

Extension Education

Enhancing Production Efficiency and Farm Profitability Through Innovative Engagement Teaching and Programming

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Abstract

Recognized by Western Agricultural Economics Association (WAEA) and Agricultural and Applied Economics Association (AAEA) as an innovative adult education (Extension/outreach) program. Testing Agriculture Performance Solutions (TAPS) was developed at the University of Nebraska-Lincoln's (UNL) West Central Research, Extension, Education Center (WCREEC) in North Platte, NE. This program was created to enhance Extension education by increasing stakeholder engagement and commitment. This engagement comes in the form of a series of season-long contests, the application of andragogical principles, and the support of Extension programming and materials. Four key groups make this program viable: facilitators, competitors, integrators, and followers. This program is hosted and maintained by the university facilitators, with help from integrators and agribusinesses. Competitors make production and management choices recorded and acted upon by the facilitators, with reports and publications made available to all, including followers. This paper describes the reasoning and application of the program with accompanying feedback by competitors. The current program focuses on farm profitability in conjunction with nitrogen and irrigation efficacy and efficiency. While the program is effective, it is costly and requires special resources that are limited. To address these issues, a virtual version is being developed. This new virtual TAPS will increase flexibility and reduce costs, making it more accessible and useful.

1 Introduction

The Testing Agriculture Performance Solutions (TAPS) program was created by the University of Nebraska-Lincoln (UNL) research and Extension professionals at the West Central Research, Extension, Education Center (WCREEC), located in North Platte, Nebraska, to better match the education modalities of its clientele, adult learners. Traditional Extension meetings are great tools for sharing information quickly and widely but generally lack the individual engagement required for learning to become an internally driven process. TAPS is much different from most of the methods employed in modern Extension education. This program came about as a result of the desire to focus on what individual farm managers needed to help them increase their skills and knowledge to successfully operate a farm business in a time of increased regulation, volatile markets, and many production risks. The need to create an environment that is conducive to exploring, testing, applying, and creating new ideas; thinking deeper; and improving operation methods and management skills is a self-evident fact of living in the modern world. While the TAPS program is new, the concepts behind it are not. These concepts are andragogical, adult education-oriented.

Frederichs (2018) efficiently summarizes what she calls the six principles of Malcom Shepard Knowles andragogical theory. These principles encapsulate many of those found in the TAPS program: (1) adults are self-directed learners, (2) their accumulated experience becomes an increasingly rich resource in learning, (3) readiness to learn is related to their social role, (4) they desire immediate

application of knowledge, (5) they tend to be self-motivated, and (6) they expect to find a reason to learn something.

To identify and functionally implement an anthropological approach, Maryellen Weimer (2002), author of *Learner-Centered Teaching*, suggests five key changes to practice. Part One of her book specifically focuses on classroom teaching and uses some radically motivated ideas, but her points about effectively using methodology that empower students is relevant to the principles behind the TAPS program. These five keys are listed by Chapters in the book and are most applicable to Extension teaching and/or programming. Here are the five changes she suggests:

- (1) “The Balance of Power” ” (p. 23).
The TAPS program by its nature changes the role of the learner to a free competitor so that they have more freedom to explore knowledge and/or skills they feel are relevant to their needs.
- (2) “The Function of Content” ” (p. 46). She indicates students need to have some control of what they are to learn. This aids their empowerment, or buy in. This changes the focus of learning to teaching how to learn rather than what to learn. The TAPS program leaves the learner responsible for what they wish to learn providing a lab.
- (3) “The role of the Teacher/Instructor.” (p.72). She shares her view that the role of the instructor should shift from center stage to the sidelines, where they coach and empower, not direct. TAPS has no instructors. The university plays a role by competing using the latest research recommendations. In addition, the university provides information and opportunities for individuals to further their knowledge.
- (4) “The Responsibility for Learning” (p. 95). Shifting this from the instructor to the student provides accountability. With no curriculum, and no formal discussions about what to do, competitors are left to pursue answers and solutions to increasing productivity, profit, or efficiency as they choose. This makes the outcomes relatable to the individual participants.
- (5) “The Purpose and Process of Evaluation” (p.119).
Weimer alludes to the importance of evaluation as a process when internalized by students, becomes native to the experience more is learned by them. Competitors’ performance is based on real outcomes. The evaluations on performance are internal to each participant, based on what they set out to accomplish by participating. An annual report is published where competitors are able to compare and evaluate their performance as well as their peers.

The idea of andragogy is to match teaching methods with learner type. The TAPS program does just that. TAPS is about increasing the effectiveness of learning, building skills, instilling competence, and creating understanding of the crop production business. At the center of the program is a real-time physical gamulation, a term used to identify a game that incorporates simulation.

This paper chronicles the why, what, and how of the program by describing its components and methods, with limited discussion of the theoretical and a smattering of some recently obtained survey feedback. The intention is to share this unique and successful program in such a way that readers can evaluate it and, if so inclined, emulate it. However, any adoption of TAPS is likely to require adjustments to localize it, depending on the situation and needs of the user. This work is a recipe, an explanation, and evidence of the program wrapped into a single document.

1.1 TAPS Core Programming

The core idea of the TAPS program is for participants to experience a series of real-life, real-time critical farm production and management choices for a complete season in a competitive environment. This

format encourages participants to perform at their best. It is expected they will use tried and true knowledge and develop, learn, copy, and experiment with new ones. All decisions and the resulting outcomes are recorded, measurable, and comparable, providing a way to benchmark, adjust, and learn new things, especially if they compete over multiple seasons. The competitions are held on scientifically controlled plots and include various crops, such as corn, wheat, cotton, soybeans, and sorghum. Some of the competitions are irrigated and others rainfed.

