agriculture and mechanical skills (USDA-NIFA, 2024a). At the time, university-level education was only available to the wealthiest families in the U.S. due to the cost of tuition and living expenses. Now, these original (i.e., 1862) land-grant universities are home to traditional two-year and four-year programs and graduate-level programs. Kansas State University was the first operational land-grant university, opening on February 16<sup>th</sup>, 1863 (K-State Alumni Association, n.d.). In following years, the Morrill Acts of 1890 and 1994 allowed historically black colleges and universities (HBCUs) and tribal colleges and universities, respectively, to gain land-grant university status and gain access to more resources to educate the public and conduct research. These colleges and universities are a mixture of community colleges (two-year programs) and traditional four-year and graduate programs across the U.S. (USDA-NIFA, 2024a, 2024b).

The Hatch Act of 1887 added the second land-grant university mission, research, by providing federal funding to create agricultural research stations across their state. The research conducted was intended to help alleviate the agricultural problems of those in their communities (USDA-NIFA, 2024a). As society has progressed, so has the need for innovative and innovative research. Today, land-grant universities continue to honor their roots and innovate within the

agricultural sector, while conducting research in many other fields as well, such as medicine, engineering, and more with research stations across their respective states.

The Smith-Lever Act of 1914 created the final mission, Cooperative Extension, for land-grant universities. Designed to help disseminate unbiased, research-based information to the public through publications and knowledgeable experts living and working in the community while being supported by professors, researchers (scientists), and other experts in the field (USDA-NIFA, 2024a). With over 3,000 offices across counties and parishes within the U.S., these offices are a wealth of knowledge, providing expert advice, resources, in-person events and programs, on-site consultations, and more (USDA-NIFA, 2024c). Local extension offices can contain many programs and materials to support the community, from plant health care of crops and horticultural crops to personal and financial health, family and consumer sciences, and more. Depending on the number of land-grant universities in each state, it can impact the management structure of Cooperative Extension offices. Some offices are managed and staffed by just one land-grant university, such as Kansas State University with K-State Research and Extension, or there could be multiple universities involved, such as the Alabama Cooperative Extension System which is supported by both Auburn University and Alabama A&M University (Alabama Cooperative Extension System, n.d.).

Traditionally, print media (e.g., extension publications, brochures), direct communications (e.g., face to face, on the phone, written), and in-person workshops (e.g., classes, conferences, field days) have been the primary information delivery methods for Cooperative Extension education services. With recent advancements in technology, increased internet access for most of the U.S., including rural areas, and a post-COVID-19 world pandemic mindset, many have started to look towards using more online publications, webinars, social media, and other online-based sources of information. More research is needed to understand which Cooperative Extension materials homeowners prefer and what their most important considerations are when using Cooperative Extension materials (e.g., recency of publication, ease of finding, or delivery method). This research could assist in guiding new extension material creation to potentially assist in increasing end-user awareness, trustworthiness, and relevance. The primary objective of this experiment was to better understand the current lawn and landscape practices of non-professional end users (e.g., homeowners), how they use current

extension resources, and which delivery methods they prefer to assist and inform Cooperative Extension professionals across the U.S. on where to direct more effort.

## **Past Research on Cooperative Extension Use**

Research has been conducted to understand how U.S. homeowners maintain their lawn and landscape areas (Blaine et al., 2012; Varlamoff, et al., 2001). A better understanding of these trends allows researchers to conduct targeted research to see the efficacy of mailed education campaigns, demographic impacts, and their willingness to switch to non-traditional lawns [e.g., low-input turfgrasses (i.e., less maintenance inputs) or artificial (i.e., synthetic) turf] (Barnes & Watkins, 2022; Carpenter & Meyer, 1999; Mangiafico et al., 2012). Other research has found that families in the southern U.S. tend to trust University extension education resources more than their counterparts in the three other U.S. geographic regions; however, all geographic regions mentioned that garden centers or hardware stores provided more applicable information (Yue et al., 2017). Therefore, there is a need to further research these trends and better understand the thoughts of homeowner extension use and future use considerations.

Irrigation is often one of the more discussed components of the lawn and landscape with increasing water restrictions in many states within the U.S. Homeowners do not always understand when a lawn needs to be irrigated, how long the irrigation system needs to run, or how much water is applied in that timeframe. Martini and Nelson (2015) found that regardless of knowledge level (i.e., low, medium, or high knowledge), most homeowners were irrigating by set run times that do not take into consideration whether the turfgrass needs it, the soil moisture, or any other environmental influences. However, most homeowners did know to irrigate in the morning to help reduce the risk of disease and the amount of water lost to wind or evaporation (Martini & Nelson, 2015). Bremer et al. (2012) and Mangiafico et al. (2012) reported most homeowners tried to keep a well-maintained lawn; however, few understood the proper times to irrigate and fertilize their lawns. For example, most surveyed homeowners in Kansas in 2009 with above-ground irrigation (i.e., hose and sprinkler), and some with in-ground irrigation, would irrigate when the “lawn looks dry” or “when weather is hot & dry” without checking soil moisture to see if the lawn needed the irrigation or if there was any precipitation in the forecast (Bremer et al., 2012). Although having a green appearance and healthy lawn throughout the season was important for many of these respondents, homeowners in drier regions, such as

Salina, KS, were more concerned about their water bills, recent drought periods, and in turn, were more likely to irrigate less, regardless of irrigation system type (Bremer et al., 2012). These results provide opportunities for extension education efforts to be created and delivered in these communities.

Mangiafico et al. (2012) reported that only 36% of homeowners had a well-rounded knowledge of horticultural practices, such as the importance of soil testing for nutrients and being able to create a plan from those results. These knowledge gaps can be attributed to a variety of reasons; education level (regardless of degree), plant health knowledge, ease of use of extension resources (or lack thereof), and availability of other external resources (e.g., garden centers, family, and horticultural professionals). Respondents with higher levels of education are statistically more likely to use and trust university extension resources, however, it is still a small difference (Yue et al., 2017). One possibility is that those with higher education levels may be more aware of land-grant university extension information and education services; however, more research is required on this topic.

Applying fertilizer and other pesticide products is something that most homeowners either apply themselves or hire someone to do (Martini et al., 2015; Sewell et al., 2010; Varlamoff et al., 2001). These products can be beneficial to the lawn and landscape. For example, when overall turfgrass health and density is increased then ecosystem service benefits are enhanced (Braun et al., 2023a). Nevertheless, improper applications (e.g., overapplication or misapplication) of these management inputs can cause damage to the soil, plants in the soil, or runoff into the local watershed (Braun et al., 2023a). Over half of surveyed homeowners in several Nebraska communities reported they did not read the application instructions or the fertilizer label when making fertilizer applications on their lawns (Sewell et al. 2010).

More recently, there has been increasing interest in low-input turfgrass systems that require less fertilization, irrigation, and in some cases, mowing (Braun et al., 2020; 2023a; 2023b; Patton et al., 2017). Yue et al. (2012) found that most homeowners would prefer a lawn that requires less frequent mowing (every two weeks to monthly) and less frequent irrigation, even if the initial cost for the seed is more expensive. Fertilization was a consideration along with the less frequent irrigation and mowing, however, like the findings of Carpenter and Meyer (1999), Yue et al. (2012) reported that homeowners would continue to apply fertilizers or hire someone to apply for them without many changes from their current practices. This could be

attributed to a lack of knowledge of plant and soil health among homeowners and because of the reduced frequency of fertilizing when compared to irrigating and mowing. Creating educational materials (i.e., extension publications and other materials) that help homeowners and contractors alike understand the true needs of the plants they are maintaining is an important part of Cooperative Extension. These materials can range from print or online publications to videos to social media posts and more, all with research-based results, no commercial gain, or other influences. The primary objectives for this study were to gain a better understanding of how homeowners of 12 Great Plains and surrounding states are maintaining their landscapes and how they are or are not using Cooperative Extension resources, what their challenges in use are, and which delivery methods they would like to use more in the future.

## **Materials and Methods**

An online survey was conducted at Kansas State University from 12 June 2023 to 30 Mar. 2024. A 50-question survey was created in Qualtrics (Qualtrics, Provo, UT), primarily consisting of yes/no and Likert-scale (1 to 5) questions (Table 1.1). To start, there was a qualifier question asking if the respondent was a “homeowner” and to select the current state in which they reside. To continue, the respondent must be a homeowner in one of the Great Plains or surrounding states (Arkansas, Colorado, Iowa, Kansas, Minnesota, Missouri, Montana, Nebraska, North Dakota, South Dakota, or Wyoming, Figure 2). Following the two qualifiers, respondents were asked about their basic lawn and landscape maintenance practices including mowing, irrigation, and fertilizer and pesticide applications. They were then guided to a series of questions on their experience of using Cooperative Extension resources with the questions customized to reflect the state they reside in (e.g., Kansas residents would see “Kansas State University Research and Extension”). They were asked about their primary information source for lawn and landscape-related questions, how they had used (or not used) Cooperative Extension in the past year, what is their biggest challenge with accessing extension materials, and their willingness to use new extension material delivery methods (Table 1.1). This study was IRB approved under the criteria set forth in the Federal Policy for the Protection of Human Subjects, 45 CFR §104(d), category: Exempt Category 2 Subsection ii (Proposal Number: IRB-11576).

The survey was distributed through Amazon Mechanical Turk (mTurk, Amazon, Seattle, WA), an independent contractor platform where potential respondents are able to complete surveys and other tasks for compensation, and each respondent was compensated \$0.50 upon completion. It was expected that the survey would take between five and seven minutes to complete and mTurk closed the redemption window after 10 minutes. The survey was open from 16 June 2023 to 1 Mar. 2024 on mTurk and closed in Qualtrics on 27 Mar. 2024. All responses were downloaded from Qualtrics as a Microsoft Excel Spreadsheet (Microsoft, Redmond, WA) to be filtered before being imported to R statistical software (R Development Core Team, 2024). The original data was duplicated onto a second page to be modified and imported into R for statistical analysis. The second-page data was cleaned to remove any unnecessary columns with data that was not collected (e.g., first and last name, external reference, etc.), a reCAPTCHA score of 0.7 or less, and any surveys that were not completed. In the final extension-related question, respondents were asked to select “Somewhat Unlikely” as one of the options for an attention check. If they did not properly answer that question, they could not complete the survey. Then, results from each state’s extension programs were condensed into one series of columns, and all Likert-style responses were converted to numerical responses using Find and Replace. Once these steps were completed, the spreadsheet was imported into R statistical software using the RStudio interface using the “readxl” package for analysis. Within R, a function was created to find the mean, median, mode, standard deviation, standard error, the number of each response, and the confidence intervals at 68, 95, and 99 percent rounded to three decimal places. Paired *T*-tests were conducted on all Likert-scale questions to explore statistical differences between homeowner challenges in use and which tools they would be more likely to use.

## **Results and Discussion**

### **Respondent States**

Five (Colorado, Kansas, Minnesota, Missouri, and Oklahoma) of the 12 surveyed states represent over 790 of the 1,145 responses (Figure 2 and Table 1.2). Three of the five states (Kansas, Missouri, and Oklahoma) are all similar “transitional climatic zone” states and allow for a wider variety of plants to be grown, with mixtures of cool- and warm-season turfgrasses

and a wide variety of trees, shrubs, and other perennial landscape plants while Colorado and Minnesota have wider ranging climatic zones.

## **Lawn and Landscape Maintenance Practices**

The largest group of homeowners at 28.6% reported a lawn size between 2,001 to 5,000 square feet and 68% of homeowners indicated they had a lawn size <7,500 square feet (Table 1.3). Most homeowners reported that they perform their own lawn (96.2%) and landscape maintenance (96%) and most (64.5%) do not hire out any other landscape-related services (e.g., fertilization and pesticide applications (Table 1.4). Fifty-eight percent of homeowners in this survey typically reported spending between two and five hours per week working on their lawn and landscape during the growing season, which is similar to the six hours per week found by Blaine et al. (2012, Table 5).

When asked about mowing practices, homeowners reported mowing on a weekly schedule (47.3%), bi-weekly (every two weeks) (21.4%), or a monthly (14.3%) regular set schedule, which unfortunately, may cause more than one-third of the turfgrass blade to be removed at one time, which can cause excessive stress on the plant and is not recommended (Hoyle, 2017, Table 1.6). However, 8.4 and 7.2% reported they do not mow on a set schedule or that they follow the 1/3<sup>rd</sup> rule, respectively, which is beneficial because more frequent and routine mowing, at the proper height, is better for turfgrass health when compared to an infrequent mowing schedule. These results show some progress in the right direction for proper turfgrass maintenance by homeowners but more homeowner education is needed for proper mowing frequency to promote healthy turfgrass stands. More extension-based education resources and improvements in technology with robotic mowers and other technologies may help educate homeowners to better follow the one-third rule while reducing emissions and stress to their lawns (Christians et al., 2017). Some homeowners did report that they mow more infrequently (i.e., monthly or even less), which can lead to excessive stress on both the turfgrass plants and mowing equipment, and attract unwanted pests (e.g., ticks, fleas, poison ivy, and other noxious pests). Furthermore, too infrequent mowing could lead to potential fines from local jurisdictions for exceeding lawn height limitations. If homeowners hired professional contractors (e.g., lawn care operators) to mow, there was a similar distribution of mowing frequencies compared to homeowner mowing frequency (Table 1.7).

Further mowing practice questions indicated that 64% of homeowners bag (collect) clippings from their lawn ( $n=705$ ), and only 16% of lawn care operators collect lawn clippings on a regular basis for homeowners (Table 1.8). Results also indicated that 13.6% of homeowners reported clippings were “at least sometimes” collected by lawn care operators. (Table 1.8). In addition, 27% of homeowners who had their lawns maintained by lawn care operators did not know if clippings were or were not collected. When clippings were bagged, it appears that most homeowners are composting them (62%) while 36% are putting them in a yard waste bag or bin for removal (Table 1.9). Research at land-grant universities and multiple extension publications have focused on the benefits of allowing clippings to return to the turfgrass surface compared to bagging and removing clippings. Allowing grass clippings to return to the plant-soil system in adequate amounts can help return nitrogen and other nutrients to the soil, improve soil health, and increase organic matter (Bigelow et al., 2005; Kopp & Guillard, 2002; Law et al., 2017). This is another area where Cooperative Extension programming needs to focus more efforts on educating homeowners on this best management practice. A question was asked to find out how debris (e.g., grass clippings, leaves, soil) blown onto the pavement during mowing was managed after. Most (65%) homeowners reported they did blow or sweep off paved surfaces after mowing (Table 1.10). The question did not ask where those clippings were blown into (e.g., into the lawn or into landscape beds). It is important to blow any clippings from the paved areas back into the lawn so they can decompose into the soil and return nutrients to the ecosystem and to prevent runoff during rain or excessive irrigation into local streams and ponds that may cause algal blooms (Christians et al., 2017). Blowing or sweeping debris from paved surfaces back into the lawn can not only provide essential nutrients back to the lawn, reducing fertilizer input needs, but can also help prevent injury to others from slipping, help reduce algal blooms in ponds and waterways, and reduce the clogging of storm drains and other wastewater management systems.

Respondents were asked to select which turfgrass species or group of species was in their lawn and the largest category of homeowners (~24%) reported they did not know what turfgrass species was in their lawn. The remaining 76% reported they indicated which species they believed was in their lawn, however, this could not be verified (Table 1.11). Furthermore, there were reports of warm-season turfgrass species being the primary turfgrass species in lawns in northern states, such as North Dakota and Montana, and other climates that the species are not adapted to (Table 1.12). These results are similar to Bremer et al. (2012), who reported up to

73% of homeowners across three Kansas cities indicated that they knew what turfgrass species were in their lawns; however, Beck and Patton (2015) found that after offering 120 live plant samples (turfgrass and weed species) at a fall, in-person training seminar for practitioners, attendees were only able to accurately identify four out of 20 samples more than 50% of the time, indicating that identification skills can vary from person to person and some could believe that they are better at identification than they are. This finding indicates that there is a lack of knowledge and plant identification skills by homeowners. More easily accessible turfgrass identification tools that include images and diagrams of different turfgrass species at different heights, colors (due to nutrient deficiencies or cultivar differences), and growing conditions delivered through Cooperative Extension could help homeowners better identify the turfgrass species on their properties and then apply the correct maintenance practices.

Most homeowners indicated they received a fertilizer and/or pesticide application in their lawn and landscape areas (Table 1.13). This is similar to the findings of Blaine et al. (2012), who reported that 62% of homeowners applied pesticides themselves or had someone make the application for them. Results from the survey indicated that 18% of homeowners applied one fertilizer application per year themselves and ~69% of homeowners reported they self-applied fertilizer two to four times a year. Similar results of fertilizing the landscape around the property were reported by homeowners. The most frequent application of pesticides applied by homeowners was two and three applications per year at 22.3 and 22.9% of responses. When homeowners hired a professional lawn care operator to apply fertilizer to the lawn or landscape, then most homeowners reported receiving two applications per year in each area (35.6 and 19.5% respectively). For pesticide control by the lawn care operator, 20% of homeowners indicated they received two applications per year, while 33% of homeowners received three to four pesticide applications. As expected, 40% of homeowners do not have their soil tested by a private lab or land-grant university to know their soil's properties or nutrient status (data not shown). This is a higher percentage than the findings of Osmond and Hardy (2004) and Sewell et al. (2010), who found that only 20% of households in five North Carolina communities and 3% of Nebraska sandpit homeowners, respectively, base their fertilization application plans on soil test results. Extension educational resources focused on proper fertilization and pesticide application process and how to base those applications on soil tests are some of the areas that Cooperative Extension efforts should focus on.

Most (60%) homeowners indicated that they had an in-ground irrigation system designed to water the turfgrass and/or landscape areas of their property (Table 1.4). Israel and Hague (2002) found similar results with between 58% and 75% of homeowners reported having a permanent irrigation system. Of these 689 homeowners with in-ground irrigation systems, nearly 58% indicated their irrigation system is less than 7 years old (Table 1.14). Results indicate that ~40% of homeowners adjust their in-ground irrigation watering schedule at least weekly (Table 1.15). Furthermore, ~46% of homeowners reported adjusting their in-ground irrigation system run times at least seasonally, if not more frequently. This is more common than the findings of Bremer et al. (2012), where up to 50% of homeowners across Kansas were only adjusting their run times seasonally. This could indicate that homeowners may have become more water conscious or have a better understanding of necessary irrigation system run times in the last decade or more since the Bremer et al. (2012) data. There is still room to improve in this area as ~12% of homeowners indicated they only adjust watering schedule runtimes twice a year or less often. Additional questions related to ownership of an in-ground irrigation system revealed that 59% of homeowners reported they have had their irrigation system audited two or more times in the last ten years and 62.4% of homeowners have their in-ground irrigation adjusted at least once a year or multiple times a year to ensure they are not watering non-desired areas (Tables 1.16 and 1.17). The question asking about irrigation audits did not specifically define an audit as a test conducted with catch cans to measure the efficiency and uniformity of their irrigation system and it is possible that homeowners could believe that the survey was asking about seasonal adjustments, backflow checks, or other possibilities. There was a question asking which “smart” devices homeowners had on their irrigation systems (e.g., Wi-Fi connectivity, rain sensor, soil moisture sensor, etc.), however, due to an error with the survey, that data was not collected. With most irrigation systems being less than 10 years old, it is safe to assume that there is potential to encourage homeowners to update and improve the system from the controller side by adding rain or soil moisture sensors, and upgrading to smart controllers that can connect to Wi-Fi and interact with local weather stations. Another way that homeowners can potentially help conserve water is by changing to pressure-regulated sprinklers, more efficient nozzles, or ensuring that their sprinklers are properly adjusted to water within intended areas; however, this information was not collected in this survey. Through new extension educational materials, and partnering with local governments for rebate programs, Cooperative Extension programs can help extension

be leaders in encouraging homeowners to use water more efficiently and effectively. While some cities have started creating their own rebate programs, such as the Hays, KS Water Department Smart Irrigation Controller Rebate Program, there is room for growth within these programs with financial support and educational campaigns from Cooperative Extension programs and other state and federal level programs (Hays, 2024).