To illustrate how the TAPS program works, the framework of the sprinkler irrigated corn competition, held in North Platte, Nebraska, is presented. This contest focuses on six decision types: the purchase of crop insurance, hybrid selection, specifying planting population, nitrogen (N) fertilizer application(s), irrigation application(s), and the use of market tools to dispose of all grain. Marketing may be executed in five different ways. Four of these methods are a form of preharvest pricing or sales: (1) futures contracts, (2) forward cash pricing, (3) hedge-to-arrive, and (4) basis contracts. The remaining marketing method is spot cash sales, which all occur after harvest. Annual TAPS competitions start in March and conclude at the end of harvest, generally in November. Multiple field days, a kick-off event, and an end-of-year banquet comprise the rest of the yearly schedule. Each competing team's farm consists of three replicated plots, which total less than half an acre. These plots are located at UNL's WCREEC and are overseen by university faculty, staff, and graduate students associated with the TAPS program.

The TAPS sprinkler corn competition budget and results represent an amplified 3,000-acre irrigated corn farm in North Platte, Nebraska. Competitions vary in amplification depending on the contest and crop type. Amplification provides adequate scale to make both costs and revenue choices worth considering carefully. It brings home the point that small decisions make real differences. Costs are based on the current year's localized production costs. This is done by modifying the appropriate values of the current year's UNL crop budget to match the local area practices and productivity. The budget fixes the cost of machinery, land, and many of the standard operation costs of running a 3,000-acre farm. The costs relating to each team's decisions—such as insurance, seed hybrid, water, and fertilizer as well as grain transportation and drying costs—vary according to their actual use and productivity of the individual teams. Throughout the season, competitors confidentially make their decisions via a portal. This portal is an interactive website that shares real-time information about their farm, such as recent and current soil water status, field conditions, aerial photos, real-time photographs, field weather. One of the underlying benefits of competing is access to some of the current and new technology used on modern farms, including several kinds and makes of electronic soil water sensors, plant sensors, drone flight information, and leaf tissue analysis. At the end of the competition, much of this information becomes available to all as part of an annual report. Each competitor is tracked and reported on using assigned farm numbers. This helps maintain competitor anonymity.

TAPS awards three cash prizes in each of its crop competitions. The award categories focus on three different critical outcomes: (1) most profitable, (2) highest input use efficiency, and (3) greatest yield. Competitions provide a scientifically controlled environment, resulting in an even playing field for competitors to individually decide on what they wish to focus. The three awards provide incentives and relate to the decisions needed to win in a specific area. As with so many things in this world, value is measured in dollars and cents. The use of profit provides a benchmark. Each farm can easily judge how their decisions affected yields, water, and N efficiency in terms of the resulting profit level and rank. The key to profitability is understanding productivity, the cost, and return of the inputs (efficiency) with the implementation of successful marketing. Not unexpectedly, appropriate cost control results in a high degree of resource efficiency, in terms of water and nitrogen fertilizer use, but too much control has a negative impact on productivity. Focusing just on efficiency has a similar outcome. At a certain input level, ever-increasing units of added N fertilizer and water have an ever-diminishing effect on productivity, which increases costs of additional units produced. Knowing what those levels are

provides the basis for making sure that each added unit of N does not cost more than the value of the production it created.

This past year there was an interesting example; Farm 18 was ranked first in efficiency, had the lowest cost per bushel, and ranked third in yield but was not the most profitable. Revenue was the problem; this team's revenue per bushel was ranked 32 out of 37 competitors. They had \$160/acre less revenue than the top ranked farm. Producers have the choice to choose their objective; they can strive for the most production, try to be the most efficient, seek the highest profit, or work at some combination of yield, efficiency, and profit. This is the point of TAPS; individual competitors decide what is most important to them. From this example, it is easy to see the value of marketing in obtaining profitability; for many, it becomes a focal point. Cost control and high productivity and efficiency can take competitors only so far. Nearly 75 percent of the grain produced in the TAPS subsurface irrigated (SDI) corn contest in 2023 was marketed at harvest; 47 percent of the 75 percent had been hedged with futures, and the remaining 53 percent was sold without the use of a forward pricing tool. The profit winner was not one of the competitors that chose not to use a forward pricing tool. This is consistent with the Farm Credit Services (2017) survey report. The fickle and abstract nature of markets, the overwhelming physical demands of running a farming operation, never enough time to do everything, a focus on factors that can be better controlled (e.g., input costs), a lack of infrastructure to store grain, and/or the high cost of commercial storage may all contribute to the fact that a portion of producers sell their production at the season's most likely lowest prices. In discussions with producers, it is noted that many have little or no trouble jumping into the hands-on physical needs of farming but often display less enthusiasm toward the business management side of their operations.

Table 1. Selected information gleaned from the TAPS 2018 year-end participant survey

Response	Question
79.4%	TAPS increased recognition of maximizing profit, requiring both business and agronomic skill
76.5%	Now look for marketing opportunities
73.5%	Now look for more preharvest or early sales opportunities
73.5%	Now wish to utilize the futures market in some way
70.6%	Now look forward to contracting grain
70.6%	Have consequently changed how they market grain on their own operation
55.9%	Increased understanding of the role of crop insurance in overall marketing

Notes: (Author files, 2018 Year-End Program Evaluation)

At the conclusion of the 2018 year's contest, a set of questions was asked as a measure to look for program impact. Some of the results focused on marketing, with the outcome listed in Table 1. This first poll was an early effort used for Extension reporting and internal purposes. It is an indication that TAPS during that period was shown to have a positive impact on the view and intended action producers intend to practice marketing based on their TAPS experience. The TAPS program has brought home just how important marketing is to farm business success. This fact has reinforced the programs' continued use and inclusion of profit as an award and metric. This survey and others have led to developing a more

formal and thorough study of TAPS impacts. A more comprehensive study of TAPS impacts was done in 2022 by Stephanie Kennedy and Mark Burbach (2022), with funds provided by the Nebraska Corn Board.