## **Extension Resource Use**

Less than 7% (6.1%) of surveyed homeowners indicated that Cooperative Extension was their primary source of information relating to the lawn and landscape questions (Table 1.18). Most homeowners reported family (38%), and friends (11%) were their primary information sources for lawn and landscaping-related questions. Online influencers (19%, e.g., YouTube channel personalities), lawn care companies (11.1%), and garden/hardware stores (6.8%) all seemed to be more preferred information sources for homeowners over Cooperative Extension resources. These findings are concerning since many of these resources can provide information that is not research-based or proper for the region, both of which Cooperative Extension does provide. Just over half (53%) of homeowners noted that they were aware of resources available for the lawn and landscape from university extension, and 18% indicated that they knew of university extension resources but did not know there were resources for the lawn and landscape (Table 1.19). The remaining 29% of homeowners were not aware of extension education materials available for the lawn and landscape, agronomy, or family and consumer sciences. Furthermore, of the 808 respondents aware of Cooperative Extension, 31.7% used extension education resources <1 time in the last year, whereas nearly 56% of homeowners used it two to three times in the past year (Table 1.20). These results are higher than the findings of Israel and Hague (2002), who reported that homeowners surveyed at in-person Cooperative Extension workshops averaged <1 use per year, and homeowners surveyed through randomly selected mailings reported <0.2 Cooperative Extension contacts in the past year. When extension education resources were used, the survey revealed that the three most used information delivery methods were social media (30%), online publications (23.1%), and website blogs (22.4%, Table 1.21). The remaining five options (interactive sessions, emailed newsletter, mailed newsletter, phone app/tool, and in-person workshops/events) were all  $\leq 7.1\%$  each and combined for the remaining 24.5% of responses (Table 1.21).

Respondents were asked to select the biggest challenge for not using Cooperative Extension resources and considerations for future use of extension education resources (Tables 1.22 and 1.23). In addition, 17 and 18% of respondents noted that Cooperative Extension information seems “outdated” or that it requires more time to find the extension information, respectively. Similarly, 12% of homeowners felt the answers to their questions on lawn and landscaping from the Cooperative Extension resources were not easily available. Therefore, homeowners did not use extension resources for a variety of reasons, such as a lack of awareness being the most prevalent. Many homeowners reported that they struggle to find information easily and quickly on Cooperative Extension websites (Table 1.22). Only 3% and 7% of homeowners believed the information from Cooperative Extension resources was “not trustworthy” or “not useful,” respectively. Survey results also revealed if homeowners did find the extension information they were searching for, many thought that it was outdated (16.7%). While many management practices, scientific names, and other characteristics of plants often do not change, there are still changes in where people search and find information (e.g., search engines, platforms), branding changes for the parent university or extension system, or other cultural changes. Seed companies and plant breeding programs at land-grant universities continue to release new and improved cultivars with better abiotic and biotic stress tolerances and lower maintenance inputs (e.g., irrigation, pesticides, fertilizer). Thus, older cultivars often become no longer commercially available, and therefore, some extension publications can become “out of date” or not as relevant in as little as a few years, whereas others may be able to be relevant for decades without needing revision. Among those who did know about Cooperative Extension resources, their use of extension resources was still low. For example, 32% of the surveyed homeowners who knew of Cooperative Extension opportunities did not use any of the resources or only used them once in the past year (Table 1.20). Nearly as many homeowners (34%) reported using the resources twice in the past year and 21% of surveyed homeowners mentioned using Cooperative Extension resources three times in the last year. Further results indicated that homeowners are less likely to utilize Cooperative Extension four or more times a year. This has led to more questions for further research, such as “What other sources are homeowners using to attain information about lawn and landscaping?” or “What are the major roadblocks for homeowners getting extension information?” or “How do Cooperative Extension

services have a greater presence?” due to homeowners often lacking horticultural education and potentially having more questions relating to lawn and landscape practices.

These survey results may help Cooperative Extension services know where to direct future efforts to reach a larger homeowner audience. For example, having a system and plan in place to update online extension publications promptly with relevant information and current university branding may help increase use. Other methods may include updating extension websites, social media accounts and blogs while ensuring that other links are working properly. Additional steps can be taken to increase extension information use by making sure existing websites and publications readily show up in search engines like Google (Alphabet, Mountain View, CA), Bing (Microsoft, Redmond, WA), Yahoo (Altaba, New York, NY), and many other companies, especially those utilizing artificial intelligence to generate answers to queries. This can make Cooperative Extension resources more discoverable and utilized because of their proximity to the top of search results. These previous solutions are further confirmed by survey results using Likert-scale questions on a 1 to 5 scale (1=very unimportant, 5=very important) to ask homeowners how important each of the following “when considering using Cooperative Extension resources about your lawn and landscape?” (Table 1.23). Homeowners considered extension resources that were easy “to find/search” and information that was “updated in the past 5 years” as equally important items to consider and above “somewhat important” ranking with means of 4.11 and 4.08, respectively. After that, they considered the “ability to chat” with extension educators near “somewhat important” (3.6) and being “active on social media” was closer to “neither important nor unimportant” (3.3). These final two items to consider by homeowners were significant at the 0.001 level compared to “easiness to find/search” and “updated in the past five years” when pairwise *T*-test statistics, suggesting that these considerations of extension resources were significantly different from one another.

Homeowners were then asked what educational resource tools they would be most likely to use for new Cooperative Extension materials using 5-point Likert-scale questions (1 = very unlikely, 5 = very likely, Table 1.24). Video platforms were the most popular, with a mean of 4.02 and significantly different from all other tools based on pairwise *T*-tests. This shows the importance of not only informing homeowners of proper practices in the lawn and landscape but also visually showing them how to carry out the actions in the lawn and landscape or visually demonstrating how to inspect plants for potential issues. There was a four-way tie for the second

most popular educational tool, which included social media (3.93) and phone-based applications, blogs, and online publications all at 3.91. These four tools were similar to one another but significantly different than all other education tools. Social media is another avenue for Cooperative Extension professionals to share existing resources and help increase awareness in a timely manner. Online publications and blog posts are two of the more common delivery methods among extension programs today. A phone-based application would be a tool that homeowners could use to find publications, identify plants, or more. Workshops (3.77), phone calls and online chats (3.76), email newsletters (3.76), and mailed newsletters (3.72) all received some interest as well from homeowners but were similar to one another when pairwise *T-tests* were conducted. Overall, these results show a greater need for Cooperative Extension involvement in communities through multiple education resource tools and the ease of access of Cooperative Extension agents to the public. All responses in this survey question were near “somewhat likely” (a 4 on a 1 to 5 Likert-scale), further research could help identify differences in preferences among age groups, socio-economic backgrounds, and geographic regions.

## **Conclusion and Recommendations**

Most homeowners did indicate that they are following best maintenance practices for their lawn and landscape, such as mowing regularly, not having too many fertilizer applications in one growing season, and adjusting their irrigation system schedules to adjust for seasonal weather changes. However, homeowner respondent percentages indicate there is still room for homeowners to improve lawn and landscape practices and incorporate best management practices. New Cooperative Extension resources could be created and older ones likely need to be updated to help guide homeowners on how they can best follow these best management practices while also promoting methods to save time working in the lawn and landscape, reduce fertilizer and pesticide inputs, and conserve water through smarter irrigation.

Cooperative Extension from land-grant universities is a well-known resource among homeowners residing in the Great Plains and surrounding states; however, only about 53% of homeowners know that Cooperative Extension provides resources to assist with lawn and landscape management. Among those homeowners who are aware, many (~47%) believed that the resources required too much time to find answers and that it was difficult to find the information they needed, or the information seemed outdated. Working to increase overall

awareness by creating new publications in traditional online formats on Cooperative Extension websites that are easier to navigate and by creating new long-form formats, such as video platforms like YouTube (Alphabet, Mountain View, CA) or short-form video platforms and social media sites such as Instagram and Facebook Reels (Meta Platforms, Menlo Park, CA) may help reach a wider audience and improve online search engine results.

## References

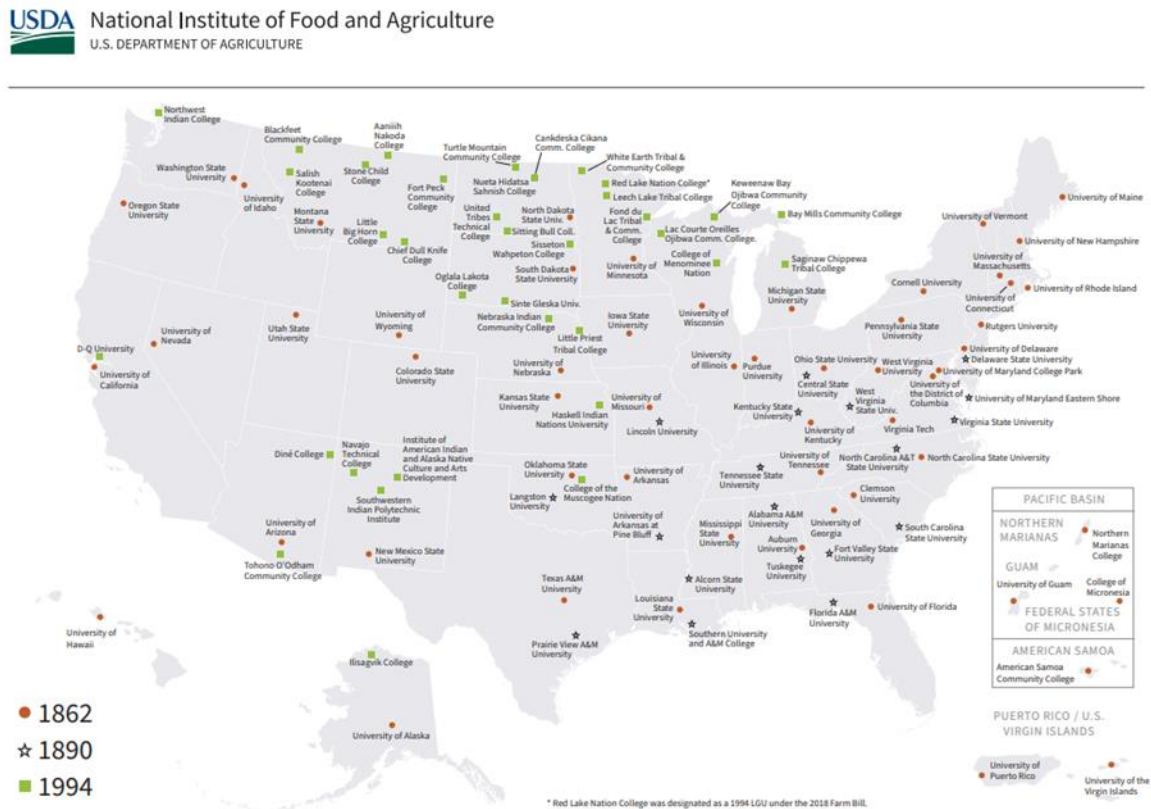
- Alabama Cooperative Extension System. (n.d.-b). *About Us*. Retrieved July 1, 2024  
<https://www.aces.edu/blog/category/about-us/>
- Barnes, M. R., & Watkins, E. (2022). Differences in likelihood of use between artificial and natural turfgrass lawns. *Journal of Outdoor Recreation and Tourism*, 37, 1–9  
<https://doi.org/10.1016/j.jort.2021.100480>
- Beck, L., & Patton, A. J. (2015). Weed Garden: An effective tool for extension education. *The Journal of Extension*, 53, Article 15. <https://doi.org/10.34068/joe.53.04.15>
- Bigelow, C.A., Waddill, D. W. & Chalmers, D. R. (2005). Turf-type tall fescue lawn turf response to added clippings. *International Turfgrass Society Research Journal*, 10, 916–922.
- Blaine, T. W., Clayton, S., Robbins, P., & Grewal, P. S. (2012). Homeowner attitudes and practices towards residential landscape management in Ohio, USA. *Environmental Management*, 50, 257–271. <https://doi.org/10.1007/s00267-012-9874-x>
- Braun, R. C., Patton, A. J., Watkins, E., Koch, P., Anderson, N. P., Bonos, S. A., & Brilman, L. A. (2020). Fine fescues: A review of the species, their improvement, production, establishment, and management. *Crop Science*, 60, 1142–1187.  
<https://doi.org/10.1002/csc2.20122>
- Braun, R. C., Straw, C. M., Soldat, D. J., Bekken, M. A. H., Patton, A. J., Lonsdorf, E. V., & Horgan, B. P. (2023a). Strategies for reducing inputs and emissions in turfgrass systems. *Crop, Forage and Turfgrass Management*. 9, e20218. <https://doi.org/10.1002/cft2.20218>
- Braun, R. C., Watkins, E., Hollman, A. B., & Patton, A. J. (2023b). Assessing the fertilizer and pesticide input needs of cool-season turfgrass species. *Crop Science*, 63, 3079-3095.  
<https://doi.org/10.1002/csc2.21046>
- Bremer, D. J., Keeley, S. J., Jager, A., Fry, J. D., & Lavis, C. (2012). In-ground irrigation systems affect lawn-watering behaviors of residential homeowners, *HortTechnology*, 22, 651–658. <https://doi.org/10.21273/HORTTECH.22.5.651>

- Carpenter, P. J., & Meyer, M. H. (1999). Edina goes green part III: a survey of consumer lawn care knowledge and practices. *HortTechnology*, 9, 491–494.
- Christians, N. E., Patton, A. J., & Law, Q. D. (2017). *Fundamentals of Turfgrass Management* 5<sup>th</sup> edition. John Wiley & Sons
- City of Manhattan, KS (2024). Code of Ordinances, Chapter 21- Nuisances.  
[https://library.municode.com/ks/manhattan/codes/code\\_of\\_ordinances?nodeId=COOR\\_C\\_H21NU\\_ARTIIIWE](https://library.municode.com/ks/manhattan/codes/code_of_ordinances?nodeId=COOR_C_H21NU_ARTIIIWE) Accessed 11 July 2024
- City of Hays, KS (2024). Smart Irrigation Controller Rebate.  
<https://www.haysusa.com/838/Smart-Irrigation-Controller-Rebate> Accessed 11 July 2024
- Hoyle, J. (2017). Mowing your lawn. *K-State Research and Extension*,  
[https://bookstore.ksre.ksu.edu/download/mowing-your-lawn\\_MF1155](https://bookstore.ksre.ksu.edu/download/mowing-your-lawn_MF1155)
- Israel, G. D., & Hague, G. W. (2002). A recruiting challenge for extension education: a comparison of nonparticipants and participants in homeowner landscaping programs. *Journal of Agricultural Education*, 43, 76–87. <https://doi.org/10.5032/jae.2002.04076>
- Association, K-S. A. (n.d.). *K-State History*. Retrieved July 1, 2024 <https://www.k-state.com/about/history.php>
- Kopp, K. L., & Guillard, K. (2002). Clipping management and nitrogen fertilization of turfgrass: growth, nitrogen utilization, and quality. *Crop Science*, 42,1225–1231.  
<https://doi.org/10.2135/cropsci2002.1225>
- Law, Q. D., Trappe, J. M., Jiang, Y., Turco, R. F., & Patton, A. J. (2017). Turfgrass selection and grass clippings management influence soil carbon and nitrogen dynamics. *Agronomy Journal*, 109, 1719–1725. <https://doi.org/10.2134/agronj2016.05.0307>
- Mangiafico, S. S., Obropta, C. C., & Rossi-Griffin, E. (2012). Demographic factors influence environmental values: A lawn-Care survey of homeowners in New Jersey. *Journal of Extension*, 50, 1–7. <https://doi.org/10.34068/joe.50.01.23>
- Martini, N. F., & Nelson, K. C. (2014). The role of knowledge in residential lawn management. *Urban Ecosystems*, 18, 1031–1047 <https://doi.org/10.1007/s11252-014-0415-7>
- Osmond, D. L., & Hardy, D. H. (2004). Characterization of turf practices in five North Carolina communities, *Journal of Environmental Quality*, 33, 565–575.  
<https://doi.org/10.2134/jeq2004.5650>

- Patton, A. J., Schwartz, B. M., & Kenworthy, K. E. (2017). Zoysiagrass (*Zoysia* spp.) history, utilization, and improvement in the United States: A review. *Crop Science*, 57, S37–S72. <https://doi.org/10.2135/cropsci2017.02.0074>
- Sewell, S., McCallister, D., Gaussoin, R., Wortmann, C. (2010). Lawn management practices and perceptions of residents in 14 sandpit lakes of Nebraska, *Journal of Extension*, 48, 1–8.
- USDA-NIFA (United States Department of Agriculture-National Institute of Food and Agriculture). (2024a). *History of NIFA*. Retrieved February 12, 2024, from <https://www.nifa.usda.gov/about-nifa/who-we-are/history>
- USDA-NIFA (United States Department of Agriculture-National Institute of Food and Agriculture). (2024b). *USDA-NIFA Land-grant colleges and universities*. Retrieved February 12, 2024, from [https://www.nifa.usda.gov/sites/default/files/2023-04/NIFALGUs\\_MapREV\\_AI0522\\_508.pdf](https://www.nifa.usda.gov/sites/default/files/2023-04/NIFALGUs_MapREV_AI0522_508.pdf)
- USDA-NIFA (United States Department of Agriculture-National Institute of Food and Agriculture). (2024c). *USDA-NIFA Land-grant colleges and universities*. Retrieved February 12, 2024, from <https://www.nifa.usda.gov/about-nifa/how-we-work/extension/cooperative-extension-system>
- Varlamoff, S., Florkowski, W. J., Jordan, J. L., Latimer, J., & Braman, K. (2001). Georgia homeowner survey of landscape management practices, *HortTechnology*, 11, 326–331
- Yue, C., Hugie, K., & Watkins, E. (2012). Are consumers willing to pay more for low input turfgrass on residential lawns? Evidence from Choice Experiments. *Journal of Agricultural and Applied Economics*, 44, 4, 549–560. <https://doi.org/10.1017/S107407080002410X>
- Yue, C., Wang, J., Watkins, E., Bonos, S., Nelson, K.C., Murphy, J.A., Meyer, W., & Horgan, B. (2017). Consumer preferences for information sources of turfgrass products and lawn care. *International Turfgrass Research Journal*, 109, 1726–1732. <https://doi.org/10.2134/agronj2016.05.0310>

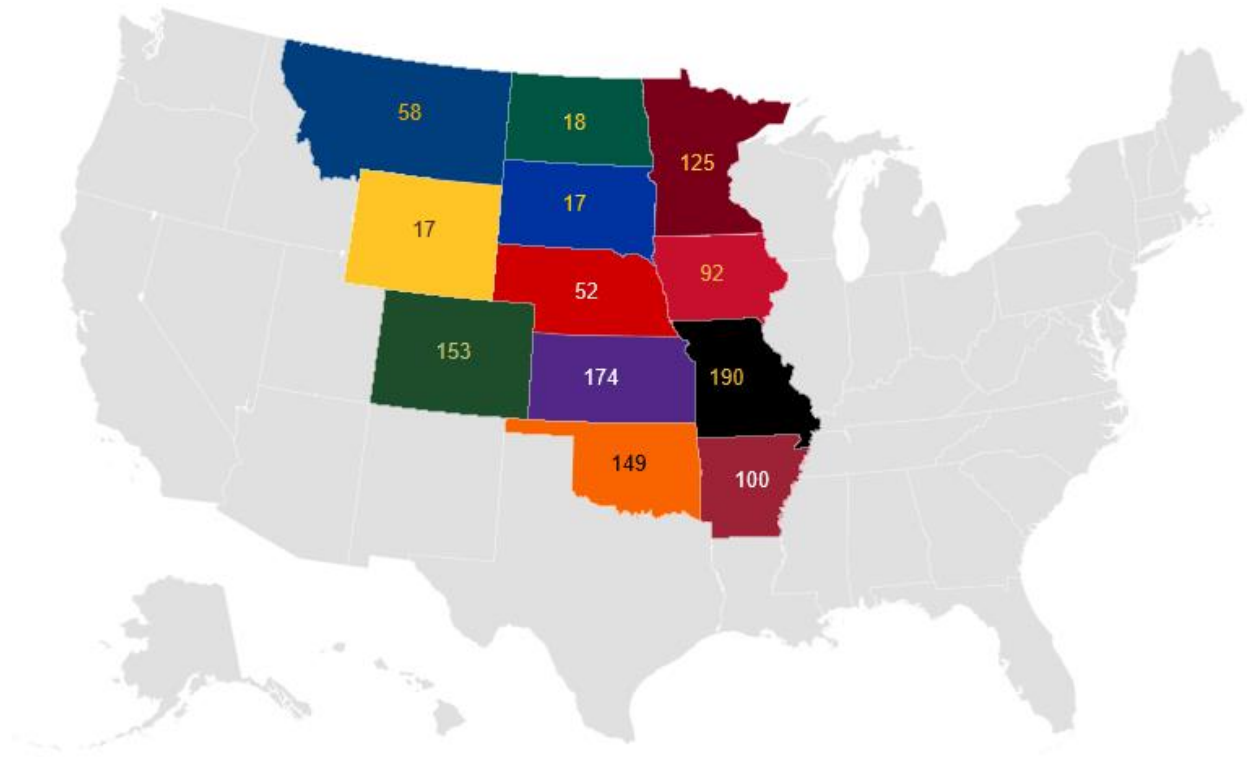
## Figures

Figure 1.1. USDA NIFA Map of all Land-Grant Universities within the United States and its territories.



Retrieved from [https://www.nifa.usda.gov/sites/default/files/2023-04/NIFALGUs\\_MapREV\\_AI0522\\_508.pdf](https://www.nifa.usda.gov/sites/default/files/2023-04/NIFALGUs_MapREV_AI0522_508.pdf)

Figure 1.2. The number of responses from each of the 12 states surveyed.



## Tables

Table 1.1. The questions and response options presented to homeowners.

| Introduction Questions                                                                                                                                                        | Response Options                                                                                                                                                       |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Are you a homeowner with a lawn and landscape?                                                                                                                                | Yes or No                                                                                                                                                              |
| What state do you live in?                                                                                                                                                    | All 50 states were listed (multiple-choice drop down)                                                                                                                  |
| Lawn and Landscape Maintenance Questions                                                                                                                                      |                                                                                                                                                                        |
| Do you mow your own lawn?                                                                                                                                                     | Yes or No                                                                                                                                                              |
| Do you maintain the landscape beds on your property?                                                                                                                          | Yes or No                                                                                                                                                              |
| During the growing season, about how many hours per week do you spend working in your lawn and landscape? Please round up to the nearest whole number.                        | 21 options (1 hr. to 20+ hr.)                                                                                                                                          |
| What is the main type of grass in your lawn?                                                                                                                                  | The seven most common lawn species were listed; "I don't know"; mixture options; and other                                                                             |
| Do you apply fertilizer or any pest control products to your own lawn or landscape?                                                                                           | Yes; No, I hire someone to; No, there is no fertilizer applied                                                                                                         |
| Do you have an in-ground irrigation system?                                                                                                                                   | Yes or No                                                                                                                                                              |
| How often do you mow your lawn?                                                                                                                                               | I follow the 1/3rd rule; Weekly; Bi-weekly (every two weeks); Monthly; More than monthly; I do not mow on a set schedule                                               |
| -OR-<br>How often does the company you hired mow your lawn?                                                                                                                   | -OR-<br>Weekly; Every 10 days; Biweekly (every two weeks); Infrequently; I don't know                                                                                  |
| Do you bag your clippings?                                                                                                                                                    | Yes/No                                                                                                                                                                 |
| -OR-<br>Does your lawn care company bag the clippings?                                                                                                                        | -OR-<br>No, I think so; Sometimes; Yes                                                                                                                                 |
| What do you do with the lawn clippings?                                                                                                                                       | Compost them; Place them in yardwaste bin or bag; Other (please specify)                                                                                               |
| Are paved surfaces around your lawn swept or blown off after mowing? This includes sidewalks, streets, driveways and patios                                                   | Yes/No                                                                                                                                                                 |
| Approximately what size is your lawn?                                                                                                                                         | Less than 2,000 square feet; 2,001-5,000 square feet; 5,001-7,500 square feet; 7,501-15,000 square feet; 1/3 of an acre to 1 acre; 1-2 acres; Over 2 acres; Don't know |
| Do have your soil tested to better understand its nutrient needs?                                                                                                             | Yes, by a land grant University; Yes, by a private lab;                                                                                                                |
| About how many times last year did you apply fertilizer to your own lawn?                                                                                                     | 0 to 9 scale; and I don't know option                                                                                                                                  |
| -OR-<br>About how many times was fertilizer applied to your lawn by the person you hired?                                                                                     |                                                                                                                                                                        |
| About how many times did you apply fertilizer to your landscape (trees, shrubs, landscape beds, etc.)?                                                                        | 0 to 9 scale; and I don't know option                                                                                                                                  |
| -OR-<br>About how many times was fertilizer applied to your landscape (trees, shrubs, landscape beds, etc.) by the person you hired?                                          |                                                                                                                                                                        |
| About how many times last year did you apply insect control to your lawn and landscape?                                                                                       | 0 to 9 scale; and I don't know option                                                                                                                                  |
| -OR-<br>About how many times last year was insect control applied to your landscape (trees, shrubs, landscape beds, etc.) by the person you hired?                            |                                                                                                                                                                        |
| Approximately how old is your irrigation system?                                                                                                                              | Less than 3 years old; 3-7 years old; 7-10 years old; More than 10 years old; I don't know                                                                             |
| How often do you adjust the watering schedule for your irrigation system?                                                                                                     | Daily; Weekly; Monthly; Seasonally; Twice a Year; Once a Year; Other; Never                                                                                            |
| Does your irrigation controller (clock) have any smart features? This could be a rain sensor, Wi-Fi connectivity, soil moisture sensors, or any other remote control options. | *This was the question with the error. It was supposed to be a "select all that apply" and somehow reverted to a Likert-scale question                                 |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| About how many times in the last ten years has your irrigation system been audited? This is when a professional comes to your property and measures the uniformity and precipitation rate of your system.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Never; Once; Twice; Three times; Four or more times                                                                                                                                                                                                                                                                                                                                                                                   |
| About how often is your irrigation system adjusted to ensure that it is not watering non-lawn or landscape areas?                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Multiple times a year; Annually; Every couple years; More than every 5 years; Never                                                                                                                                                                                                                                                                                                                                                   |
| <b>Extension Use Questions</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <b>Response Options</b>                                                                                                                                                                                                                                                                                                                                                                                                               |
| Which of the following would you describe as your top source of information for lawn and landscape management?                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Family; Friend; Garden/hardware store; Lawn care company; Neighbor; Other; Radio or Television; University Extension; Website/Online influencer                                                                                                                                                                                                                                                                                       |
| Are you aware of free education information available from [respondent's home state cooperative extension program]?                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Yes; Yes, but I was not aware they had resources for the lawn and landscape; No                                                                                                                                                                                                                                                                                                                                                       |
| About how many times did you use information from [respondent's home state cooperative extension program] in the past year?                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Once; Twice; Three times; Four times; More than four times; I did not use [respondent's home state cooperative extension program] sources last year                                                                                                                                                                                                                                                                                   |
| What [respondent's home state cooperative extension program] information delivery methods have you used the most?                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Social media; Website blog; Online Extension publications; Monthly-to-seasonal email newsletter; Monthly-to-seasonal mailed newsletter; Workshops; field days; other in-person events; Interactive sessions online; over the phone; video or chat; Phone or online app/tool                                                                                                                                                           |
| What would you describe as your top challenge when trying to obtain information from [respondent's home state cooperative extension program] sources?<br>-OR-<br>What would you describe as the main reason you do not use [respondent's home state cooperative extension program] sources?                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Information and answers are not easily available; Information seems outdated; Information is not useful; Information seems not trustworthy; Requires more time to find information<br>-OR-<br>Unaware of University extension resources available; Information and answers are not easily available; Information seems outdated; Information is not useful; Information seems not trustworthy; Requires more time to find information |
| On a scale from very unimportant to very important, how important are the following considerations in obtaining [respondent's home state cooperative extension program] services and resources<br>-Easiness to find/search the University extension website for answers<br>-Information has been updated in the past 5 years<br>- University extension educators are active on social media<br>- Ability to engage in conversation or chats with University extension educators                                                                                                                                                                                                                                                                         | 1 to 5 Likert-scale (1= Very unimportant; 2= Somewhat unimportant; 3=Neither unimportant or important; 4=Somewhat important; and 5=Very important)                                                                                                                                                                                                                                                                                    |
| On a scale from very unlikely to very likely, how likely would you be to obtain free [respondent's home state cooperative extension program] resources from the following platforms?<br>-Social Media (Instagram, Facebook, Twitter, etc.)<br>-Online video platforms (YouTube, Instagram Reels, etc.)<br>-Website blog<br>-Online extension publications<br>-Monthly-to-seasonal email newsletter<br>-Please Select "Somewhat Unlikely" Here*<br>-Monthly-to-seasonal mailed newsletter<br>-Workshops, field days, other in-person events<br>-Interactive sessions over the phone, virtual chat, or video<br>-Phone or online app/tool<br>*This was an attention-check question that if not properly selected would kick respondents out of the survey | 1 to 5 Likert-scale (1= Very unlikely; 2= Somewhat unlikely; 3= Neither unlikely or likely; 4= Somewhat likely; and 5= Very likely)                                                                                                                                                                                                                                                                                                   |
| What is your zip code?                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Open entry limited to 5 characters                                                                                                                                                                                                                                                                                                                                                                                                    |
| How would you describe the area where your home is located?                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Urban; Suburban; Small town; Rural                                                                                                                                                                                                                                                                                                                                                                                                    |
| What is the water source for your home?                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Municipal (city) water; Private well; Community well; Other                                                                                                                                                                                                                                                                                                                                                                           |
| Did you attend a land-grant University on the map below?                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | No; Yes, please list [open response]                                                                                                                                                                                                                                                                                                                                                                                                  |

Table 1.2. The number of homeowners surveyed from each state.

| <b>State</b>           | <b><i>n</i> (%)</b> |
|------------------------|---------------------|
| Missouri               | 190 (16.6)          |
| Kansas                 | 174 (15.2)          |
| Colorado               | 153 (13.4)          |
| Oklahoma               | 149 (13.0)          |
| Minnesota              | 125 (10.9)          |
| Arkansas               | 100 (8.7)           |
| Iowa                   | 92 (8.0)            |
| Montana                | 58 (5.1)            |
| Nebraska               | 52 (4.5)            |
| North Dakota           | 18 (1.6)            |
| South Dakota           | 17 (1.5)            |
| Wyoming                | 17 (1.5)            |
| <b>Total Responses</b> | <b>1,145</b>        |

Table 1.3. The reported lawn size by homeowners surveyed in 12 Great Plains and surrounding states.

| <b>Lawn size</b>            | <b><i>n</i> (%)</b> |
|-----------------------------|---------------------|
| Less than 2,000 square feet | 201 (17.6)          |
| 2,001 to 5,000 square feet  | 328 (28.6)          |
| 5,001 to 7,500 square feet  | 205 (17.9)          |
| 7,501 to 15,000 square feet | 164 (14.3)          |
| 1/3 <sup>rd</sup> to 1 acre | 107 (9.3)           |
| 1 to 2 acres                | 70 (6.1)            |
| Over 2 acres                | 44 (3.8)            |
| Don't know                  | 26 (2.3)            |

Table 1.4. The reported maintenance hiring practices of homeowners in 12 Great Plains and surrounding states.

| <b>Item</b>                                          | <b><i>n</i> (%)<br/>Yes</b> | <b><i>n</i> (%)<br/>No</b> | <b><i>n</i> (%)<br/>No, I hire<br/>someone to</b> |
|------------------------------------------------------|-----------------------------|----------------------------|---------------------------------------------------|
| Do you mow your lawn?                                | 1,101 (96.2)                | 44 (3.8)                   | --                                                |
| Do you maintain the landscape beds on your property? | 1,099 (96.0)                | 46 (4.0)                   | --                                                |
| Do you have an in-ground irrigation system           | 689 (60.2)                  | 456 (39.8)                 | --                                                |
| Do you apply pesticides to your property?            | 739 (64.5)                  | 257 (22.4)                 | 149 (13.0)                                        |

Table 1.5. The number of hours that homeowners report spending on their lawn and landscape.

| <b>Hours</b> | <b><i>n</i> (%)</b> |
|--------------|---------------------|
| 1            | 48 (4.3)            |
| 2            | 169 (15)            |
| 3            | 180 (16)            |
| 4            | 159<br>(14.1)       |
| 5            | 145<br>(12.9)       |
| 6            | 85 (7.5)            |
| 7            | 52 (4.6)            |
| 8            | 62 (5.5)            |
| 9            | 26 (2.3)            |
| 10           | 85 (7.5)            |
| 11           | 5 (0.4)             |
| 12           | 26 (2.3)            |
| 13           | 5 (0.4)             |
| 14           | 14 (1.2)            |
| 15           | 22 (2)              |
| 16           | 7 (0.6)             |
| 17           | 4 (0.4)             |
| 18           | 3 (0.3)             |
| 19           | 2 (0.2)             |
| 20+          | 28 (2.5)            |

Table 1.6. How often homeowners report mowing their lawns.

| <b>Mowing Frequency</b>             | <b><i>n</i> (%)</b> |
|-------------------------------------|---------------------|
| Weekly                              | 521 (47.3)          |
| Bi-weekly                           | 236 (21.4)          |
| Monthly                             | 157 (14.3)          |
| I do not mow on a set schedule      | 93 (8.4)            |
| I follow the 1/3 <sup>rd</sup> Rule | 79 (7.2)            |
| More than monthly                   | 15 (1.4)            |

Table 1.7. The mowing frequency of contractors hired by homeowners.

| <b>Mowing Frequency</b> | <b><i>n</i> (%)</b> |
|-------------------------|---------------------|
| Weekly                  | 17 (38.6)           |
| Bi-weekly               | 13 (29.5)           |
| Every 10 days           | 6 (13.6)            |
| Infrequently            | 4 (9.1)             |
| I don't know            | 4 (9.1)             |

Table 1.8. Turfgrass clipping management by homeowners and contractors hired to maintain home lawns.

| <b>Item</b>                                     | <b><i>n</i> (%)<br/>Yes</b> | <b><i>n</i> (%)<br/>No</b> | <b><i>n</i> (%)<br/>Sometimes</b> | <b><i>n</i> (%)<br/>I think so</b> |
|-------------------------------------------------|-----------------------------|----------------------------|-----------------------------------|------------------------------------|
| Do you bag your clippings?                      | 705 (64)                    | 396 (36)                   | --                                | --                                 |
| Does your lawn care company bag lawn clippings? | 7 (15.9)                    | 19 (43.2)                  | 6 (13.6)                          | 12 (27.3)                          |

Table 1.9. How homeowners are disposing of collected grass clippings.

| <b>Item</b>                           | <b><i>n</i> (%)</b> |
|---------------------------------------|---------------------|
| Compost them                          | 435 (61.7)          |
| Place them in a yard waste bin or bag | 254 (36)            |
| Other                                 | 16 (2.3)            |

**Table 1.10. Turfgrass and vegetative debris management after mowing.**

| <b>Item</b>                                  | <b><i>n</i> (%) Yes</b> | <b><i>n</i> (%) No</b> |
|----------------------------------------------|-------------------------|------------------------|
| Are paved surfaces blown off after mowing? * | 742 (64.8)              | 403 (35.2)             |

\*Further details not asked where homeowners or their contractors blow clippings into the lawn or other areas.

Table 1.11. The reported species within home lawns.

| <b>Turfgrass species</b>       | <b><i>n</i> (%)</b> |
|--------------------------------|---------------------|
| Fine fescue                    | 75 (6.6)            |
| Kentucky bluegrass             | 185 (16.2)          |
| Perennial ryegrass             | 19 (1.7)            |
| Tall fescue                    | 79 (6.9)            |
| Mixture of cool-season species | 145 (12.7)          |
| Bermudagrass                   | 104 (9.1)           |
| Buffalograss                   | 80 (7)              |
| Zoysiagrass                    | 52 (4.5)            |
| Mixture of warm-season species | 110 (9.6)           |
| Other                          | 19 (1.7)            |
| I don't know                   | 277 (24.2)          |

Table 1.12. The reported species in Montana (MT) and North Dakota (ND) home lawns.

| <b>Turfgrass Species</b>       | <b>MT</b> | <b>ND</b> |
|--------------------------------|-----------|-----------|
| Fine fescue                    | 6         | 5         |
| Kentucky bluegrass             | 4         | 4         |
| Perennial ryegrass             | 0         | 0         |
| Tall fescue                    | 5         | 0         |
| Mixture of cool-season species | 7         | 2         |
| Bermudagrass                   | 7         | 2         |
| Buffalograss                   | 6         | 1         |
| Zoysiagrass                    | 0         | 2         |
| Mixture of warm-season species | 7         | 1         |
| Other                          | 2         | 1         |
| I don't know                   | 12        | 0         |

Table 1.13. The reported number of times that fertilizer and other pesticides are applied to the lawn and landscape by homeowners or their hired contractors.

| <b>Number of Applications</b> | Homeowner Applied                    |                                   |                                | Contractor Applied                   |                                      |                                   |
|-------------------------------|--------------------------------------|-----------------------------------|--------------------------------|--------------------------------------|--------------------------------------|-----------------------------------|
|                               | <i>n (%)</i><br>Turfgrass Fertilizer | <i>n (%)</i> Landscape Fertilizer | <i>n (%)</i> Pesticide Control | <i>n (%)</i><br>Turfgrass Fertilizer | <i>n (%)</i><br>Landscape Fertilizer | <i>n (%)</i><br>Pesticide Control |
| <b>0</b>                      | 44 (6)                               | 66 (8.9)                          | 59 (8)                         | 11 (7.4)                             | 48 (32.2)                            | 22 (14.8)                         |
| <b>1</b>                      | 133 (18)                             | 139 (18.8)                        | 135 (18.3)                     | 14 (9.4)                             | 17 (11.4)                            | 26 (17.4)                         |
| <b>2</b>                      | 218 (29.5)                           | 176 (23.8)                        | 165 (22.3)                     | 53 (35.6)                            | 29 (19.5)                            | 30 (20.1)                         |
| <b>3</b>                      | 173 (23.4)                           | 154 (20.8)                        | 169 (22.9)                     | 25 (16.8)                            | 22 (14.8)                            | 24 (16.1)                         |
| <b>4</b>                      | 116 (15.7)                           | 118 (16)                          | 112 (15.2)                     | 19 (12.8)                            | 16 (10.7)                            | 25 (16.8)                         |
| <b>5</b>                      | 40 (5.4)                             | 59 (8)                            | 56 (7.6)                       | 11 (7.4)                             | 3 (2)                                | 2 (1.3)                           |
| <b>6</b>                      | 10 (1.4)                             | 18 (2.4)                          | 30 (4.1)                       | 6 (4)                                | 3 (2)                                | 6 (4)                             |
| <b>7</b>                      | 3 (0.4)                              | 6 (0.8)                           | 10 (1.4)                       | 2 (1.3)                              | 0 (0)                                | 2 (1.3)                           |
| <b>I don't know</b>           | 2 (0.3)                              | 3 (0.4)                           | 3 (0.4)                        | 8 (5.4)                              | 11 (7.4)                             | 12 (8.1)                          |

Table 1.14. The reported age of homeowner in-ground irrigation systems.

| <b>Age of irrigation system</b> | <b><i>n</i> (%)</b> |
|---------------------------------|---------------------|
| <3 years old                    | 131 (19)            |
| 3-7 years old                   | 268 (38.9)          |
| 7-10 years old                  | 155 (22.5)          |
| >10 years old                   | 114 (16.5)          |
| I don't know                    | 21 (3)              |