Besides winning awards, other activities and actions contribute to the socialization and education of the whole TAPS community. This includes the interactive website or portal that provides communication, past and current contest reports, decision input, a monthly newsletter, a written series of educational articles known as “Tips from TAPS,” and other information and announcements as needed. Once a year, a kick-off meeting is held for the contests. These meetings in the past have included technology updates, technology show and tells, tours of unique agricultural enterprises, selection of technology and insurance decisions, an evening meal, and account verification into the TAPS portal. During the year, one or two field days and/or an open house are typically held. These events are an opportunity for competitors to network with competing teams and provide educational opportunities (e.g., panel discussions, updates, special presenters). The end-of-year celebration (banquet) is the most highly attended event. At this event, the results of the contest are revealed and discussed, and awards are given. It is at this event that a complete printed report is made available. This report is later peer reviewed and published as an official Extension report and made available to the public, both as a physical and electronic document. Previous reports are available on the website.¹

1.2 TAPS Inception

The concept of a farm management competition evolved from a multidisciplinary discussion about ways of increasing the effectiveness of the university’s Extension efforts related to irrigation, water conservation, nutrient management, technology adoption, marketing skill development, and overall farm management capability. Traditional methods of Extension are generally extrinsically driven and didactic (lecture-based) in nature. Like any tool, they work well when used appropriately, typically to disseminate lots of information in a very short time, but are limited when trying to effectively create producer introspection and intrinsic learning, particularly at high levels of engagement. To help individuals achieve this intrinsic mode of learning and increase clientele engagement, the TAPS creators recognized seven objectives:

- (1) Clientele must remain a committed part of the process (Knowles 1978).
- (2) Adult, or andragogic, learners are action-oriented and often learn readily from other methods of education, such as experiential and peer methodologies (Knowles 1978; Fornaciari and Lund Dean 2014, pp. 702–703).
- (3) Clientele are not always convinced that the research information presented by the university applies to their situation, nor do they buy into the university’s assumptions (Knowles 1978).
- (4) When agricultural producers are treated strictly as clientele, students, target audiences, or learners, the university loses opportunities for valuable feedback and access to the mastery of skill(s) that this demographic possesses, as experts within their field(s).
- (5) Many producers have operational adoption risk and are reluctant to immediately trust new research or methods. This hesitancy to adopt new practices is well evidenced through interaction with producers. According to Seivold, Leifer, and Ulman (2006, p. 4), this risk “is defined as the risk of loss resulting from inadequate or failed internal processes, people, and systems or from external events.”

¹ <https://taps.unl.edu/unl-taps-report-archive/>

- (6) Traditional education programs often ignore or undervalue private-sector involvement, such as technology companies, equipment manufacturers, service companies, all of which have a vested interest in producer success, especially productivity and profitability.
- (7) While the university has an established reputation of unbiased research activity and seeks academic acclaim, real-world credibility remains suspect to many stakeholders. This reputation is helped by getting into the proverbial trenches with producers.

To address these seven challenges, TAPS was conceptualized and implemented. Creating and maintaining TAPS requires many resources and the involvement of diverse groups, as it is neither inexpensive nor effortless to implement. Herein lies one of the most valuable components of TAPS, both in theory and practical application. Participant learning is strongly enhanced by the program's carefully constructed social networking opportunities, built upon this diverse network of individuals. The university provides scientific and competitive control, physical location, land and infrastructure, farming and irrigation equipment, and support staff. Local farmers, equipment manufacturers, dealers, and service companies have contributed many resources and have a vested interest in the program, as they continue to provide some of the equipment, supplies, and knowledge. Some of these resources have a long, useful life, whereas others do not, as some are of a single use nature, and therefore require annual replacement or renewal. Many of these short-lived resources are provided by these partners, as either in-kind or monetary donations. The program is dependent on the generosity and continued enthusiasm of individuals, companies, organizations, participants, and others who choose to be involved. The program in turn strives to regularly gauge stakeholder wants, needs, and requests, continually working at strengthening its andragogical and experiential nature. The different publications and other media generated by TAPS play an important role as feedback, professional analysis, and educational materials to participants and nonparticipants alike. The current listing of the TAPS sponsors, partners, competitions, guidelines, and other related materials are available at the website.²

1.3 Program Objectives

The TAPS program seeks to address the seven identified issues by fulfilling five primary objectives:

- (1) Facilitate growers' discovery and adoption of new and emerging knowledge, as related to efficient and profitable agricultural production and management.
- (2) Create a financially safe environment for testing, observation, experimentation, and implementation of new and emerging technologies, including management and production techniques.
- (3) Create an atmosphere of excitement and competition, using andragogic learning processes.
- (4) Create a forum among stakeholders for collaboration, communication, and focus within the agricultural production sector, to face current and future challenges related to farm productivity and success.
- (5) Maintain making new discoveries, ensure information integrity, and faithfully share, report, and distribute outcomes, methods, and strategies to all active and latent stakeholders, creating an engine of education, positive change, and innovation.

² <https://taps.unl.edu/about/>.

2 Operational Components

There are ten primary operational components within the program classified into three categories or groups. Table 2 lists these components and their classifications. The three categories are (1) events (meetings and planned group activities), (2) facilities (land, equipment, technology, etc.), and (3) bodies (the people of TAPS).