Table 1.15. The frequency of homeowners adjusting their irrigation scheduling (i.e., zone run time or start time).

| <b>Watering schedule adjustments</b> | <b><i>n</i> (%)</b> |
|--------------------------------------|---------------------|
| Daily                                | 84 (12.2)           |
| Weekly                               | 197 (28.6)          |
| Monthly                              | 177 (25.7)          |
| Seasonally                           | 147 (21.3)          |
| Twice a year                         | 42 (6.1)            |
| Annually                             | 18 (2.6)            |
| Other                                | 8 (1.2)             |
| Never                                | 16 (2.3)            |

Table 1.16. The reported number of times that homeowner in-ground irrigation systems have been audited by a professional to evaluate system efficiency.

| <b>Irrigation system audits</b> | <b><i>n</i> (%)</b> |
|---------------------------------|---------------------|
| 0                               | 133 (19.3)          |
| 1                               | 148 (21.5)          |
| 2                               | 285 (41.4)          |
| 3                               | 104 (15.1)          |
| 4+                              | 19 (2.8)            |

Table 1.17. The reported frequency of homeowner in-ground irrigation systems being adjusted to ensure that they are only watering turfgrass and other desired areas.

| <b>Irrigation system<br/>adjustments</b> | <b><i>n</i> (%)</b> |
|------------------------------------------|---------------------|
| Multiple times a year                    | 129 (18.7)          |
| Annually                                 | 301 (43.7)          |
| Every couple years                       | 188 (27.3)          |
| More than every 5 years                  | 36 (5.2)            |
| Never                                    | 35 (5.1)            |

Table 1.18. The primary information sources for homeowners pertaining to lawn and landscape-related questions.

| <b>Information sources</b> | <b><i>n</i> (%)</b> |
|----------------------------|---------------------|
| Family                     | 434 (37.9)          |
| Friend                     | 130 (11.4)          |
| Garden/hardware store      | 78 (6.8)            |
| Lawn care company          | 127 (11.1)          |
| Neighbor                   | 53 (4.6)            |
| Other                      | 25 (2.2)            |
| Radio or television        | 10 (0.9)            |
| University extension       | 70 (6.1)            |
| Website/ online influencer | 218 (19)            |

Table 1.19. Homeowners of the Great Plains and surrounding states awareness of cooperative extension resources pertaining to the lawn and landscape.

| <b>Extension awareness</b>                                          | <b><i>n</i> (%)</b> |
|---------------------------------------------------------------------|---------------------|
| Yes                                                                 | 603 (52.7)          |
| Yes, but I was not aware of resources<br>for the lawn and landscape | 205 (17.9)          |
| No                                                                  | 337 (29.4)          |

Table 1.20. How many times homeowners aware of cooperative extension resources have used extension education resources in the past year.

| <b>Extension use in the past year</b> | <b><i>n</i> (%)</b> |
|---------------------------------------|---------------------|
| I did not use                         | 129 (16)            |
| 1                                     | 127 (15.7)          |
| 2                                     | 278 (34.4)          |
| 3                                     | 171 (21.2)          |
| 4                                     | 57 (7.1)            |
| 5+                                    | 46 (5.7)            |

Table 1.21. The most used extension education delivery methods by homeowners.

| <b>Most used information delivery methods</b> | <b><i>n</i> (%)</b> |
|-----------------------------------------------|---------------------|
| Interactive sessions                          | 38 (3.5)            |
| Email newsletter                              | 76 (7.1)            |
| Mailed newsletter                             | 48 (4.5)            |
| Online publications                           | 249 (23.1)          |
| Phone app/tool                                | 44 (4.1)            |
| Social media                                  | 323 (30)            |
| Website blog                                  | 241 (22.4)          |
| Workshops & in-person events                  | 57 (5.3)            |

Table 1.22. Homeowner challenges in using and obtaining resources and information from cooperative extension.

| <b>Biggest challenge for not using extension<br/>education resources</b> | <b><i>n</i> (%)</b> |
|--------------------------------------------------------------------------|---------------------|
| Answers not easily available                                             | 134 (12.4)          |
| Information is not useful                                                | 70 (6.5)            |
| Information seems not trustworthy                                        | 31 (2.9)            |
| Information seems outdated                                               | 181 (16.7)          |
| Requires more time                                                       | 194 (17.9)          |
| Unaware of resources available for lawn and<br>landscape information     | 474 (43.7)          |

Table 1.23. The most important considerations for homeowners when using cooperative extension resources.

| <b>Item</b>                                                                    | <b>Mean<sup>a</sup></b> | <b>Standard Deviation</b> | <b>Easiness to find/search</b> | <b>Updated in the past 5 years</b> | <b>Active on social media</b> |
|--------------------------------------------------------------------------------|-------------------------|---------------------------|--------------------------------|------------------------------------|-------------------------------|
| Easiness to find/search the University extension website for answers           | 4.11                    | 0.94                      |                                |                                    |                               |
| Information has been updated in the past 5 years                               | 4.08                    | 1.00                      | 1.00 <sup>b</sup>              |                                    |                               |
| University extension educators are active on social media                      | 3.30                    | 1.24                      | 18.00***                       | 18.00***                           |                               |
| Ability to engage in conversation or chats with University extension educators | 3.60                    | 1.10                      | 13.00***                       | 13.0***                            | -9.00****                     |

<sup>a</sup> 1 to 5 Likert-scale (1= Very unimportant; 2= Somewhat unimportant; 3=Neither unimportant or important; 4=Somewhat important; and 5=Very important).

<sup>b</sup>T values presented with df= 1144 and a 95% confidence interval.

\*, \*\*, \*\*\* significant at 0.05, 0.01, and <0.001 level

Table 1.24. Cooperative Extension resources and tools that homeowners would be most likely to use in the future.

| Item                                             | Mean <sup>a</sup> | Standard Deviation | Social Media         | Video Platforms | Blogs   | Online Publications | Email Newsletter | Mailed Newsletter | Workshops | Phone calls and online chats |
|--------------------------------------------------|-------------------|--------------------|----------------------|-----------------|---------|---------------------|------------------|-------------------|-----------|------------------------------|
| Social Media                                     | 3.93              | 0.93               |                      |                 |         |                     |                  |                   |           |                              |
| Video platforms (YouTube, Instagram Reels, etc.) | 4.02              | 0.92               | -3.00 <sup>b**</sup> |                 |         |                     |                  |                   |           |                              |
| Blogs (extension website)                        | 3.91              | 0.88               | 0.70                 | 3.00***         |         |                     |                  |                   |           |                              |
| Online extension publications                    | 3.91              | 0.89               | 0.60                 | 3.00**          | -0.10   |                     |                  |                   |           |                              |
| Email newsletter (monthly to seasonal)           | 3.76              | 0.96               | 5.00***              | 7.00***         | 4.00*** | 5.00***             |                  |                   |           |                              |
| Mailed newsletter (monthly to seasonal)          | 3.72              | 0.95               | 6.00***              | 8.00***         | 5.00*** | 6.00***             | 1.00             |                   |           |                              |
| Workshops, field days, in-person events          | 3.77              | 1.02               | 4.00***              | 6.00***         | 4.00*** | 4.00***             | -0.40            | -1.00             |           |                              |
| Phone call, online, virtual chats                | 3.76              | 1.09               | 4.00***              | 6.00***         | 4.00*** | 4.00***             | -0.07            | -1.00             | -0.04     |                              |
| Phone-based application (online app tool)        | 3.91              | 0.92               | 0.50                 | 3.00**          | -0.20   | -0.10               | -4.00***         | -6.00***          | -4.00***  | -4.00***                     |

<sup>a</sup> 1 to 5 Likert-scale (1= Very unlikely; 2= Somewhat unlikely; 3= Neither unlikely or likely; 4= Somewhat likely; and 5= Very likely).

<sup>b</sup> *T* values presented with df= 1144 and a 95% confidence interval.

\*, \*\*, \*\*\* significant at 0.05, 0.01, and <0.001 level.

# **Chapter 2 - Current Green Industry Management Practices, Perspectives, and Considerations of Lawn and Landscape Education Extension Resources from Land-grant Universities**

## **Abstract**

Little research has been conducted on Cooperative Extension resource use and consideration among horticultural professionals. A multi-state survey was created in Qualtrics and shared through 12 university extension programs, at in-person extension events (i.e., field days, conferences, and workshops) to attain a better understanding of how horticultural industry practitioners (e.g., golf course superintendents, sports field managers, lawn and landscape contractors, nursery and greenhouse growers, tree care, and retailers) are using Cooperative Extension resources, what are their challenges with extension resources, and future considerations. While the primary objective of this survey was to collect information on Cooperative Extension use, additional information was collected on business details and current lawn and landscape practices. Most respondents (~74%) were aware of Cooperative Extension resources and indicated that it was either their primary (~23%) or secondary (~16%) source of plant health-related information. Practitioners suggested that resources being easy to find and updated in the past five years were the two most important considerations for future use. Industry professionals prefer the current style of online extension publications and in-person events and would also be more likely to use video resources and emailed newsletters compared to other educational methods. Updating and creating new resources in mediums that practitioners prefer to use can help increase Cooperative Extension use and awareness.

## **Introduction**

### **The Professional Horticulture Industry**

The horticulture industry is a broad, encompassing term covering many different sectors, examples include turfgrass maintenance (e.g., home lawns, sports fields, golf courses), landscaping, nursery crop production, fruit and vegetable production, and many other areas. Employing between two and three million people in the U.S., horticulture is the largest employer within the agricultural sector and provides over \$250 billion in economic activity every year (U.S. Bureau of Labor Statistics, 2024, IBISWorld, 2024, 2022 Census of Agriculture, 2022).

The lawn and landscape industry in the U.S. consists of over one million employees and a market size of \$176.5 billion as of 2023 (U.S. Bureau of Labor Statistics 2024, IBISWorld, 2024). Also known as the “Green Industry”, these businesses range from small, owner-operators that specialize in one or two services to multi-billion dollar publicly traded companies with thousands of employees across the United States. These larger companies may offer more services to the end user (i.e., homeowner, property owner), such as mowing, plant healthcare (i.e., fertilization, pesticide application), irrigation installation and repair, hardscaping and softscaping, landscape design, and snow and ice management. The nursery, greenhouse, floriculture, and sod (referred to as “production” from here on out) industries are considerably smaller than the Green Industry, with ~250,000 people employed in the U.S. and annual revenues over \$21 billion (U.S. Bureau of Labor Statistics, 2024 2022 Census of Agriculture, 2024). Much like their colleagues in the Green Industry, production companies can range from small, “mom and pop” facilities to multi-national enterprises that have facilities around the globe with thousands of employees.

Maintaining over 2.3 million acres of turfgrass, the golf course maintenance industry is smaller than its counterparts in landscaping and nursery production, but many of these properties are well known worldwide. Golf course superintendents are responsible for overseeing all agronomic and business aspects of maintaining the golf course facility, including, but not limited to turfgrass, tree, and other plant maintenance, equipment, and budget management, and ensuring they are following all applicable state and federal regulations for pesticides and irrigation.

## **The History of Land-Grant Universities**

Land-grant universities were founded as a part of the Morrill Act of 1862 to provide higher education to those that otherwise could not afford it (USDA-NIFA, 2024a). These universities were primarily funded through state-level and federal funding and have expanded in definition from the original “1862” universities to now include historically black colleges and universities (HBCUs) in 1890 and tribal colleges and universities in 1994 with traditional two-year and four-year programs while offering graduate programs as well (USDA-NIFA, 2024a). The Hatch Act of 1887 provided federal funding for research stations to promote agricultural research intended to help residents with issues relevant to them (USDA-NIFA, 2024a). The Smith-Lever Act of 1914 was the final piece for the tripartite university mission, Cooperative Extension. Designed to provide unbiased, research-based information to the public through experts living in the community and resources from the university campus and its many research stations, it has formed one of the most public-facing aspects of a land-grant university being in nearly every county or parish in the United States (USDA-NIFA, 2024c).

Research is required to gain a better understanding of what resources in today’s digital age horticulture managers (e.g., golf course superintendents, sports field managers, lawn and landscape contractors, and production owners) are using to attain agronomic information and answer questions. More information on what resources these horticulture professionals (practitioners) are currently using and wish to use in the future will help provide valuable information to land-grant universities and Cooperative Extension programs, which may help to create more useful publications, resources, and digital media that are easy to disseminate, comprehend, and use daily. Therefore, the objectives of this experiment were to understand how horticulture professionals use current Cooperative Extension resources, discover the preferred delivery methods for extension education materials, and become aware of current management practices, which should assist Cooperative Extension programs across the U.S. where to direct more effort to reach these practitioners.

## **Materials and Methods**

A survey that included up to 31 questions was created in Qualtrics (Qualtrics, Provo, UT) that consisted of: select all that apply, select the best that applies, and Likert-scale (1 to 5 scale)

questions (Table 2.1). The survey had custom flows set to tailor each survey to the respondent's industry and state that they work in with three to six questions aiming to gain a better understanding of their number of staff, services offered, and where they gain new information related to plant health care. All 50 states were listed as options and the industry category options included: i) landscaping and lawn care, ii) golf course and sports turf, iii) tree care, iv) nursery production (e.g., nursery, sod, greenhouse), and v) wholesale or retail (to end consumer or installer). The survey was distributed in collaboration with 12 university extension programs, which was presented in brochures, presentations, or flyers at field days, winter conferences, and in-person workshops (Table 2.2). The survey was announced on paper or digital programs as half-page handout that included a QR code link to the survey and a brief survey description. In addition, collaborators at each institution often sent a reminder email within one to two weeks after each event in an attempt to increase survey participation. Respondents were not compensated for their time taking the survey, but they had the option to enter a drawing for one of five \$100 gift cards to a nationwide hardware store of their choice. The survey was intended to take five to seven minutes and could be completed between speaking events or during other intermissions. This study was IRB approved under the criteria set forth in the Federal Policy for the Protection of Human Subjects, 45 CFR §104(d), category: Exempt Category 2 Subsection ii (Proposal Number: IRB-11576).

The survey was shared with all collaborators on 21 Apr. 2023 with a brief description of the survey to be communicated to potential respondents, a QR code to direct respondents to the survey, and direct links. Upon closing the survey on 1 Apr. 2024, all responses were downloaded as a Microsoft Excel (Microsoft, Redmond, WA) spreadsheet and the data was duplicated onto a second page to be modified and imported into R statistical software (R Development Core Team, 2024) for statistical analysis. The second-page data was trimmed to remove any unnecessary columns with data that was not collected (e.g., first and last name, external reference, etc.), and data was further filtered to remove any responses with a reCAPTCHA score of 0.7 or less, and any surveys that were not completed. To further help catch dishonest survey respondents, respondents were asked to select “Somewhat Unlikely” as one of the options in a final extension-related question for an “attention check.” If they did not properly answer that question, they could not complete the survey. Results from each state’s extension programs were condensed into one series of columns, and all Likert-scale responses were converted to numerical responses

using Find and Replace function. Once these steps were completed and the spreadsheet was imported into R statistical software using the “readxl” package for analysis. Within R, a function was created to easily find the mean, median, mode, standard deviation, standard error, the number of each response, and the confidence intervals at 68, 95, and 99 percent rounded to three decimal places. Pairwise *T*-tests were conducted on all Likert-scale questions to explore statistical differences between practitioner challenges in use and which tools they would be more likely to use.

## **Results and Discussion**

### **Responses**

Survey respondents were from 18 states within the U.S.; however, five states [Arkansas (9.3%), Indiana (23%), Kansas (25%), Ohio (11%), and Texas (18%)] comprised 85.5% of the total survey pool (Figure 2.1 and Table 2.3). This may have been because the survey was more frequently mentioned, advertised, or reminded to field day and conference attendees in these states. Regardless, eight of the 18 respondent states had more than 10 participants (Figure 2.1 and Table 2.3).

Out of 561 practitioners surveyed, the lawn care and landscaping industry had the largest participation rate at 53%, golf course and sports turf were next highest at 32%, followed by retail (wholesale or to end consumer) at 9%, and production and tree care industries at 3 and 2%, respectively (Table 2.4). The lower participation rate among production, tree care, and retail may have been due to the specific field day, conferences, or workshops not having relevant programming targeted toward their industries. Survey results also revealed that most practitioners (~67%) have at least an Associate’s degree and an additional 21% reported that they had completed at least some college (Table 2.5). Martini and Nelson (2015) reported that there is a connection between an individual’s education level and their understanding of not only the plants they are responsible for maintaining but the ecosystem surrounding it. The majority of participants in this survey were educated as indicated by having received a higher education degree (Associate’s, Bachelor’s, Graduate’s level, or professional degree).

To understand the business sizes of survey participants, the number of employees was inquired. Most participants surveyed reported that they have  $\leq 25$  employees (69%, Table 2.6).

We did not collect information on revenue or budget ranges for the businesses surveyed or how they believe these numbers will change in the next five years. This could be studied in the future to better understand how these small businesses are serving their communities and how Cooperative Extension resources could help them beyond being a plant healthcare resource.

## **Lawn and Landscape Contractors**

Lawn and landscape contractors indicated they offered the following service options: fertilizer and pesticides (92%), pest control products (90%), and both irrigation service and installation (43%, Table 2.7). With most lawn and landscape contractors offering specialty services, there is a potential for Cooperative Extension programs to partner with state licensing agencies (e.g., state-level Departments of Agriculture, Department of Revenue/Commerce, etc.) or state-based trade organizations (e.g., Kansas Nursery and Landscape Association, Indiana Irrigation Contractors Council, Indiana Nursery and Landscape Association, Illinois Landscape Contractors Association, Ohio Irrigation Association, etc.) to increase training to these contractors and potentially create endorsement or additional certification programs that allow contractors to show that they have undergone additional training. These programs could encourage more efficient use of pesticides, fertilizers, and irrigation water. Additionally, these training programs by Cooperative Extension programs in partnership with state-based trade organizations would help provide prompt information about new regulations, increase the level of professionalism within the industry, and may help some businesses offer new services.

When questioned about what computer software is used for customer relation management, survey results revealed that no customer relation manager platform was consistently used among lawn and landscape contractors (Table 2.8). Furthermore, 56% of contractors indicated that they do not use a customer relation program. This can be concerning because these programs can benefit contractors by allowing them to potentially manage many aspects of their business (e.g., project scheduling, billing, client information) in one location and can be available on many different devices.

## **Trade Organization Membership**

Participants in each industry sector were asked an optional question to learn of memberships to trade organizations, with multiple options (select all that apply) provided (Table 2.1). Membership with respective national/international level trade organizations within each

respective industry sector was lawn and landscape (47.5%), golf course and sports turf (62.9%), and tree care (66.7%, Table 2.9). Across the three sectors of lawn and landscape, golf course and sports turf, and tree, most participants reported between 33 and 52% membership in their state or local level trade organization. Many state-level programs have Cooperative Extension support or involvement in workshops and educational materials. Unfortunately, due to low response rates from nursery production practitioners, no trade organization membership was able to be collected.

## **Extension Resources**

“Local trade show or conference” and “University extension” were the two highest primary information sources when seeking help for lawn and landscape information for practitioners at 21 and 23% respectively (Table 2.10), which reveals that practitioners do find value in local trade shows or conferences and Cooperative Extension resources. Cooperative Extension programs organize many local trade shows and conferences; thus, it could be viewed that 44% of surveyed practitioners use extension resources as their primary information source. If not selected as “primary” information sources, “Local trade show or conference” and “University extension” were also higher “secondary” information sources at 18 and 16%, respectively. Suppliers (seed, fertilizer, pesticides, and other products) could have a large influence on practitioners because they specified suppliers were “primary” and “secondary” information sources at 14 and 18%, respectively. Results also reveal 13 and 14% of practitioners indicated colleagues were primary and secondary information sources, respectively. Other resources, such as brand sales representatives, national or international trade shows or conferences, peer groups, or consultants are not utilized as often for agronomic assistance as these options were selected <8% for both primary and secondary information sources. Online influencers were selected 8 to 13% of the time for both primary and secondary information sources, which highlights additional information delivery methods. One problem with these alternative information sources, such as online influencers, colleagues, suppliers, or other less utilized options (e.g., consultants, peer group, brand sales rep) is incorrect or biased information could be provided to practitioners compared to non-biased research-based information from Cooperative Extension resources (e.g., University extension, extension supported field days, workshops, or conferences).

Turfgrass and landscape practitioners revealed they were aware of Cooperative Extension resources (74.2% indicating yes and 9.1% indicating yes but not aware of lawn and landscape information, Table 2.11). Only ~17% of practitioners were unaware of Cooperative Extension resources available, which is nearly half of the ~30% of homeowner participants who indicated they were unaware of Cooperative Extension resources (Stanton, 2024). As expected, professionals are likely more aware of Cooperative Extension resources than homeowners because they i) may be an alumnus of a land-grant university, ii) may attend Cooperative Extension program events (e.g., field days, workshops, conferences) more often, or iii) may use lawn and landscape or other Cooperative Extension resources in their business.

The biggest challenge or main reason practitioners do not use extension resources may be because they are not aware of free extension resources available related to the lawn and landscape (94%, Table 2.12). Table 2.12 does not reflect all survey participants in this study because there was an error in the flow logic of the survey model in Qualtrics, and therefore, this question was not presented to all respondents. Thus, only 234 responses from the 561 survey pool were captured, and strong inferences based on these results should not be made.

When practitioners were asked to consider what aspects of educational extension resources are important using Likert-scale questions (1 to 5 scale), survey results suggest that practitioners felt that being able to easily find extension resources and resources that were updated in the last five years were the most important considerations (Table 2.13). Both of these considerations were significantly more important than the other two options (social media and ability to engage in conversations) based on pairwise *T*-tests, but they were not significantly different, indicating the importance of both. Similarly, homeowners responded the same way to this question in another survey (Stanton, 2024). Activity of extension educators on social media and the ability to chat on the phone or online were ranked as “neither unimportant or important” among practitioners and were not significantly different from one another according to pairwise *T*-tests. These results further reinforce the need for continual evaluation of current educational extension tools and materials as well as updating of online materials to ensure Cooperative Extension websites and materials are easy to search and navigate on desktop computer and mobile device interfaces. While a complete revision of extension publications every 5 years is likely not required because there are often minimal changes in species recommendations for climatic regions, there is a need for small revisions because of newer and more sustainable

cultivars continually being released, more information on best maintenance practices, and changes to branding for the parent university or universities.

Practitioners were then asked what educational extension resource tools they would be most likely to use in the future using Likert-scale questions. Survey results suggested that practitioners favored more in-person events (workshops, field days, conferences) and online extension publications (Table 2.14). Both options were similar to one another based on pairwise *T-tests*. In-person events (workshops, field days, conferences) had the highest mean of 4.3 (slightly likely) and was significantly higher in importance than all other extension resource tools except online extension publications. This indicates that practitioners believe in-person events are beneficial and they are favorable among professionals. Many of these are Cooperative Extension programs and resources are already offered, such as summer field days and winter conferences, the primary method this survey was distributed. A better understanding of what practitioners expect from in-person events can help improve extension programming and increase attendance, industry support and sponsorship, and awareness of extension resources. Previous research has explored new teaching and demonstration methods, including turfgrass and weed identification “gardens” to have at in-person events; however, further research needs to be conducted to evaluate effectiveness and long-term retention among practitioners (Beck & Patton, 2015). Attaining a better understanding of what programming and opportunities practitioners would like to see at in-person events can help increase attendance, industry support and sponsorship, and Cooperative Extension awareness. Video platforms (YouTube, Instagram Reels, and other examples) and emailed newsletters (monthly to seasonal) ranked 2<sup>nd</sup> to 3<sup>rd</sup> in likelihood to use among practitioners as both options were not significantly different compared to online extension publications but significantly different than all remaining options. This is not surprising as online extension publications and video resources are two of the more commonly created extension resources that can be found on extension websites. Social media, extension website blogs, mailed newsletters, and phone calls or phone-based applications (apps) all scored lower within the range of 3.34 to 3.77 (neither unlikely nor likely to use) among practitioners. Since all five of these tools were less favored among practitioners, this style of extension programming should not be prioritized compared to other options such as in-person events, online extension publications, and video platforms; however, if resources allow, they could be useful to professionals. Furthermore, Stanton (2024) found that homeowners may be more

willing to use social media, extension website blogs, and phone-based applications because they ranked these items higher than professionals did in this survey. Therefore, these results illustrate that extension programming leaders should consider multiple education tools and methods to reach different audiences. Frequent postings on blogs and social media may not provide as much educational material when compared to traditional written online extension publications and demonstration videos; however, they can be more tailored to specific issues promptly, such as in response to multiple inquiries on climatic issues and current plant pests while also helping increase extension awareness and improving the placement of extension websites on major search engines.

### **Conclusion and Recommendations**

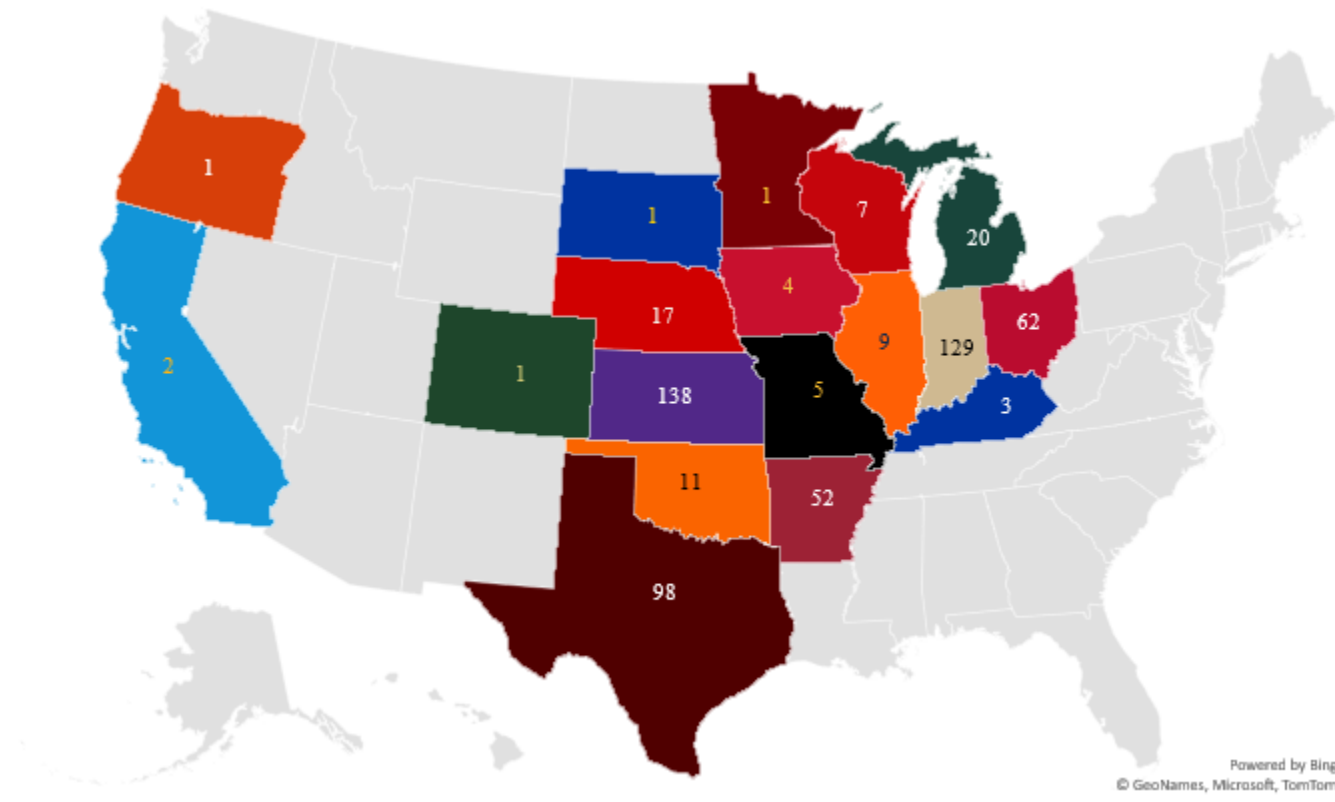
While Cooperative Extension is likely more often used by horticultural professionals compared to homeowners, there is still room for improvement with extension programming, content delivery, and awareness. Existing programs within Cooperative Extension (e.g., in-person events and online publications) are already utilized by professionals; however, they have noted that more recently updated publications that are easier to find and in different forms (i.e., videos) could increase the use. Increasing the frequency, accessibility (i.e., more locations across each state), and widening the breadth of topics for in-person events to increase overall attendance and attract the subsets of professional horticulture that less frequently attend current conferences could be three ways to increase awareness and use through methods that professionals do want to see while also providing means for further research to be conducted relating to professional extension use.

## References

- Beck, L., & Patton, A. J. (2015). Weed Garden: An effective tool for extension education. *The Journal of Extension*, 53, Article 15. <https://doi.org/10.34068/joe.53.04.15>
- Martini, N. F., & Nelson, K. C. (2015). The role of knowledge in residential lawn management. *Urban Ecosystems*, 18, 1031–1047 <https://doi.org/10.1007/s11252-014-0415-7>
- Stanton, A.C. (2024). Cooperative extension and teaching at a land-grant university: homeowner and industry perspectives and considerations of lawn and landscape extension resources and authorized crib cards in the classroom. *Kansas State University*.
- IBISWorld. (April 23, 2024). Market size of landscaping services in the United States from 2013 to 2023 (in billion U.S. dollars) [Graph]. *In Statista*. Retrieved February 12, 2024, from <https://www.statista.com/statistics/294212/revenue-of-landscaping-services-in-the-us/>
- USDA National Agricultural Statistics Service, Vilsack, T. (2024). *2022 Census of Agriculture*. Retrieved February 12, 2024, from [https://www.nass.usda.gov/Publications/AgCensus/2022/Full\\_Report/Volume\\_1,\\_Chapter\\_1\\_US/usv1.pdf](https://www.nass.usda.gov/Publications/AgCensus/2022/Full_Report/Volume_1,_Chapter_1_US/usv1.pdf)
- USDA-NIFA (United States Department of Agriculture-National Institute of Food and Agriculture). (2024a). *History of NIFA*. Retrieved February 12, 2024, from <https://www.nifa.usda.gov/about-nifa/who-we-are/history>
- USDA-NIFA (United States Department of Agriculture-National Institute of Food and Agriculture). (2024b). *USDA-NIFA Land-grant colleges and universities*. Retrieved February 12, 2024, from [https://www.nifa.usda.gov/sites/default/files/2023-04/NIFALGUs\\_MapREV\\_AI0522\\_508.pdf](https://www.nifa.usda.gov/sites/default/files/2023-04/NIFALGUs_MapREV_AI0522_508.pdf)
- USDA-NIFA (United States Department of Agriculture-National Institute of Food and Agriculture). (2024c). *USDA-NIFA Land-grant colleges and universities*. Retrieved February 12, 2024, from <https://www.nifa.usda.gov/about-nifa/how-we-work/extension/cooperative-extension-system>

## Figures

Figure 2.1. The map of the 18 states that practitioners work in with the number of responses ( $n$ ) from the respective states.



## Tables

Table 2.1. The survey questions presented to industry practitioners.

| <b>Introduction Questions for All Participants</b>                                                                     | <b>Response Options</b>                                                                                                                                                                                                                              |
|------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Which category best describes your place of employment?                                                                | Golf Course & Sports Turf; Lawn Care & Landscaping; Lawn Care; Landscaping; Tree Care; Production (Nursery, Sod, Greenhouse); Wholesale or Retail (to end consumer or installer)                                                                     |
| What state do you work in?                                                                                             | All 50 states were listed                                                                                                                                                                                                                            |
| How many employees are in your business (including seasonal workers)?                                                  | Sole Proprietor; 1-10; 11-15; 16-25; 26-50; 51-150; 151-499; 500+; Prefer not to say                                                                                                                                                                 |
| <b>Lawn and Landscape Contractor – Specific Questions</b>                                                              |                                                                                                                                                                                                                                                      |
| What services does your company offer? Please select all that apply.                                                   | Mowing; Fertilization; Irrigation; Softscaping; Hardscaping; Bed maintenance; Tree care; Snow removal & ice management; Pool service; Pool installation; Other (please list)                                                                         |
| Do you apply fertilizer products to turf and landscape areas?                                                          | Yes/No                                                                                                                                                                                                                                               |
| Do you apply any pest control products to turf and landscape areas?                                                    | Yes/No                                                                                                                                                                                                                                               |
| Do you offer in-ground irrigation system services or installation?                                                     | Service; Installation; Both; No                                                                                                                                                                                                                      |
| What are the common species of turfgrass you maintain? Please select all that apply.                                   | Kentucky bluegrass; tall fescue; fine fescue; perennial ryegrass; buffalograss; zoysiagrass; bermudagrass; St. Augustinegrass; mixture of cool-season species; mixture of warm-season species; mixture of cool- and warm-season; other (please list) |
| What customer relationship manager (CRM) do you use?                                                                   | Aspire; Service Auto Pilot; ServiceTitan; Include; Jobber; Yardbook; Lawnbuddy; RealGreen; Other (please list); None                                                                                                                                 |
| What design software do you use? This can be for landscape design, irrigation design or any other related design task. | AutoDesk CAD; Dynascape; ProLandscape; iScape; Other (please list); none                                                                                                                                                                             |
| What conference or event did you take this survey at?                                                                  | Open response                                                                                                                                                                                                                                        |
| Are you a member of any of the following trade organizations? (select all that apply)                                  | International Society of Arboriculture; American Society for Horticultural Science; National Association of Landscape Professionals; Irrigation Association; State/Local Trade Organization; Other (please list); None                               |
| <b>Golf Course and Sports Turf Practitioners – Specific Questions</b>                                                  |                                                                                                                                                                                                                                                      |
| What are the common species of turfgrass you maintain? Please select all that apply.                                   | Kentucky bluegrass; tall fescue; fine fescue; perennial ryegrass; buffalograss; zoysiagrass; bermudagrass; St. Augustinegrass; mixture of cool-season species; mixture of warm-season species; mixture of cool- and warm-season; other (please list) |
| What section of turf management do you most closely work in?                                                           | Golf course; sports field; other (please specify)                                                                                                                                                                                                    |
| What conference or event did you take this survey at?                                                                  | Open response                                                                                                                                                                                                                                        |
| Are you a member of any of the following trade organizations? (select all that apply)                                  | Golf Course Superintendents Association of America; Sports Field Management Association; Irrigation Association; American Society for Horticultural Science; State/Local Trade Organization; Other (please list); None                               |
| <b>Tree Care – Specific Questions</b>                                                                                  |                                                                                                                                                                                                                                                      |
| What tree care services do you provide? (Select all that apply)                                                        | Pruning; planting; transplanting; removal (tree and stump); disease and problem diagnosis; assessment/valuation; other (please list)                                                                                                                 |
| What conference or event did you take this survey at?                                                                  | Open response                                                                                                                                                                                                                                        |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Are you a member of any of the following trade organizations? (select all that apply)                                                                                                                                                                                                                                                                                                                                                                                           | International Society of Arboriculture; American Society of Consulting Arborists; ArbNet; Tree Care Industry Association; American Society for Horticultural Science; National Association of Landscape Professionals; State/Local Trade Organization; Other (please list); None                                                                                                                                                      |
| <b>Production (Nursery, Sod, Greenhouse) – Specific Questions</b>                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| What products do you grow and/or sell?                                                                                                                                                                                                                                                                                                                                                                                                                                          | Turfgrass sod; Turfgrass seed; Vegetables; Fruit; Flowers; Trees and shrubs; Ornamental plants; Other (please list)                                                                                                                                                                                                                                                                                                                   |
| What conference or event did you take this survey at?                                                                                                                                                                                                                                                                                                                                                                                                                           | Open response                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Are you a member of any of the following trade organizations? (select all that apply)                                                                                                                                                                                                                                                                                                                                                                                           | National Association of Landscape Professionals; American Society for Horticultural Science; AmericanHort; American Horticultural Society; Perennial Plant Growers' Association; Society of American Florists; American Institute of Floral Design; Turfgrass Producers International; State/Local Trade Organization; Other (please list); None                                                                                      |
| <b>Questions for All Participants</b>                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| What would you describe as your primary source for new information related to plant management practices and products?                                                                                                                                                                                                                                                                                                                                                          | Colleague; consultant; peer group; local trade show or conference; national/international trade show or conference; supplier; brand sales representative; university extension; website/online influencer; other (please list)                                                                                                                                                                                                        |
| What would you describe as your second most used source for new information related to plant management practices and products?                                                                                                                                                                                                                                                                                                                                                 | Colleague; consultant; peer group; local trade show or conference; national/international trade show or conference; supplier; brand sales representative; university extension; website/online influencer; other (please list)                                                                                                                                                                                                        |
| Are you aware of free education information available from [respondent's home state cooperative extension program]?                                                                                                                                                                                                                                                                                                                                                             | Yes; Yes, but I was not aware they had resources for the lawn and landscape; No                                                                                                                                                                                                                                                                                                                                                       |
| About how many times did you use information from [respondent's state cooperative extension program] in the past 365 days?                                                                                                                                                                                                                                                                                                                                                      | 1-4 times; 5-8 times; 9-12 times; More than 12 times; I did not use [respondent's state cooperative extension program] sources last year                                                                                                                                                                                                                                                                                              |
| <b>What</b> [respondent's home state cooperative extension program] information delivery methods have you used the most?                                                                                                                                                                                                                                                                                                                                                        | Social media; Website blog; Online Extension publications; Monthly-to-seasonal email newsletter; Monthly-to-seasonal mailed newsletter; Workshops; field days; other in-person events; Interactive sessions online; over the phone; video or chat; Phone or online app/tool                                                                                                                                                           |
| <b>What would you describe as your top challenge when trying to obtain information from</b> [respondent's home state cooperative extension program] sources?<br>-OR-<br>What would you describe as the main reason you do not use [respondent's home state cooperative extension program] sources?                                                                                                                                                                              | Information and answers are not easily available; Information seems outdated; Information is not useful; Information seems not trustworthy; Requires more time to find information<br>-OR-<br>Unaware of University extension resources available; Information and answers are not easily available; Information seems outdated; Information is not useful; Information seems not trustworthy; Requires more time to find information |
| On a scale from very unimportant to very important; how important are the following considerations in obtaining [respondent's home state cooperative extension program] services and resources<br>-Easiness to find/search the University extension website for answers<br>-Information has been updated in the past 5 years<br>- University extension educators are active on social media<br>- Ability to engage in conversation or chats with University extension educators | 1 to 5 Likert-scale (1= Very unimportant; 2= Somewhat unimportant; 3=Neither unimportant or important; 4=Somewhat important; and 5=Very important)                                                                                                                                                                                                                                                                                    |
| On a scale from very unlikely to very likely, how likely would you be to obtain free [respondent's home state cooperative extension program] resources from the following platforms?                                                                                                                                                                                                                                                                                            | 1 to 5 Likert-scale (1= Very unlikely; 2= Somewhat unlikely; 3= Neither unlikely or likely; 4= Somewhat likely; and 5= Very likely)                                                                                                                                                                                                                                                                                                   |

- 
- Social Media (Instagram, Facebook, Twitter, etc.)
  - Online video platforms (YouTube, Instagram Reels, etc.)
  - Website blog
  - Online extension publications
  - Monthly-to-seasonal email newsletter
  - Please Select "Somewhat Unlikely" Here\*
  - Monthly-to-seasonal mailed newsletter
  - Workshops, field days, other in-person events
  - Interactive sessions over the phone, virtual chat, or video
  - Phone or online app/tool