2.1 Events and/or Activity Types

The three types of events discussed, shown in Table 2, items 1–3, contribute much to the success of the TAPS program. They are centered around participant interaction, educational opportunities, and relationship building. These event activities provide the proper atmosphere to drive competition, enhance the experiential learning processes, and facilitate peer-to-peer interactions. The social and educational gatherings, such as the kick-off meeting, field days, banquet, and debriefings, present and share knowledge, gather feedback, and present scientific analysis. Competing teams often have their own meetings, which vary according to the group and their needs. Teams that have many partners

Table 2. The list of the ten TAPS operational components and their respective categories

Component Name	Classification/Type
1. Social and education gatherings	Event
2. Individual and/or team decision-making	Event
3. Evaluations, reports, analysis, project summaries, and information sharing	Event
4. Production space (physical plots)	Facilities
5. Communication hub/portal (TAPS website)	Facilities
6. Equipment, buildings, technology, etc.	Facilities
7. Facilitators*	Bodies
8. Competitors*	Bodies
9. Integrators*	Bodies
10. Followers*	Bodies

Notes: Author files, 2018 year-end program evaluation. * Indicates additional explanation in Section 2.3

generally have more meetings, while individuals may seek other means to build strategies and actions. Some teams meet on a regular basis, others meet intermittently, and some have other means of communication. The multiplayer teams often get together and discuss the upcoming decisions and reflect on their progress. The banquet and debriefing meetings are the culmination of the season's competition decisions and results and provide an opportunity to reflect on the outcome, ask/answer questions, investigate some of the why questions, and, for competitors, benchmark their performance. These meetings are guided by facilitators. The kick-off meeting is often combined with a local tour of relevant agricultural businesses. So far TAPS has toured the Bayer water center in Holdridge, Nebraska; Ward Labs in Kearney, Nebraska; and Corteva seed facility in Doniphan, Nebraska.

During the kick-off meeting, competitors are assigned a farm number, obtain a password, are given updates on the rules of the competition, and meet facilitators and integrators. The first decisions for this contest are hybrid selection, seeding rate, pre-plant fertilizer, and insurance. These choices are due within a few days of the kick-off event. Field days are a chance to meet with technology suppliers and visit the grow site. These fields also include presentations about relevant topics (e.g., irrigation, N fertilizer). The banquet is the place where everyone gets to enjoy being social and celebrate the

completion of another season. This has been done by sharing a special meal accompanied by the announcement of the results and the recognition to the winners and supporters of the program.

During the year, a newsletter is periodically sent electronically to competitors, integrators, and followers. The written annual report is made available at the banquet and includes summarized data of decisions and results. This information is presented by assigned farm numbers. “Tips from TAPS” is a focused series of articles written by or about someone active in TAPS, sharing what they have learned, what they think is important to a specific decision or topic, and something relevant to the current season or situation. This provides food for thought to competitors and followers.

2.2 Physical Facilities

While TAPS events create opportunities for educational interaction, the physical components and facilities, such as the competition farm site(s), provide experimental and experiential workspace for studying input effects, output production, and facilitation of communication, and ensures reliability, realism, detail, and consistency among competitors. Both the events and the facilities are necessary for a successful TAPS experience. Without scientific control with identified and measurable factors, true competition cannot be realized. How can one compare the individual results when the economic conditions and opportunities, soil type, planting date, harvest date, and environmental conditions are not the same? Using scientific methods such as the control of physical factors ensures that variations in outcomes are purely due to only the factors under the competitor’s control (e.g., irrigation, marketing, insurance, fertilization, hybrid selection, and planting density). The actions of individual competitors are made transparent at the conclusion of the season by farm numbers only. This privacy allows for decisions to be made without undue peer pressure. However, in the end, transparency makes it possible to make true comparisons among the individual farm’s performance. The programs’ methods of operation legitimize making direct comparisons among farms, ranking them, creating benchmarks, and relating individual farm performance to the choices of their operators and are the basis for constructive discussions, insightful analysis, and individual introspection.

2.3 Participant Types

TAPS is intended to be an experiential journey among participants. The four participant types are identified with an accompanying description:

- (1) *Facilitators* are all personnel who plan, direct, and work to make TAPS successful. While the program itself is directed by the executive committee, others provide much needed help including the program manager, university scientists, specialists, administrators, Extension educators, technicians, and other staff, who assist in facilitation, implementation, and documentation of TAPS.
- (2) *Competitors* are individuals and/or teams who compete in any TAPS competition. While anyone can participate, it is understood that participants who find the most value are those who are or will be engaged in the production agriculture industry or related field. To date, the program has enrolled competitors who are farmers, agricultural businesspeople, members of agriculture-related nongovernmental organizations (NGOs), and/or governmental organization/agencies related to agriculture, high school, and collegiate agricultural teachers and students. TAPS is focused on innovative and experiential agricultural production education, although its programming remains inclusive, and anyone who could benefit from competing (whatever their background) is encouraged to participate.

- (3) *Integrators* are associated individuals, companies, and organizations with a vested interest in TAPS. This group includes any technology that relates to agriculture production, any associated agriculture services and support organizations, agriculture regulatory agencies, and other agricultural and aligned businesses that collaborate with and invest in the success of the program.
- (4) *Followers* are individuals or groups that benefit from the information and results generated by the TAPS program. This could include noncompeting producers, competitor's neighbors, and any other stakeholder. These followers benefit from reports, articles, field days, educational programs, and their interaction with facilitators, competitors, and integrators.