***\*This was an attention-check question that if not properly selected would kick respondents out of the survey***

|                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                               |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| What is the highest level of education you have completed?                                                                                                                                                                                                                                            | Some high school or less; High school diploma or GED; Some college; but no degree; Associates or technical degree; Bachelor's degree; Graduate or professional degree (MA, MS, MBA, PhD, JD, MD, DDS etc.), Prefer not to say |
| Which best describes your degree?                                                                                                                                                                                                                                                                     | Plant Science (Horticulture, Agronomy, Botany, etc.); Business (Including Management, Finance, etc.); Science; Technology; Engineering; or Mathematics related (STEM); Other (please list)                                    |
| What is the zip code where you work?                                                                                                                                                                                                                                                                  | Open entry limited to five characters                                                                                                                                                                                         |
| How would you describe the area where your home is located?                                                                                                                                                                                                                                           | Urban; Suburban; Small town; Rural                                                                                                                                                                                            |
| As a thank you for your participation in this survey, would you like to be entered in a raffle to win one of five \$100 gift cards to a nationwide hardware store (Lowes, The Home Depot, or Menards, your choice upon winning)? If so, please put your email in the box below. One entry per person. | Yes, please enter me!; No, I am not interested in participating in the raffle                                                                                                                                                 |

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Table 2.2. The university and cooperative extension associated collaborators and all cooperative extension-associated field days, workshops, or conferences where the survey was distributed.

| University                      | Collaborators                                                                         | Event Dates     |                        |
|---------------------------------|---------------------------------------------------------------------------------------|-----------------|------------------------|
|                                 |                                                                                       | Field day       | Conference or workshop |
| Kansas State University         | Alex Stanton, Dr. Ross Braun, Dr. Steve Keeley, Dr. Cheryl Boyer, Dr. Cody Domenghini | 3 Aug. 2023     | 29-30 Nov. 2023        |
| Purdue University               | Dr. Aaron Patton                                                                      | 18 July 2023    | 17-19 Jan. 2024        |
| Texas A&M University            | Dr. Manuel Chavarria                                                                  | 16-18 July 2023 | 11-12 Dec. 2023        |
| The Ohio State University       | Dr. Tyler Carr                                                                        | 2 Aug. 2023     | 4-7 Dec. 2023          |
| University of Arkansas          | Dr. Wendell Hutchins                                                                  | 1 Aug. 2023     | 25-26 Jan. 2024        |
| Michigan State University       | Dr. Kevin Frank                                                                       | 9 Aug. 2023     | 9-11 Jan. 2024         |
| University of Nebraska, Lincoln | Dr. Roch Gaussoin, Amanda Folck                                                       | 23 July 2023    | 9-11 Jan. 2024         |
| Oklahoma State University       | Dr. Mingying Xiang                                                                    | 20 Sept. 2023   | 14-15 Nov. 2023        |
| University of Wisconsin         | Dr. Paul Koch, Dr. Doug Soldat                                                        | 1 Aug. 2023     | 10-11 Jan. 2024        |
| Iowa State University           | Dr. Adam Thoms                                                                        | 13 Sept. 2023   | 13-15 Feb. 2024        |
| University of Minnesota         | Dr. Jon Trappe, Dr. Michael Barnes                                                    | 27 Sept. 2023   | 23-25 Jan. 2024        |
| Colorado State University       | Dr. Tony Koski                                                                        | 5-7 Dec. 2023   | --                     |

Table 2.3. The number of responses (*n*) by state that industry practitioners work in.

| <b>State</b>           | <b><i>n</i> (%)</b> |
|------------------------|---------------------|
| Arkansas               | 52 (9.3)            |
| California             | 2 (0.4)             |
| Colorado               | 1 (0.2)             |
| Illinois               | 9 (1.6)             |
| Indiana                | 129 (23)            |
| Iowa                   | 4 (0.7)             |
| Kansas                 | 138 (24.6)          |
| Kentucky               | 3 (0.5)             |
| Michigan               | 20 (3.6)            |
| Minnesota              | 1 (0.2)             |
| Missouri               | 5 (0.9)             |
| Nebraska               | 17 (3)              |
| Ohio                   | 62 (11.1)           |
| Oklahoma               | 11 (2)              |
| Oregon                 | 1 (0.2)             |
| South Dakota           | 1 (0.2)             |
| Texas                  | 98 (17.5)           |
| Wisconsin              | 7 (1.2)             |
| <b>Total Responses</b> | <b>561</b>          |

Table 2.4. The breakdown of industry affiliation of practitioners at cooperative extension led in-person workshops.

| <b>Item</b>                              | <b><i>n</i> (%)</b> |
|------------------------------------------|---------------------|
| Golf Course and Sports Turf              | 182 (32.4)          |
| Lawn Care and Landscaping                | 300 (53.5)          |
| Production (nursery, greenhouse, or sod) | 17 (3)              |
| Tree Care                                | 11 (2)              |
| Retail (wholesale or to end consumer)    | 51 (9.1)            |

Table 2.5. The education level of horticultural industry practitioners surveyed.

| <b>Education level</b>          | <b><i>n</i> (%)</b> |
|---------------------------------|---------------------|
| Some high school or less        | 2 (0.4)             |
| High school diploma or GED      | 65 (11.6)           |
| Some college, but no degree     | 117 (21)            |
| Associates or technical degree  | 78 (14)             |
| Bachelor's degree               | 250 (44.8)          |
| Graduate or professional degree | 44 (7.9)            |
| Prefer not to say               | 2 (0.4)             |

Table 2.6. The number of employees in businesses surveyed, including seasonal workers.

| <b>Number of employees</b> | <b><i>n</i> (%)</b> |
|----------------------------|---------------------|
| Sole Proprietor            | 33 (5.9)            |
| 1-10                       | 197 (35.2)          |
| 11-15                      | 70 (12.5)           |
| 16-25                      | 84 (15)             |
| 26-50                      | 76 (13.6)           |
| 51-150                     | 59 (10.6)           |
| 151-499                    | 19 (3.4)            |
| 500+                       | 16 (2.9)            |
| Prefer not to say          | 5 (0.9)             |

Table 2.7. The most common additional services<sup>a</sup> offered by lawn care and landscape companies.

| <b>Service</b>          | <b><i>n</i> (%) Yes</b> | <b><i>n</i> (%) No</b> |
|-------------------------|-------------------------|------------------------|
| Fertilizer & Pesticides | 315 (91.6)              | 29 (8.4)               |
| Pest control products   | 307 (89.8)              | 35 (10.2)              |
| Irrigation Service      | 58 (17)                 | -- <sup>a</sup>        |
| Irrigation Installation | 3 (0.9)                 | -- <sup>a</sup>        |
| Irrigation (both)       | 146 (42.7)              | 135 (39.5)             |

<sup>a</sup> Respondents were given Irrigation Service, Irrigation Installation, Irrigation Service and Installation, or No as options, resulting in the blank responses

Table 2.8. The most used customer relationship managers by lawn care and landscaping companies surveyed.

| <b>Customer Relation Manager Use</b> | <b><i>n</i> (%)</b> |
|--------------------------------------|---------------------|
| Aspire                               | 13 (7.7)            |
| Jobber                               | 5 (3)               |
| RealGreen                            | 8 (4.7)             |
| Service Auto Pilot                   | 8 (4.7)             |
| ServiceTitan                         | 1 (0.6)             |
| Yardbook                             | 7 (4.1)             |
| Other                                | 33 (19.5)           |
| None                                 | 94 (55.6)           |

Table 2.9. Trade organization membership<sup>a</sup>.

| Lawn and Landscape Contractor <sup>b</sup>      |      | Golf and Sports Turf Practitioners <sup>c</sup>    |      | Tree Care <sup>d</sup>                          |      |
|-------------------------------------------------|------|----------------------------------------------------|------|-------------------------------------------------|------|
| Options                                         | %    | Options                                            | %    | Options                                         | %    |
| International Society of Arboriculture          | 10.0 | Golf Course Superintendents Association of America | 47.2 | International Society of Arboriculture          | 55.6 |
| American Society for Horticultural Science      | 2.5  | Sports Field Management Association                | 14.2 | American Society of Consulting Arborists        | 0    |
| National Association of Landscape Professionals | 27.5 | Irrigation Association                             | 1.0  | National Association of Landscape Professionals | 0    |
| Irrigation Association                          | 7.5  | American Society for Horticultural Science         | 0.5  | ArbNet                                          | 0    |
| State/Local Trade Organization                  | 51.2 | State/Local Trade Organization                     | 36.5 | Tree Care Industry Association                  | 11.1 |
| Other                                           | 1.3  | Other                                              | 1.0  | American Society for Horticultural Science      | 0    |
| None                                            | 0    | None                                               | 0    | National Association of Landscape Professionals | 0    |
| --                                              | --   | --                                                 | --   | State/Local Trade Organization                  | 33.3 |
| --                                              | --   | --                                                 | --   | Other                                           | 0    |
| --                                              | --   | --                                                 | --   | None                                            | 0    |

<sup>a</sup> Respondents were able to “select all that apply”. Not all respondents completed this portion of the survey, including none associated with production-related careers (nursery, sod, or greenhouse).

<sup>b</sup> *n* = 80 selections.

<sup>c</sup> *n* = 197 selections.

<sup>d</sup> *n* = 9 selections.

Table 2.10. The primary and secondary information sources for practitioners surveyed relating to horticultural plant management and plant health management.

| <b>Information Sources</b>                      | <b><i>n</i> (%)</b> | <b><i>n</i> (%)</b> |
|-------------------------------------------------|---------------------|---------------------|
|                                                 | <b>Primary</b>      | <b>Secondary</b>    |
| Brand Sales Representative                      | 37 (6.6)            | 34 (6.2)            |
| Colleague                                       | 74 (13.3)           | 74 (13.5)           |
| Consultant                                      | 24 (4.3)            | 23 (4.2)            |
| Local Trade Show or Conference                  | 114 (20.5)          | 100 (18.2)          |
| National/International Trade Show or Conference | 20 (3.6)            | 20 (3.6)            |
| Other                                           | 1 (0.2)             | 4 (0.7)             |
| Peer Group                                      | 38 (6.8)            | 39 (7.1)            |
| Supplier                                        | 76 (13.6)           | 98 (17.9)           |
| University Extension                            | 127 (22.8)          | 86 (15.7)           |
| Website/Online Influencer                       | 46 (8.3)            | 70 (12.8)           |

Table 2.11. Practitioner awareness of cooperative extension resources.

| <b>Extension awareness</b>                                               | <b><i>n</i> (%)</b> |
|--------------------------------------------------------------------------|---------------------|
| Yes                                                                      | 415 (73.9)          |
| Yes, but I was not aware of resources relating to the lawn and landscape | 51 (9.1)            |
| No                                                                       | 93 (16.6)           |

Table 2.12. The primary reason or challenges in using cooperative extension resources by practitioners.

| <b>Biggest challenge</b>                                          | <b><i>n</i><sup>a</sup> (%)</b> |
|-------------------------------------------------------------------|---------------------------------|
| Answers not easily available                                      | 4 (1.7)                         |
| Information is not useful                                         | 1 (0.4)                         |
| Information seems not trustworthy                                 | 0 (0)                           |
| Information seems outdated                                        | 2 (0.9)                         |
| Requires more time                                                | 6 (2.6)                         |
| Unaware of resources available for lawn and landscape information | 221 (94.4)                      |

<sup>a</sup> Note *n*=234 of 561 total responses due to an error in the flow logic of the survey model in Qualtrics, and therefore, this question was not presented to all respondents.

Table 2.13. The considerations by practitioners when using cooperative extension resources relating to plant health care and maintenance.

| <b>Item</b>                                                                             | <b>Mean<sup>a</sup></b> | <b>Standard<br/>Deviation</b> | <b>Easiness to<br/>find/search</b> | <b>Updated in the<br/>past 5 years</b> | <b>Active on social<br/>media</b> |
|-----------------------------------------------------------------------------------------|-------------------------|-------------------------------|------------------------------------|----------------------------------------|-----------------------------------|
| Easiness to<br>find/search the<br>University extension<br>website for answers           | 4.01                    | 1.31                          |                                    |                                        |                                   |
| Information has been<br>updated in the past 5<br>years                                  | 4.05                    | 1.37                          | -0.9 <sup>b</sup>                  |                                        |                                   |
| University extension<br>educators are active<br>on social media                         | 3.26                    | 1.23                          | 12.0***                            | 13.0***                                |                                   |
| Ability to engage in<br>conversation or chats<br>with University<br>extension educators | 3.76                    | 1.22                          | 5.0***                             | 7.0***                                 | -10.0***                          |

<sup>a</sup> 1 to 5 Likert-scale (1= Very unimportant; 2= Somewhat unimportant; 3=Neither unimportant or important; 4=Somewhat important; and 5=Very important).

<sup>b</sup>T values presented with df= 536 and 555, and a 95% confidence interval.

\*, \*\*, \*\*\* significant at 0.05, 0.01, and <0.001 level

Table 2.14. The mediums that practitioners would be most likely to use for future cooperative extension educational materials pertaining to plant health care and maintenance.

| Item                                             | Mean <sup>a</sup> | Standard Deviation | Social Media          | Video Platforms     | Blogs                | Online Publications | Email Newsletter    | Mailed Newsletter    | Workshops           | Phone calls and online chats |
|--------------------------------------------------|-------------------|--------------------|-----------------------|---------------------|----------------------|---------------------|---------------------|----------------------|---------------------|------------------------------|
| Social Media                                     | 3.56              | 1.37               |                       |                     |                      |                     |                     |                      |                     |                              |
| Video platforms (YouTube, Instagram Reels, etc.) | 4.09              | 1.02               | -10.0 <sup>b***</sup> |                     |                      |                     |                     |                      |                     |                              |
| Blogs (extension website)                        | 3.61              | 1.16               | -1.0 <sup>***</sup>   | 9.0 <sup>***</sup>  |                      |                     |                     |                      |                     |                              |
| Online extension publications                    | 4.12              | 0.97               | -8.0                  | -0.5                | -12.0 <sup>***</sup> |                     |                     |                      |                     |                              |
| Email newsletter (monthly to seasonal)           | 4.10              | 0.96               | -8.0 <sup>***</sup>   | -0.3                | -9.0 <sup>***</sup>  | 0.8                 |                     |                      |                     |                              |
| Mailed newsletter (monthly to seasonal)          | 3.67              | 1.20               | -1.0 <sup>***</sup>   | 7.0 <sup>***</sup>  | -1.0                 | 8.0 <sup>***</sup>  | 9.0 <sup>***</sup>  |                      |                     |                              |
| Workshops, field days, in-person events          | 4.3               | 0.92               | -11.0                 | -4.0 <sup>***</sup> | -13.0 <sup>***</sup> | -4.0 <sup>***</sup> | -4.0 <sup>***</sup> | -11.0 <sup>***</sup> |                     |                              |
| Phone call, online, virtual chats                | 3.34              | 1.16               | 3.0 <sup>***</sup>    | 14.0 <sup>***</sup> | 5.0 <sup>***</sup>   | 14.0 <sup>***</sup> | 13.0 <sup>***</sup> | 5.0 <sup>***</sup>   | 19.0 <sup>***</sup> |                              |
| Phone-based application (online app tool)        | 3.77              | 1.07               | -3.0 <sup>***</sup>   | 6.0 <sup>***</sup>  | -3.0 <sup>**</sup>   | 6.0 <sup>***</sup>  | 6.0 <sup>***</sup>  | -1.0                 | 11.0 <sup>***</sup> | -9.0 <sup>***</sup>          |

<sup>a</sup> 1 to 5 Likert-scale (1= Very unlikely; 2= Somewhat unlikely; 3= Neither unlikely or likely; 4= Somewhat likely; and 5= Very likely).

<sup>b</sup> Pairwise *T*-test values presented with df between 525 and 554 and a 95% confidence interval.

\*, \*\*, \*\*\* significant at 0.05, 0.01, and <0.001 level.

# **Chapter 3 - The Influence of Authorized Crib Cards on Student Test Performance and Test Anxiety in an Introductory Horticulture**

## **Course**

### **Abstract**

Understanding how students learn and retain information is an important part of providing a well-rounded education. With recent advancements in technology, a world pandemic, and increasing costs, higher education has changed how course materials are delivered, and students are evaluated. Authorized crib cards (e.g., crib sheets, cheat sheets, notecards, condensed notecards) have been allowed in certain classrooms since the 1950's; however, little research has been conducted in a horticultural classroom. Students were allowed to use crib cards on four of eight tests in Basic Turfgrass Culture (HORT 515) during the Spring 2023 and Spring 2024 semesters at Kansas State University. The objectives of the study were to attain a better understanding of student study habits, crib card use, testing performance, and how the crib card influenced their test anxiety. For most students, there was a <2% change in their average test scores when comparing traditional testing (i.e., no crib card) to crib card-allowed tests; however, students did report that the crib cards, “help[ed] motivate me to study” and assisted in helping them create a “plan for what I didn’t know” while studying for the test. The crib cards did help students with a GPA of 2.65 or less the most, while six of the seven students who noticed decreases in average scores had a GPA between 3.1 and 4.0. Overall, crib cards are tools that can help encourage students to study more for upcoming tests and feel more confident about the test. While crib cards may slightly hinder higher-performing students, there was a minimal influence on their performance, and like many other resources for classroom education, crib cards can be offered as a tool to use, but use should not be required.

## Introduction

Traditionally, assessments such as examinations, quizzes, and tests have been the most common method to measure a student's ability to retain and use the content taught. These assessment methods can vary in design, ranging from selecting the best answer from a list of four or five options (i.e., multiple-choice questions) to multiple-page essays to show expertise on the topic from memory. Students often spend hours, if not days, studying course material by rewriting notes, rewatching lectures (if applicable), reviewing slides, and creating devices to help them study for one exam that is often completed in less than two hours. Understanding how students study for these exams and how educators can use a wide variety of devices to help them perform better is another method to help provide a well-rounded education.

Higher education has recently changed because of technological innovations, increasing tuition and material costs, and a world pandemic, which may potentially influence how students learn, how they retain information, and how they study for exams. Authorized crib cards (e.g., cheat sheets, crib sheets, note cards, condensed notecards) have been utilized in the classroom for ~75 years; however, little research has been done on their influence on student test scores, study habits, and/or self-reported student stress levels in a horticulture course (Janick, 1990; Kalish, 1958). Since the 1950s, collegiate professors have been experimenting with various forms of in-person written examination methods, such as implementing open book or open note examinations or allowing students to create condensed notecards (crib cards) to use on the examination (Kalish, 1958). The use of a crib card has been reported to reduce a student's anxiety related to the exam (Erbe, 2007) by acting as a "security blanket" of sorts that the student can use for more in-depth concepts that they were not able to fully commit to memory (Burns, 2014). As Jules Janick noted, "I realize I am tricking the students into studying" because the creation of the crib cards requires students to review their notes and provided materials and summarize them onto another medium (Janick, 1990).

Research has reported that while a crib card may help lower student test anxiety, it may not always assist the students as they think it will. For example, de Raadt (2012) reported students who created crib cards that focused more on the course concepts performed better than their counterparts with crib cards that contained examples directly from the materials provided. When students created crib cards to include as much content as possible in a nursing course, many students created 8 x 10-inch crib cards with up to 105 lines per side with 40 words per line

which was only decipherable by the creator and the evaluation team was required to ask the students for clarification (Drake et al., 1998). Gharib (2012) reported students taking open-book exams had increased levels of test anxiety when compared to crib card-allowed exams. This could have been due to students spending less time studying for the open book examination whereas they would spend time studying the material during the crib card creation; however, more research is needed to compare these two methods against one another.