3 Conceptual Underpinnings

There are four foundational components behind the TAPS program that make it successful. These components are (1) motivation and competition, (2) experiential learning, (3) peer-to-peer interaction, and (4) socialization. These components are again andragogic in orientation and provide a nurturing environment of self-motivation, provide self-reliance in learning, and promote adaptive management concepts (Knowles 1978). According to Knowles (1978), andragogy is focused on how to effectively teach adults, based on the way adults learn. These components play a key role in the TAPS program design and as indicated, are theoretically and practically consistent with adult education. Knowles, Holton, and Swanson (2015) outlined six assumptions of andragogy that can be found in the TAPS program. The adult learner must be able to clearly understand the need to learn specific knowledge or skills. The adult learner focuses on self-conception, which requires seeking control over one's own life (Knowles, Holton, and Swanson 2015). Accordingly, the adult learner "must incorporate their lived experiences into new learning opportunities and be ready and willing to learn, possess an orientation to learn, as well as the motivation to seek new knowledge and skills" (Knowles, Holton, and Swanson 2015, p. 6).

Land-grant institutions, by nature, typically follow a much more pedagogic educational approach, where experts, such as researchers and Extension personnel, feel obliged to bring about change by setting curriculum and continue using traditional lecture-based instruction. This approach is very much in the pedagogical camp; however, most individuals who participate in learning opportunities through Extension prefer active and experiential learning (Downing and Finley 2005, Figure 3). Actively participating as a learner, while simultaneously sharing with others via one's own collected knowledge, is andragogic. This is increasingly evident, as over time adult learners have become more educated and sophisticated in their knowledge and increased skill sets compared to their forebears. Though adult learners seek new knowledge, methods, and skills, as all students do, it should never be overlooked that every adult learner already possesses a lifetime of these same assets, which is advantageous to all others involved in the same andragogic educational process and should therefore be utilized and not ignored in the process of learning (Knowles 1978).

3.1 Motivation and Competition

Daniel H. Pink, author of books in business and human behavior, claims that if one wants to create motivation for complex and cognitive tasks, three things are required of participants: autonomy, mastery, and purpose (Pink 2009). According to Pink (2009), people are motivated by autonomy, establishing engagement as the result of independently directing oneself. This relates directly to the experiential learning embodied in each TAPS competition, as competitors are autonomous in their six management decisions and free to focus efforts on learning, as they individually see fit. Individual teams have the autonomy to develop their own strategy, make their own decisions regarding every phase of

production and marketing, and use the technologies of their choosing. Conceptually, autonomy is in line with all the andragogic premises discussed.

Mastery is a second motivational key. Pink (2009) suggests that it is natural for people to find fulfillment in accomplishment, progression, and performing well. TAPS contestants are similarly recognized for their achievement, as awarded for being the most profitable, most efficient, and/or most productive. Another way that mastery is validated and encouraged by TAPS is peer-to-peer recognition and respect. The very act of competing provides participants a certain measure of validation with respect to their individual mastery. TAPS competitors openly learn from others, compete against people they respect within their occupational field(s), and openly demonstrate their own skills and knowledge. Competing peer-to-peer naturally culminates in the motivation to achieve and demonstrate mastery.

The third motivating factor is purpose. Observationally, people generally seize an opportunity and enjoy contributing toward making a difference. Arguably, this is likely one of the reasons performing public service is widely done, despite its occasionally overwhelming challenges. These feelings, in turn, often seem closely tied to recognition and self-fulfillment (Pink 2009). TAPS contests provide purpose as well as recognition of mastery. Two programmatic aims are first finding solutions to challenges they individually face on their farm and second the pursuit of solutions common to their industry. Contributing to finding these solutions is purposeful. There is purpose in being profitable, to care for loved ones' needs. There is purpose in being part of the effort to find ways to ward off the ever-growing threat of world hunger and promote worldwide food security. Participants can directly translate knowledge from TAPS competitions to their own individual operations, which creates a powerful purpose. The more competitors feel purpose, the more likely they are intrinsically motivated to be engaged and focused on their involvement, helping them take more seriously the available learning and skill building opportunities TAPS offers.

Each of the three behavioral motivations posed by Pink (2009) is captured by the application of the four TAPS foundational components, including competition, experiential learning environment, peer-to-peer interaction, and socialization. TAPS competitions are more than events that interest the contestants; they reciprocally enhance and enable the experiential and peer-to-peer learning processes and provide additional elements of motivation and learning throughout an expansive occupational community.

3.2 Experiential Learning

At the core of TAPS programming is a devout belief in experiential learning and its benefits, particularly for adult learners. As has been previously explored, the contrast of pedagogy and andragogy is resolute and requires attention and flexibility in educational endeavors of the adult learner. "In its simplest form, experiential learning means learning from experience or learning by doing. Experiential education first immerses learners in an experience and then encourages reflection about the experience to develop new skills, new attitudes, and/or new ways of thinking" (Lewis and Williams 1994, p. 5).

With TAPS, the experience is the competition, and participants spend an entire crop season experiencing the production, management, and sales of corn for grain. All throughout this experience, reflection and conversation are encouraged and prompted by TAPS personnel. This is done to directly promote the generation, acknowledgment, and acceptance of best skills, methods of thinking, and farm management practices.

The three key concepts that make experiential learning the method of choice, as identified by Moon (2006, p. 165), are:

- (1) "the student [competitor] manages their own learning;
- (2) the relationship between student [competitor] and instructor is different, with the instructor passing much of the responsibility on to the student [competitor]; and

- (3) the curriculum itself may not be clearly identified, and the student [competitor] may have to identify the knowledge they require and then work to acquire it themselves, reflecting on their learning, as they progress.”

In line with many experiential learning characteristics set forth by Chapman, McPhee, and Proudman (1995), TAPS programming strikes a balance between experiential activities and underlying theory. There exists a hybridization in that much of the focus is on the simulated farming competition(s), yet traditional practices remain in the form of meetings, field day events, “Tips from TAPS” articles, annual reporting, research, and reading materials. Similarly, TAPS establishes a safe space for competitors to self-discover. This is evidenced in many ways, including the assignment of anonymous contestant numbers to ensure confidentiality during the competition. Only the winners’ names are revealed, and then only at the season’s end, to present the awards. Of course, participants are welcome and encouraged to discuss their process(es) and results, but programmatically, TAPS reserves the right for each contestant to learn by trial and error without repercussion(s) or judgment(s) from program facilitators, peers, and/or others. Each team has access only to its own management decisions and related information. Special care is taken so that no participant is penalized for or embarrassed by their own learning. Prioritizing relevance to those it serves, TAPS programming ensures that all concepts learned and explored directly correlate to the work, concerns, and interests of modern crop production. For example, TAPS participants are provided with current technology. This technology may be new or different from what they have or use in their home operation. By using it as part of the TAPS competition, they have the opportunity to determine its value and cost. This knowledge is easily transferred to their own farm situation.

Chapman, McPhee, and Proudman (1995) emphasize the importance of adult learners’ need for a correlation between what is learned and real-world application(s) as well as their ability to make these connections for themselves. In many ways, this epitomizes the lifeblood of TAPS programming because competitors are free to apply learned concepts, techniques, knowledge, and technology to their own crop production operation and/or their expertise.

Since TAPS is an andragogic educational program specific to the agricultural industry, all those legitimately involved are likely to be emotionally invested to some degree, whether their individual focus is improving productivity, efficiency, and/or profitability on their own operation; providing better support and resources for farmer clients; developing and improving conservational efforts, familiarization with and implementation of crop production technology, crop and/or soil research, and/or otherwise. Furthermore, the competitive component has been observed to enhance both emotional investment and individual motivation of participants, many of whom have commented to TAPS personnel and others that the program was both valuable and relevant (Chapman, McPhee, and Proudman 1995). This is particularly true for the marketing choices and the management of irrigation and nitrogen decisions, where experiential learning and anonymized comparison and contrast of annual results leads to a natural examination of current thoughts, standard practices, and rules of thumb. A TAPS competitor bears no monetary risk, and the contest environment inherently encourages participants to develop, compare, and consider new ideas, strategies, etc.

Finally, Chapman, McPhee, and Proudman (1995), allude to meaningful relationships as essential for successful, experiential adult learning, and peer-to-peer engagement has been vital for TAPS. The professionals of TAPS and the network of sponsoring specialists and representatives remain happily available to assist in the learning of participants and followers, yet the peer-to-peer interactions between producers have arguably created the greatest impact, even culminating in lasting relationships outside the program’s scope. While only observed, the qualities that successful experiential learning imparts, as identified by Moon (2006, p. 163), are evident among TAPS participants. These qualities are:

- (1) Willingness to reorder or alter individual conception of a topic;
- (2) Self-reasoning and successful defense of individual position;
- (3) Development of clarity of purpose in undertaking tasks and, to a larger degree, the self-management skills necessary to successfully work alone;
- (4) Value of open-mindedness and ability to work with people with different views; and
- (5) Identification of the role that emotion plays in learning, as well as reflection on how the individual gained new knowledge (Moon 2006).

3.3 Peer-to-Peer Learning

Peer-to-peer learning requires learners to increase initiative and take greater responsibility for their own education. In peer learning, students construct their own meaning and understanding of what they need to learn. Essentially, students are involved in searching for, collecting, analyzing, evaluating, integrating, and applying information to complete an assignment or solve a problem (e.g., profit maximizing, increased nutrient and/or water efficiency). Thus, students (competitors) will engage themselves intellectually, emotionally, and socially in constructive conversation to learn through each other's perspectives via a reached consensus or dissention (Boud, Cohen, and Sampson 2001).

Peer learning is optimized when incorporated as an integral component of a curriculum. In this instance, the integral component is a focused, organized effort of various TAPS competitions, which are each a sequential season of many decision points, as each choice potentially alters outcomes. As noted in the introduction with the excerpt from *Learner-Centered Teaching: Five Key Changes to Practice* (2002) by Maryellen Weimer and supported by Fornaciari and Lund Dean (2014, p. 703), "Andragogy principles firmly move power, responsibility, and motivation toward the learner, away from the instructor." Decision-making about and ownership of learning outcomes are shared among students and instructors. Weimer further emphasizes the need for a shift from teacher-centered education to student-centered education at the college level in her book, *Inspired College Teaching: A Career-Long Resource for Professional Growth* (Weimer 2010, pp. 10–11).

Naturally connected to andragogical principles, peer-to-peer learning inherently allows the adult learner to shift their focus from instructor-oriented learning to openly learning from and teaching peers, both within and outside the TAPS program.

In the case of TAPS, the teacher is replaced by the program director and executive team. This group guides competitors and followers by the careful crafting of the rules, preparing and presenting annual results, while emphasizing the relationship between choices and outcomes, writing pertinent articles on selected topics in the newsletter, "Tips from TAPS," and planning and holding group events.

3.4 Socialization

Socialization provides a connection and a sense of being part of a group, which may lead to increased satisfaction and motivation in participating in TAPS. Human socialization provides opportunities to form friendships and to expand one's knowledge and thinking. Socializing often exposes individuals to new and different ideas and to finding those who are of a like mind. Beyond the desire to be social, the TAPS group has a diverse number of participants, including scientists, producers, students, technology providers and salespeople. TAPS provides a unique opportunity to network and learn from outside the normal group you socialize with. This expands the diversity of each participant's circle of associates. These new acquaintances understand something about the decisions and challenges of the crop production business (e.g., production techniques, equipment use, marketing methods, insurance use, irrigation timing). What is gained by socialization depends solely on the circumstances and the

individuals involved. Socialization increases the likelihood that all who participate will be enriched and increasingly motivated (Morin 2021).