While there are studies on student crib card design and construction, it has received less attention than the effectiveness of using crib cards as a concept. Crib cards can be evaluated on their informational density, use of color, the number of abstract concepts and equations compared to direct course content, the number of sections and organization, and more (Danielian & Buswell, 2019, Shaw & Almedia, 2018; Visco, et al., 2007,). These factors can be more subjective than test scores and other quantitative data, but coding systems can be created. Evaluating the density of writing on student crib cards was completed by Danielian and Buswell (2019) in a mechanics and materials course and Shaw and Almedia (2018) in two anatomy and physiology courses, with the two studies finding conflicting results in crib card density in relation to exam performance. Danielian and Buswell (2019) reported that students with more dense or more organized notecards (i.e., crib cards) did not consistently have better examination performance, which was contrary to the findings of Shaw and Almedia (2018), who reported that students who had more color and organization on their crib cards typically performed better on tests. Therefore, increased crib card organization with colors and divided sections may be beneficial to an extent but there can be a point of diminishing return for over-organizing crib cards with limited space and taking away from time dedicated to studying course materials (Danielian & Buswell, 2019, Shaw & Almedia, 2018, Visco, et al., 2007). Crib cards can range from elaborately made flip books to small word documents that students create in a rush before the exam (Drake et al., 1998). Depending on the instructor's preference, they can range in size and medium from a single-sided, handwritten 3 × 5-inch notecard to a double-sided sheet of A4 paper (i.e., 8 × 11.5 inch) that can be typed or handwritten (Butler & Crouch, 2011, Shaw & Almedia, 2018). Both Drake et al. (1998) and Erbe (2007) reported their students spent hours creating elaborate crib cards, some were color-coded with ciphers, full of text that was almost too small to read, or even flipbooks with multiple sheets of paper attached to the original crib card. The study by Erbe (2007) was unique compared to other mentioned literature because it

allowed students to attach other pages to their original crib card, increasing the surface area that students can write and draw on.

While multiple studies have investigated crib card construction and use in undergraduate courses, many of the studies used to form this project were conducted in courses related to the arts and sciences or engineering fields. There has been little research on the utilization of crib cards in horticulture or agriculture-based courses that have both lecture and hands-on laboratory sections.

## **Materials and Methods**

Basic Turfgrass Culture (HORT 515) is the introductory turfgrass science and management course at Kansas State University in Manhattan, KS. This course is taught every spring semester, and the course description is: “Turfgrass identification and adaptation; establishment and maintenance of turfgrass for golf courses, sports fields, home lawns, parks, and commercial/institutional grounds and advanced topics in golf and sports turfgrass maintenance, focusing on practices unique to intensively used and managed turf.” The course has five primary units focusing on the identification, cultivation, maintenance, and adaptation of the 20 most used turfgrass species for home lawns, golf courses, sports fields, and public areas, and over 40 of the most common biotic pests (e.g., weeds, diseases, insects) found in those turfgrass stands across North America. It is a three-credit hour, in-person-only course with two one-hour lectures per week (~30 total including lecture exam dates) and one two-hour lab (~14 total with lab quizzes included in certain labs).

For the Spring 2023 and Spring 2024 semesters, students in a horticultural undergraduate course titled “Basic Turfgrass Culture” (HORT 515) at Kansas State University were allowed to use crib cards on four of the eight tests throughout the semester (two of four lab quizzes and two of four lecture exams) with the research objectives to better understand testing performance, studying habits, and the test-taking anxiety of the student (Table 3.1).

There were 16 and 13 students enrolled in HORT 515 in the Spring of 2023 and 2024, respectively, with class average GPA of 3.15 and 3.12, respectively (Table 3.2). The 2023 class was 56% male and consisted of one sophomore (6%), three juniors (19%), and 12 seniors (75%). In 2024, the course was 76% male and consisted of three sophomores (23%), six juniors (46%), and four seniors (30%). All students had horticulture as their declared major in both years, with

eight students (50%) having declared a specialization in Golf Course and Sports Turf Operations (i.e., Turfgrass Science) in 2023, and seven students (53%) having declared a specialization in Golf Course and Sports Turf Operations in 2024.

This study was IRB approved under the criteria set forth in the Federal Policy for the Protection of Human Subjects, 45 CFR §104(d), category: Exempt Category 1 (Proposal Number: IRB-11442). In both years, all students were given a verbal explanation of the project during the first lecture period. In addition, they were handed a written description of the study to keep for later reference. Students were then asked to sign an IRB Informed Consent form if they agreed to be a part of the study. Consent to the study did not impact their ability to use crib cards on the specified exams. Thus, they could still use crib cards on specified exams if they did not wish to participate in the study. Regardless, all students in both semesters consented to participate in the study.

Blank 5x8-inch notecards were handed to students at least one week before a test (i.e., quiz or exam). Students were informed in the first lecture and each time blank crib cards were handed out that the only rules were that only one side of the notecard could be used (i.e., written on) and that it must be handwritten (text, figures, diagrams, etc.). During the explanation at the beginning of the semester, they were given a pre-survey to fill out exploring their past crib card use and if they had any formal education on what to include within crib cards. They could use any medium in any color(s) to write or draw on the card. They were given multiple copies of a notecard each time in case there was an error on the card they were constructing. They were given no other guidance on what should or should not be included on the notecard. Figures, notes, formulas, or drawings they thought would benefit them were all allowed. On the reverse side of the crib card, students were required to self-report an estimate of how long they spent making the crib card (to the nearest 30 minutes), how long they spent studying in total (including crib card creation), and a unique identifier to match crib cards to exams. These cards were turned in with the exam and not returned to the students at any time during or after the semester. Figure 1 shows four crib cards from various exams throughout each semester showing some of the strategies used by students such as color coding and compartmentalizing course material and how other students did not include as much information on them.

Hort 515 tests generally consisted of 34% multiple choice questions, 33% matching questions, and 33% short answer (i.e., short essay) questions. In both years, students were

allowed to use crib cards in the lab final quiz and lecture final exam (i.e., exam 4 and quiz 4). The other two exams were alternated from year one to year two to compare student test performance with or without crib cards (Table 3.1). In both years, students were not allowed to use crib cards on lecture exam 2 or lab quiz 3 due to the content of the test. For example, quiz 3 involved seed and pesticide calculations, and students were provided with any relevant conversion values. Lab quiz 1 was turfgrass identification-based station questions where students had to identify turfgrass species by their “common” or Latin (i.e., scientific) name with no word banks provided. Lab quiz 2 comprised of identification stations where students had to identify live weed plants and pictures of plant disease pests and insect pests, with no word banks, and it also consisted of five short-answer (i.e., essay) questions and seven multiple-choice questions. Lecture exam 4 and lab quiz 4 were cumulative tests with content from the three previous lecture exams or three previous lab quizzes, respectively. Lecture exam 4 had a post survey at the end to explore each student’s perceptions of crib cards throughout the semester and they were given five points of extra credit for completing this survey. All exams and quizzes were identical in content across both years. After each test (exam or quiz) was graded, students could review their test results in the following lecture or lab period, but all were collected again by the instructor in the same period. While the crib cards were collected after each test, they were not evaluated for comprehensiveness, content, or design style. The self-reported study habits on the back were the primary reason for collecting the crib cards and to prevent students from sharing their crib cards with future students and compromising the study.

On the exams that allowed crib cards, there was a blank line to the left of each question number where students self-reported with an “x” if they used the crib card to help answer that question. After each exam was graded, the result of each question was recorded in a Microsoft Excel (Microsoft, Redmond, WA) spreadsheet using the following coding: i) crib cards used, correct; ii) crib cards used, wrong; iii) no crib cards used, correct; and iv) no crib cards used, wrong. Each year had its own respective workbook with tests having their own worksheets and there being a “primary” worksheet where data was compiled. For each question, the percentage right and wrong and the percentage of crib card use/non-use were calculated. These instances were then quantified and analyzed to explore trends with students and trends with certain questions independently. From these workbooks, the average exam scores of both crib card-allowed and non-crib card-allowed, the differences in exam scores, student GPAs, and the

number of times they used the crib card throughout the semester was collected into one sheet to be imported into R (R Development Core Team, 2024) statistical software for further analysis. Pairwise *T*-tests were conducted to explore statistical differences between both years including GPA, test scores, crib card usage between students with <2.9 GPA and >3.0 GPA, and linear regressions were conducted to explore if the time students spent studying had an influence on their test scores and if the time spent constructing crib cards had an influence on test scores. All tests were conducted at 95% confidence intervals. Alongside all the question-specific data, the self-reported study habits of students were recorded for each test and the start and stop time of the test. This data was compiled to find the average time spent creating the crib card and the average time spent studying for each student for the semester. The time spent studying was not collected for non-crib card-allowed tests. In each semester, the eight total exams accounted for 66% of the student's overall grade. In Tables 3.5 and 3.6, the column “Influence of Crib Card Tests on Course Grade” is the traditional test (i.e., non-crib card exam) mean score subtracted from the mean crib card test score and multiplied by 0.33 (the weight of the 4 exams).

At the end of the study, each crib card was visually rated on a 1 to 5 scale based on their “completeness” with 1 = minimal-to-no content and 5 = crib card is completely filled in. There was no evaluation of the content contained within the cards or use of color, organization or diagrams.

## **Results and Discussion**

### **Pre-survey**

Most students (90%) had used crib cards at a previous time in their educational career and only one student reported that they used a crib card that was created by a professor or graduate teaching assistant (Table 3.3). Prior to the start of the experiment, most students who had used crib cards in the past agreed that crib cards decreased their stress about upcoming tests and improved their confidence going into the test. Students reported that they believed that crib cards would increase the total amount of time they spent studying and that it will help increase their organization while studying.

## Test Performance

The 2023 class had an average student GPA of 3.15 and the 2024 class had an average student GPA of 3.12 (Table 3.2). When pairwise *T*-tests were conducted, they were not significantly different ( $p=0.900$ , Table 3.4). Mean crib card-allowed test scores ranged from 64 to 98% and 57 to 94% in 2023 and 2024, respectively (Tables 3.5 and 3.6). Mean traditional (non-crib) test scores ranged from 44 to 95% and 56 to 98% in 2023 and 2024, respectively. In 2023, students averaged 5.2% higher scores when allowed to use crib cards on the tests (Table 3.6). The greatest increase in mean test scores when using crib cards was 21.9% for one student and the greatest decrease was -10.6% for another student; however, most students had better performance on crib card-allowed tests compared to non-crib card tests (Tables 3.5 and 3.6). In 2024, there were fewer differences in mean test score performance, with students scoring 0.03% worse on average on crib card-allowed tests when compared to non-crib card tests; however, there was one outlier with one student having a decrease of 18.83% for crib card-allowed tests compared to non-crib card tests (Table 3.6). If this outlier is removed, then students in 2024 averaged 2% higher test scores when crib cards were allowed, which is similar to the observed 5% in 2023. While it appears that the use of crib cards did lead to higher course grades across both years, only two out of 29 students (7%) saw an overall course grade percentage improvement of five percent or more, with both being in 2023 (Tables 3.5 and 3.6). Moreover, 48% of students only had a course grade change between zero and two percent and 21% of students experienced an increase in course grade between two and five percent due to crib card-allowed tests. Seven students (24%) did see an overall decrease in course grade between 0.1 and 6.3 percent. While it appears that the use of crib cards helped 76% of students increase their course grade percentages across both years, only three students (10%) would have had a letter grade difference because of crib card use, based on their increased performance on the four tests studied. Two of the three students could be considered outliers based on the data set. Upon further inspection of the seven students where crib card-allowed tests negatively impacted overall course grade percentage, data revealed mean regular test scores ranged from 83 to 98%, with an overall mean of 90%. Four of those seven students had grade point averages between 3.1 and 3.85 and two had 4.0 grade point averages. With these typically higher-performing students performing worse on tests where crib cards were allowed in this study, it indicates that crib cards may be harmful to some students' performance because the crib card can introduce a change to

their normal study habits or test-taking procedures. The three largest increases in course grade percentages across both years were from students with grade point averages between 2.05 and 2.63, indicating that crib cards could be beneficial to students who typically do not perform as well on exams by encouraging them to study by creating the crib card and to give them another tool during the exam to help them remember or be able to use concepts that they might not be able to fully utilize otherwise. This study did not evaluate the content contained within the crib cards collected and that could have had an influence on student study habits, test scores, and anxiety. Regardless, most students benefited from creating and being able to use crib cards on tests, especially for students who traditionally do not perform as well in the classroom, and if it does impact the student negatively, it often is less than a 1% influence on the overall course grade percentage. Similar to the findings of Whitley (1987), the use of crib cards is an “it depends” situation where they can help some students, and for others, it may not affect their performance or even hurt their scores.

### **Crib Card Usage**

When *T*-tests were conducted, there were no differences in the number of times (i.e., occurrences) that students with >3.0 GPAs used crib cards on tests compared to <2.99 GPA students, but there were significant differences in their exam scores at the 0.01 confidence level (Tables 3.4 and 3.7). This result is different than the findings of Burns (2014), where “moderate” and “low” achieving students used their crib cards more than “high” achieving students. There was no statistical significance in the traditional exams and crib card-allowed exam scores between 2023 and 2024 (Table 3.4). There was a correlation between the time a student spent studying and their test performance in 2023; however, there was no correlation in 2024 and there was no correlation between time spent constructing crib cards and performance on tests (Table 3.7). When the mean rating of student’s crib cards from all 4 tests was compared to their mean test score, there was a positive relationship between the completeness of the card and their performance on the test. While the content contained in the crib cards was not evaluated and could have influenced the student's test results, these results are similar to the findings of Shaw & Almedia (2018).

## **Post-Survey**

Students agreed (4.17) that their stress levels were lower and they felt more confident during tests that allowed crib cards (Table 3.9). Students also agreed that they would prefer to use crib cards on all tests in HORT 515 and in other Horticulture courses (Table 3.8). Students leaned toward “agree” (3.9) with the statement that “I found the crib cards helpful in reinforcing and remembering course material.” Students agreed (4.28) that the act of creating a crib card helped organize their thoughts and made studying easier. Students were neutral to disagreeing on that the creation of the crib cards was fun (2.86) and creating the crib cards was stressful (2.34), indicating that the crib cards are not a particularly enjoyable tool to use for studying, but they are a low stress study aid that students can see the importance in because they believed that it helped them organize their thoughts while studying. The students in this experiment concluded that crib cards were useful because they strongly disagreed to disagreed (1.59) with the statement “I did not find the crib sheet useful.” While students indicated that crib cards slightly increased their time spent studying (3.76), students nearly agreed that the crib cards decreased their stress about the upcoming test with a mean of 3.93 and they found themselves using the crib cards less than they anticipated on the tests (3.83). Many of these findings are similar to those of Butler (2011) and Dickson (2008), who reported that crib cards helped students have less stress about the upcoming test, and helped them understand the material better, while better reinforcing the content. Many students reported in the free-response portion that the crib cards were helpful because they helped them organize their studying further and “dive into topics [they] were unsure about.” Some students did note however that the crib cards seemed as, “a way to learn [and] dump the information that you learned” or that, “if we got one every time, I think I wouldn’t actually learn, rather just make a good card” indicating that while they were in favor of the crib sheets, some students did recognize that they could become too dependent on the card that it could potentially harm their future performance and retention.

## **Conclusion**

Results in this horticultural course indicate crib cards can be a great tool for students to help organize their thoughts while studying. Like a textbook, printed or posted slides, or other informational handouts, crib cards are simply another tool that instructors can give their students to utilize. Crib card-allowed tests increased test performance and overall grade percentages more

for students with a lower GPA compared to higher GPA students. However, crib cards may not be beneficial, and even slightly detrimental, to higher performing (i.e., higher GPA) students. Therefore, instructors need to carefully consider crib card use frequency in a course. Similar to past research, crib card assistance and its impact on test performance likely depends on the type of student. Regardless, crib cards can be a beneficial tool for students to use to increase studying time and to have during an exam or quiz; however, students may not use it as much as they think they will. Most students reported that the crib card construction lowered their test anxiety and increased their time spent studying when compared to non-crib card allowed tests. Furthermore, students did not report that the construction of the crib card was enjoyable. They also did not express discomfort.

This study did not evaluate long-term retention of content taught throughout the semester or if there is increased retention past the semester that students are enrolled in. Further research is needed to evaluate the long-term retention of course material during the current semester and in subsequent semesters. Replication of the study in other similar horticultural courses with similar difficulties would help with attain a better understanding of how crib cards can be best used in the classroom. Future research should also investigate other study aid methods, in addition to crib cards, to help lower testing anxiety and promote study habits.

## References

- Burns, K. C. (2014). Security blanket or crutch? Crib card usage depends on students' abilities. *Teaching of Psychology*, 41, 66–68, <https://doi.org/10.1177/0098628313514181>
- Butler, D., & Crouch, N. (2011). Student experiences of making and using cheat sheets in mathematical exams. *The Australian Association of Mathematics Teachers*, 134–141, <https://hdl.handle.net/2440/71007>
- Danielian, S. A., & Buswell, N. T. (2019). Do support sheets actually support students? A content analysis of student support sheets for exams. *American Society for Engineering Education*, 2019 Pacific Southwest Section Meeting, California State University, Los Angeles, California. <https://peer.asee.org/31824>
- Dickson, K. L., & Bauer, J. J. (2008). Do students learn course material during crib sheet construction. *Teaching of Psychology*, 35, 117–120. <https://doi.org/10.1080/00986280801978343>
- Drake, V. K., Freed, P., & Hunter, J. M. (1998). Crib sheets or security blankets? *Issues in Mental Health Nursing*, 19, 291–300.
- Erbe, B. (2007). Reducing test anxiety while increasing learning: the cheat sheet. *College Teaching*, 55, 96–98. <https://doi.org/10.3200/CTCH.55.3.96-98>
- Gharib, A., & Phillips, W. (2012). Test anxiety and performance on open book and cheat sheet exams in introductory psychology. *IPEDR*, 53, 1, 1–4
- Janick, J. (1990). Crib sheets *The Teaching Professor*, 6, 2.
- Kalish, R. A. (1958). An experimental evaluation of the open book examination. *Journal of Educational Psychology*, 49, 200–204
- Raadt, M. de (2012). Student created cheat-sheets in examinations: impact on student outcomes. *Proceedings of the Fourteenth Australasian Education Conference*, 123, 71–76. Melbourne, Australia.
- Shaw, J.A., & Almedia, M.G. (2018). Does the quality of student crib cards influence anatomy and physiology exam performance. *HAPS Educator*, 22, 50–54, <https://doi.org/10.21692/haps.2018.005>
- Visco, D., Saravanan, S., Zagumny, L., & Anthony, H. (2007). Interpreting student-constructed study guides. *American Society for Engineering Education*, 12.955.1–12.955.10, 2007 Annual Conference & Exposition, Honolulu, HI, 24 June 2007. <https://doi.org/10.18260/1-2--1818>
- Whitley, B. E., (1996). Does "cheating" help? The effect of using authorized crib notes during examinations. *College Student Journal*, 30, 489–493

## Figures

Figure 3.1: Two crib cards collected during the study showcasing the use of color, diagrams, and sections within the card.