4 Programmatic Outcomes

As an ongoing effort by the UNL-TAPS executive team to improve TAPS and to evaluate its impact on producer attitudes, motivations, decision-making processes, and behavior, researchers from UNL's School of Natural Resources completed a survey³ and report (Kennedy and Burbach, 2023, referred to as the KB

report). They applied what they called a convergent mixed methods designed survey. Their stated goal was determine the impact of the TAPS project on participants and their operation. In this design, both quantitative survey data and qualitative interview data are combined as complementary information on the same topic area. Using the different measures provides a clearer picture of impact and "better illuminates the impact that the TAPS program has on participants and their operation" (Kennedy and Burbach 2023, p. 3). Their work was focused on eleven key concepts:

- (1) Behavior related to adoption (actions, intentions, and attitudes),
- (2) Injunctive norms (personal conviction),
- (3) Descriptive norms (popularity),
- (4) Perceived behavioral control of behavior (do they have the necessary skills, equipment, or can they acquire them),
- (5) The value of incentive programs,
- (6) The motivation to compete,
- (7) How TAPS did or did not meet expectations,
- (8) Peer interaction,
- (9) Demographic variables,
- (10) Experiential education, and
- (11) Risk impact.

These eleven concepts directly relate to the four foundational components covered in Section 3 of this paper. The 32-page KBS report has many insights. Readers are encouraged to explore the whole report to gain further detail. This section provides a small portion of the KBS results and is intended to demonstrate who participates in the program and to exhibit a sample of their results.

4.1 Demographics

KBS demographic measures were simple: gender, gross farm income level, acres farmed, and education level. Of those surveyed, 95 percent were male, 2.5 percent female, and 2.5 percent preferred to not say. Gross farm income for 35 percent of those who answered the question exceeded \$1 million, while nearly 30 percent of respondents had between \$500,000 and \$1 million in gross revenue. Nearly 14 percent of respondents indicated a gross farm income of less than \$500,000 and at least \$250,000, with about 19 percent grossing \$100,000 to just under \$250,000, with the remaining 2 percent of responses showing gross income of less than \$100,000. The number of acres farmed by respondents ranged from 120 acres to 7,500 acres, with 50 percent farming more than 1,400 acres. Individual education level was skewed in favor of higher education, with 100 percent having a high school diploma or equivalent, 95 percent having some college, ~83 percent with at least a two-year degree, ~68 percent holding a four-year degree, and 10 percent holding a degree requiring six or more years to complete.

³ IRB (2022)# 20220621967EX.

4.2 Survey Sample Result (Adoption Behavior, Action)

One of the purposes of TAPS is to help producers in their adoption of new technologies and new management practices. Specifically, technologies and management help them increase profitability and nitrogen and water use efficiencies while maintaining high yields.

Two questions within the KBS report directly addressed this topic area (Kennedy and Burbach 2023, p. 5, 6). These statements, posed as response questions, had 44 respondents, with the results illustrated in Figure 1. These two questions are categorized as behavior related to adoption shown by action, listed as Concept (1) on the previous page. The KBS report has other similar questions, found in the full report that focused on respondents’ “intentions” to act and “attitudes” that might help form intentions. The responses were collected by an online survey and were conditioned as actions taken after participating in the TAPS program.