Moist - rough blue  
Thatch - warm succulent  
Dry shrubs - ferns  
Feel along, flat, silted  
Mowing is a stress  
Perforation good for getting into thatch  
700 nm - red light

Thatch - 61m

Dry shade - fescues

feel, drag, split, sickle bar

Murphy is a stress

Newton used calculus to match

700 nm - Red light

[illegible]

## Tables

Table 3.1: Description of when crib cards were allowed for Basic Turfgrass Culture (HORT 515) tests during spring 2023 and 2024 semesters at Kansas State University.

| <b>HORT 515 Test</b> | <b>Spring 2023</b> | <b>Spring 2024</b> |
|----------------------|--------------------|--------------------|
| Lecture Exam 1       | Yes                | No                 |
| Lecture Exam 2       | No                 | No                 |
| Lecture Exam 3       | No                 | Yes                |
| Lecture Exam 4       | Yes                | Yes                |
| Lab Quiz 1           | No                 | Yes                |
| Lab Quiz 2           | Yes                | No                 |
| Lab Quiz 3           | No                 | No                 |
| Lab Quiz 4           | Yes                | Yes                |

Table 3.2: Demographics of HORT 515 students in the spring 2023 and spring 2024 semesters.

| <b>HORT 515 Test</b>                                            | <b>Spring 2023</b> | <b>Spring 2024</b> |
|-----------------------------------------------------------------|--------------------|--------------------|
| Total Students                                                  | 16                 | 13                 |
| Number of Students Specializing in<br>Golf Course & Sports Turf | 8                  | 7                  |
| Mean Class GPA                                                  | 3.15               | 3.12               |
| Sophomore Standing                                              | 1                  | 3                  |
| Junior Standing                                                 | 3                  | 6                  |
| Senior Standing                                                 | 12                 | 4                  |

Table 3.3: The pre-survey results on students perceptions on how they will use crib cards during the semester (2023 and 2024 data was combined)

| Item                                                                                                     | Mean              | Standard Deviation |
|----------------------------------------------------------------------------------------------------------|-------------------|--------------------|
| Consent: Please indicate “yes” or “no” if you choose to participate in this study.                       | 1.00 <sup>a</sup> | 0.0                |
| I have used exam helper sheets (crib sheets) before in a previous course when the instructor offered it. | 0.90 <sup>a</sup> | 0.31               |
| I created my past crib cards.                                                                            | 1.00 <sup>a</sup> | 0.0                |
| An instructor created my past crib cards.                                                                | 0.04 <sup>a</sup> | 0.20               |
| I find that crib sheets improve my test taking confidence.                                               | 4.00 <sup>b</sup> | 1.36               |
| I find that crib sheets decrease my stress about the test.                                               | 3.88 <sup>b</sup> | 1.07               |
| I would prefer that all Horticulture courses allow crib sheets.                                          | 4.12 <sup>b</sup> | 0.91               |
| I feel that crib sheets will help reduce my test related stress in HORT 515.                             | 4.21 <sup>b</sup> | 0.86               |
| I feel that crib sheets will help me organize my studying better.                                        | 4.03 <sup>b</sup> | 0.98               |
| I feel that crib sheets will _____ my time spent studying.                                               | 3.55 <sup>c</sup> | 0.83               |

<sup>a</sup> The question was a yes (1) or no (0) question.

<sup>b</sup> Likert-scale question from strongly disagree (1), slightly disagree (2), neither disagree or agree (3), slightly agree (4), and strongly agree (5).

<sup>c</sup> Likert-scale question from strongly decrease (1), slightly decrease, neither decrease or increase (3), slightly increase (4), and strongly increase (5).

Table 3.4: The *T*-test results of HORT 515 tests from spring 2023 and spring 2024.

| Items Compared                                                                                | T Value | P Value   | df |
|-----------------------------------------------------------------------------------------------|---------|-----------|----|
| 2023 Student GPAs Compared to 2024 Student GPAs                                               | 0.1     | 0.9       | 12 |
| 2023 Crib Card-Allowed Test Scores Compared to 2024 Crib Card-Allowed Test Scores             | 0.3     | 0.8       | 12 |
| 2023 Non-Crib Card-Allowed Test Scores Compared to 2024 Non-Crib Card-Allowed Test Scores     | -0.6    | 0.5       | 12 |
| 2023 Difference in Test Scores Compared to 2024 Difference in Test Scores                     | -2.0    | 0.06      | 11 |
| Crib Card Usage of >3.0 GPA Students Compared to Crib Card Usage of ≤2.9 GPA Students         | 4.0     | 1.0       | 11 |
| Average Test Scores of >3.0 GPA Students Compared to Average Test Scores of ≤2.9 GPA Students | 6.0     | <0.001*** | 11 |

\*, \*\*, \*\*\* significant at 0.05, 0.01, and <0.001 level

Table 3.5. The mean test results of HORT 515 students in the spring of 2023.

| Mean Crib Card<br>Test Score <sup>a</sup> | Mean Traditional Test<br>Score <sup>a</sup> | Difference of<br>Mean Test<br>Scores <sup>b</sup> | Influence of Crib<br>Card Tests on<br>Overall Course<br>Grade<br>Percentage <sup>c</sup> | GPA  |
|-------------------------------------------|---------------------------------------------|---------------------------------------------------|------------------------------------------------------------------------------------------|------|
| ----- % -----                             |                                             |                                                   |                                                                                          |      |
| 76.43                                     | 87.06                                       | -10.64                                            | -3.54                                                                                    | 3.10 |
| 94.40                                     | 94.81                                       | -0.41                                             | -0.14                                                                                    | 4.00 |
| 90.35                                     | 90.63                                       | -0.28                                             | -0.09                                                                                    | 4.00 |
| 90.20                                     | 89.88                                       | 0.32                                              | 0.11                                                                                     | 3.14 |
| 78.85                                     | 78.38                                       | 0.47                                              | 0.16                                                                                     | 2.35 |
| 97.55                                     | 95.00                                       | 2.55                                              | 0.85                                                                                     | 4.00 |
| 93.35                                     | 90.50                                       | 2.85                                              | 0.95                                                                                     | 3.62 |
| 64.35                                     | 60.50                                       | 3.85                                              | 1.28                                                                                     | 2.63 |
| 85.40                                     | 79.50                                       | 5.90                                              | 1.96                                                                                     | 3.52 |
| 88.25                                     | 82.13                                       | 6.13                                              | 2.04                                                                                     | 3.44 |
| 85.10                                     | 78.75                                       | 6.35                                              | 2.11                                                                                     | 3.13 |
| 66.10                                     | 59.38                                       | 6.73                                              | 2.24                                                                                     | 2.66 |
| 96.10                                     | 85.94                                       | 10.16                                             | 3.38                                                                                     | 4.00 |
| 86.10                                     | 73.88                                       | 12.23                                             | 4.07                                                                                     | 2.63 |
| 73.05                                     | 58.00                                       | 15.05                                             | 5.01                                                                                     | 2.27 |
| 65.75                                     | 43.81                                       | 21.94                                             | 7.31                                                                                     | 2.05 |
| Average:                                  |                                             |                                                   |                                                                                          | 3.15 |

<sup>a</sup> Mean scores were calculated using the average of the four tests (quizzes and exams) when crib cards were or were not allowed.

<sup>b</sup> Difference of mean tests score was calculated by subtracting mean traditional test score from mean crib card test score.

<sup>c</sup> Influence of Crib Card Tests on Course Grade was calculated by subtracting the traditional test (i.e., non-crib card exam) mean score the mean crib card test score, then multiplying by 0.33 (the weight of the 4 exams).

Table 3.6. The mean test results of HORT 515 students in the spring of 2024.

| Mean Crib Card Test Score <sup>a</sup> | Mean Traditional Test Score <sup>a</sup> | Difference of Mean Test Scores <sup>b</sup> | Influence of Crib Card Tests on Overall Course Grade Percentage <sup>c</sup> | GPA  |
|----------------------------------------|------------------------------------------|---------------------------------------------|------------------------------------------------------------------------------|------|
| ----- % -----                          |                                          |                                             |                                                                              |      |
| 67.05                                  | 85.88                                    | -18.83                                      | -6.27                                                                        | 3.33 |
| 93.55                                  | 97.50                                    | -3.95                                       | -1.32                                                                        | 3.83 |
| 81.03                                  | 82.63                                    | -1.60                                       | -0.53                                                                        | 2.21 |
| 89.05                                  | 90.00                                    | -0.95                                       | -0.32                                                                        | 3.73 |
| 56.73                                  | 56.25                                    | 0.48                                        | 0.16                                                                         | 2.28 |
| 83.30                                  | 82.25                                    | 1.05                                        | 0.35                                                                         | 2.39 |
| 93.60                                  | 92.50                                    | 1.10                                        | 0.37                                                                         | 4.00 |
| 92.53                                  | 91.13                                    | 1.40                                        | 0.47                                                                         | 3.69 |
| 89.75                                  | 87.50                                    | 2.25                                        | 0.75                                                                         | 2.96 |
| 84.03                                  | 81.50                                    | 2.53                                        | 0.84                                                                         | 2.71 |
| 90.48                                  | 87.88                                    | 2.60                                        | 0.87                                                                         | 3.62 |
| 74.53                                  | 69.63                                    | 4.90                                        | 1.63                                                                         | 2.64 |
| 73.45                                  | 64.75                                    | 8.70                                        | 2.90                                                                         | 3.23 |
| Average:                               |                                          |                                             |                                                                              | 3.12 |

<sup>a</sup> Mean scores were calculated using the average of the four tests (quizzes and exams) when crib cards were or were not allowed.

<sup>b</sup> Difference of mean tests score was calculated by subtracting mean traditional test score from mean crib card test score.

<sup>c</sup> Influence of Crib Card Tests on Course Grade was calculated by subtracting the traditional test (i.e., non-crib card exam) mean score the mean crib card test score, then multiplying by 0.33 (the weight of the 4 exams).

Table 3.7. The linear regression results of student crib card use in HORT 515 by students in both 2023 and 2024.

| Items Compared                                                                                      | Adjusted R <sup>2</sup> | P Value | df  |
|-----------------------------------------------------------------------------------------------------|-------------------------|---------|-----|
| Time Spent Constructing Crib Card Test Compared to Mean Crib Scores (2023)                          | 0.09                    | 0.01**  | 62  |
| Time Spent Constructing Crib Card Test Compared to Mean Crib Scores (2024)                          | 0.01                    | 0.21    | 49  |
| Time Spent Constructing Crib Card Test Compared to Mean Crib Scores (both years)                    | 0.06                    | 0.05    | 114 |
| Time Spent Studying Compared to Mean Crib Card Test Scores (2023)                                   | 0.09                    | 0.01**  | 62  |
| Time Spent Studying Compared to Mean Crib Card Test Scores (2024)                                   | -0.01                   | 0.51    | 49  |
| Time Spent Studying Compared to Mean Crib Card Test Scores (both years)                             | <0.01                   | 0.17    | 114 |
| Mean Crib Card Completeness Rating Compared to Mean Crib Card Test Scores (both years) <sup>a</sup> | 0.194                   | 0.01**  | 27  |

\*, \*\*, \*\*\* significant at 0.05, 0.01, and <0.001 level

<sup>a</sup> At the end of the study, each crib card was visually rated on a 1 to 5 scale based on their “completeness” with 1 = minimal-to-no content and 5 = crib card is completely filled in. There was no evaluation of the content contained within the cards or use of color, organization or diagrams.

Table 3.8. The post-survey results on students perceptions on how they will use crib cards during the semester (2023 and 2024 data was combined).

| Item                                                                                                                                        | Mean              | Standard Deviation |
|---------------------------------------------------------------------------------------------------------------------------------------------|-------------------|--------------------|
| My stress levels were lower during laboratory quizzes and lecture exams that allow the crib cards.                                          | 4.17 <sup>a</sup> | 0.89               |
| I felt more confident during laboratory quizzes and lecture exams that allowed the crib cards.                                              | 4.17 <sup>a</sup> | 0.76               |
| I would prefer to use allowed crib cards in all of my other Horticulture courses.                                                           | 4.38 <sup>a</sup> | 0.98               |
| I would prefer to use allowed crib cards for all of my exams in Basics of Turfgrass Culture.                                                | 4.07 <sup>a</sup> | 1.03               |
| I found the crib cards was helpful in reinforcing and remembering course material.                                                          | 4.34 <sup>a</sup> | 0.67               |
| The crib cards helped me feel I will retain the course information longer.                                                                  | 3.90 <sup>a</sup> | 1.14               |
| Creating the crib sheet helped me organize my thoughts and made studying easier.                                                            | 4.28 <sup>a</sup> | 0.92               |
| Creating the crib cards was fun.                                                                                                            | 2.86 <sup>a</sup> | 0.88               |
| Creating the crib cards was stressful                                                                                                       | 2.34 <sup>a</sup> | 1.01               |
| I did not use the crib cards during exams as much as I thought I would because preparation of the sheet helped me to remember the material. | 3.83 <sup>a</sup> | 1.04               |
| I did not find the crib sheet useful                                                                                                        | 1.59 <sup>a</sup> | 0.68               |
| I found that crib cards ____ my time studying                                                                                               | 3.76 <sup>b</sup> | 0.95               |
| I found that crib cards decreased my stress about the test                                                                                  | 3.93 <sup>a</sup> | 0.96               |

**Comments left by students:**

“I think it helps me ‘plan’ for what I don’t know”

“I hardly ever actually use it”

“Reduced stress over forgetting small details”

“I love having a crib sheet. I feel that it is a way to motivate me to study and get my thoughts in order”

“Its a way to learn [and] dump information that you learned”

“Creating the sheet made me dive into topics I was unsure about and ended up understanding it”

“I thought it was a good way to ensure you study”

“I did not use it as much as I thought, but simply creating it made me study more”

“Makes studying more organized and increased my time spent studying significantly”

“If we got one every time, I think I wouldn’t actually learn, rather just make a good card”

<sup>a</sup> Likert-scale question from strongly disagree (1), slightly disagree (2), neither disagree or agree (3), slightly agree (4), and strongly agree (5).

<sup>b</sup> Likert-scale question from strongly decrease (1), slightly decrease, neither decrease or increase (3), slightly increase (4), and strongly increase (5).

## Appendix

### Appendix A - Chapter 1

Appendix Table A.1. Homeowner living areas.

| <b>How would you describe where<br/>your home is located?</b> | <b><i>n</i></b> | <b>%</b> |
|---------------------------------------------------------------|-----------------|----------|
| Urban                                                         | 420             | 37.0     |
| Suburban                                                      | 366             | 32.2     |
| Small town                                                    | 163             | 14.3     |
| Rural                                                         | 187             | 16.5     |

Appendix Table A.2. Homeowner water sources.

| <b>What is your primary water<br/>source?</b> | <b><i>n</i></b> | <b>%</b> |
|-----------------------------------------------|-----------------|----------|
| Community well                                | 80              | 7.0      |
| Municipal water                               | 712             | 62.7     |
| Private well                                  | 320             | 28.2     |
| Other                                         | 24              | 2.1      |

Appendix Table A.3. Land-grant university attendance.

| <b>Item</b>                             | <b><i>n</i> Yes</b> | <b>% Yes</b> | <b><i>n</i> No</b> | <b>% No</b> |
|-----------------------------------------|---------------------|--------------|--------------------|-------------|
| Did you attend a land-grant university? | 176                 | 15.5         | 960                | 84.5        |

## Appendix B - Chapter 2

Appendix Table B.1. Turfgrass species maintained by all practitioners (when applicable)

| <b>Turfgrass species</b> | <b><i>n</i></b> | <b>%</b> |
|--------------------------|-----------------|----------|
| Annual bluegrass         | 51              | 8.1      |
| Annual ryegrass          | 16              | 2.6      |
| Bermudagrass             | 93              | 14.8     |
| Buffalograss             | 7               | 1.1      |
| Creeping bentgrass       | 86              | 13.7     |
| Fine fescues             | 36              | 5.7      |
| Kentucky bluegrass       | 86              | 13.7     |
| Perennial bluegrass      | 22              | 3.5      |
| Perennial ryegrass       | 66              | 10.5     |
| St. Augustinegrass       | 4               | 0.6      |
| Tall fescue              | 96              | 15.3     |
| Zoysiagrass              | 55              | 8.8      |
| Other                    | 9               | 1.4      |

## Appendix C - Chapter 3

Appendix Table C.1. The number of times students used crib cards and whether they got the question correct or not, sorted by GPA.

| Crib Card Used,<br>Correct | Crib Card Used,<br>Wrong | No Card Use,<br>Correct | No Card Use,<br>Wrong | GPA  |
|----------------------------|--------------------------|-------------------------|-----------------------|------|
| 30 <sup>a</sup>            | 17                       | 100                     | 64                    | 2.05 |
| 27 <sup>b</sup>            | 15                       | 109                     | 14                    | 2.21 |
| 40 <sup>a</sup>            | 15                       | 104                     | 52                    | 2.27 |
| 16 <sup>b</sup>            | 23                       | 84                      | 42                    | 2.28 |
| 78 <sup>a</sup>            | 36                       | 81                      | 16                    | 2.35 |
| 76 <sup>b</sup>            | 14                       | 61                      | 14                    | 2.39 |
| 118 <sup>a</sup>           | 14                       | 60                      | 19                    | 2.63 |
| 26 <sup>a</sup>            | 18                       | 102                     | 65                    | 2.63 |
| 15 <sup>b</sup>            | 4                        | 115                     | 31                    | 2.64 |
| 31 <sup>a</sup>            | 1                        | 102                     | 77                    | 2.66 |
| 29 <sup>b</sup>            | 8                        | 107                     | 21                    | 2.71 |
| 29 <sup>b</sup>            | 2                        | 121                     | 13                    | 2.96 |
| 58 <sup>a</sup>            | 19                       | 99                      | 35                    | 3.10 |
| 76 <sup>a</sup>            | 9                        | 98                      | 28                    | 3.13 |
| 47 <sup>a</sup>            | 4                        | 138                     | 22                    | 3.14 |
| 26 <sup>b</sup>            | 14                       | 97                      | 28                    | 3.23 |
| 20 <sup>b</sup>            | 14                       | 98                      | 33                    | 3.33 |
| 68 <sup>a</sup>            | 16                       | 107                     | 20                    | 3.44 |
| 51 <sup>a</sup>            | 7                        | 140                     | 13                    | 3.45 |
| 117 <sup>a</sup>           | 14                       | 54                      | 26                    | 3.52 |
| 28 <sup>b</sup>            | 4                        | 122                     | 11                    | 3.62 |
| 5 <sup>b</sup>             | 2                        | 147                     | 10                    | 3.69 |
| 56 <sup>b</sup>            | 6                        | 92                      | 11                    | 3.73 |
| 45 <sup>b</sup>            | 2                        | 110                     | 8                     | 3.83 |
| 20 <sup>a</sup>            | 0                        | 172                     | 19                    | 4.00 |
| 101 <sup>a</sup>           | 4                        | 84                      | 22                    | 4.00 |
| 14 <sup>b</sup>            | 1                        | 139                     | 11                    | 4.00 |
| 17 <sup>a</sup>            | 0                        | 184                     | 10                    | 4.00 |
| 9 <sup>a</sup>             | 1                        | 189                     | 12                    | 4.00 |

<sup>a</sup> Indicates 211 questions administered.

<sup>b</sup> Indicated 165 questions administered

Appendix Table C.2. The mean test score of crib card allowed tests and the average rating of card density on a scale from 1 to 5, sorted by mean test scores for both years.

| <b>Mean Crib Card Test<br/>Score<sup>a</sup></b> | <b>Mean Crib Card<br/>Completeness Rating<sup>b</sup></b> |
|--------------------------------------------------|-----------------------------------------------------------|
| -----%-----                                      |                                                           |
| 56.7                                             | 3.8                                                       |
| 64.4                                             | 2.3                                                       |
| 65.8                                             | 3.0                                                       |
| 66.1                                             | 4.5                                                       |
| 67.1                                             | 4.0                                                       |
| 73.1                                             | 1.8                                                       |
| 73.5                                             | 4.8                                                       |
| 74.5                                             | 2.0                                                       |
| 76.4                                             | 3.0                                                       |
| 78.9                                             | 4.5                                                       |
| 81.0                                             | 4.8                                                       |
| 83.3                                             | 4.8                                                       |
| 84.0                                             | 3.5                                                       |
| 85.1                                             | 5.0                                                       |
| 85.4                                             | 5.0                                                       |
| 86.1                                             | 4.5                                                       |
| 88.3                                             | 3.8                                                       |
| 89.1                                             | 4.5                                                       |
| 89.8                                             | 3.5                                                       |
| 90.2                                             | 2.8                                                       |
| 90.4                                             | 5.0                                                       |
| 90.5                                             | 4.3                                                       |
| 92.5                                             | 4.3                                                       |
| 93.4                                             | 4.5                                                       |
| 93.6                                             | 4.5                                                       |
| 93.6                                             | 4.5                                                       |
| 94.4                                             | 5.0                                                       |
| 96.1                                             | 4.8                                                       |
| 97.6                                             | 4.8                                                       |

<sup>a</sup> Mean scores were calculated using the average of the four tests (quizzes and exams) when crib cards were or were not allowed.

<sup>b</sup> Crib cards were rated on a 1 to 5 scale with 1 being very little on the card and 5 having written content on most of the card. No actual evaluation of the content contained in the card was evaluated.