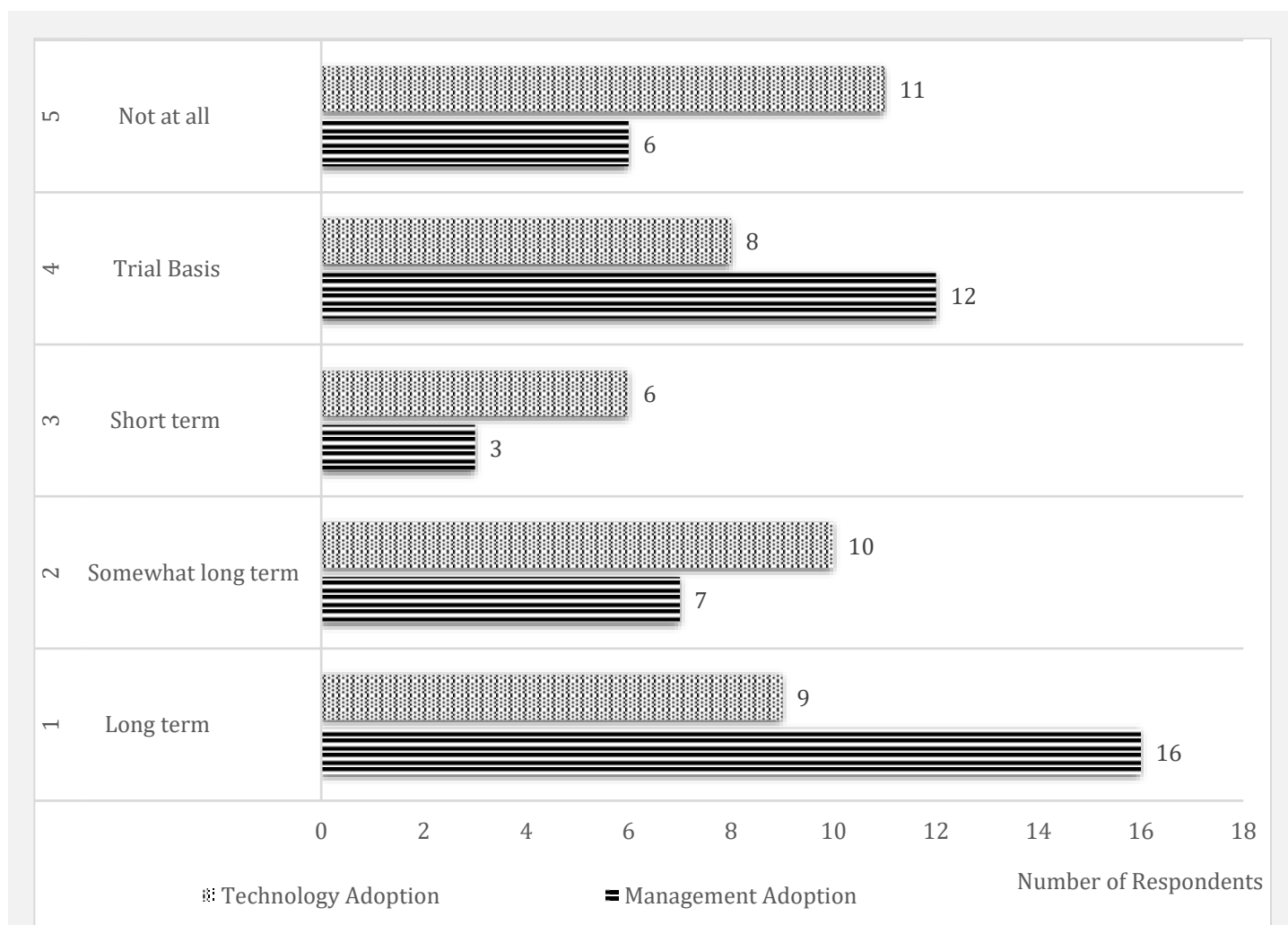


Figure 1. The number of responses for each of the five possible responses to the two statements about the adoption of any new technology and/or new management practices, since the time that the KBS respondents had participated in the TAPS program

Query 1: “I have installed new agricultural technology on some of the land that I farm?”

Query 2: “I have adopted new agricultural management practices on some of the land that I farm?”

There were five possible responses, indicating the status of an adoption made, each indicating the nature of the action: (1) long-term, (2) somewhat long-term, (3) short-term, (4) trial basis, and (5) not at all.

The written survey was followed up with related interview questions. The information from the interview questions helps in understanding the responses and explains some of the reasons behind them, especially those who had not implemented any new technology or incorporated new management strategies. Those who had not adopted new management strategies or technologies on their farm amounted to 24 percent for technology adopters and 20 percent for new management implementers.

The interviews revealed that adoptions had not been made because: (1) they were still experimenting with new technology/management in TAPS, (2) new technology/management did not make sense due to limiting factors on their farm (e.g., geography, water, money), or (3) they had already adopted the new technology/management schemes prior to their TAPS participation. Those that had made changes were asked: what were some of the new management strategies and technologies that they had adopted on their farm since participating in TAPS? These adoptions included different seeding rates, pivot technologies, irrigation application software, soil moisture probes, changes in N fertilizer methods, quantities and timing, and an altering of their marketing strategy.

The KBS report also included respondents’ comments related to these two queries.

Comment 1: “Through our pivot, we realized the benefit that we got on that TAPS corn, we got a yield boost.... So, it changed the practice with our nitrogen management, I would say probably the most” (Kennedy and Burbach 2023, p. 10).

Comment 2: “One of the participants... has a Ph.D. in economics.... Anyway, he kind of helped us with the idea of setting a parameter on when we should start marketing grain throughout the year.... We sat down as a group and decided what the probability was at certain prices, you know, what the likelihood of corn was going to be at a certain date. And so, we said, all right, if corn is X, we want to sell 20%. And if it goes to the next level that we had picked, sell another 20%.... So, we had a lot of grain to market” (Kennedy and Burbach 2023, p. 10).

Comment 3: “I think the main one for me has been with marketing in terms of looking at it from start to finish rather than just at toward the end.... But I understand it better each year and how to use my insurance coverage to try and make sure I’m getting the highest price for at least 30 to 40 percent of it that I can” (Kennedy and Burbach 2023, p. 10).

In addition to the queries on technology and management adoption, eight statements were asked that focused on the motivation to compete in TAPS. Four of those queries/statements are reported here and presented in Figure 2. For convenience and efficiency in writing, the letter “Q” replaces the terms question, query, and statement.

Q1: I participated in TAPS to gain an understanding of new agricultural technology.

Q2: I participated in TAPS to gain an understanding of new agricultural management practices.

Q5: I participated in TAPS so others will view me as a knowledgeable farmer.

Q7: There may be good reasons to participate in TAPS, but personally I don’t see any.

Each of the queries had five possible levels of agreement for survey takers to choose from: (1) completely agree, (2) considerably agree, (3) moderately agree, (4) somewhat agree, and (5) not at all agree. From Figure 2, it is easily seen that Q1 (to learn about new technology) and Q2 (to learn about new management practices) had the most agreement among respondents. The combined average for these two queries was 97.5 percent of the respondents, indicating they somewhat to completely agreed with the two statements. This group almost unanimously expected TAPS to increase their knowledge of new technology and new management practices and served as motivation to join the program. The third listed query, Q5, addresses respondents' belief of how others' perception of them affected their decision to compete. The majority, 51.3 percent of respondents at least somewhat agreed that others' perception of them encouraged them to compete. The remaining 48.7 percent completely disagreed with this idea. Last, Q7 (TAPS has no personal value) was not at all agreed with by 94.5 percent of respondents, with the remaining 5.5 percent having the lowest degree of agreement by somewhat agreeing.

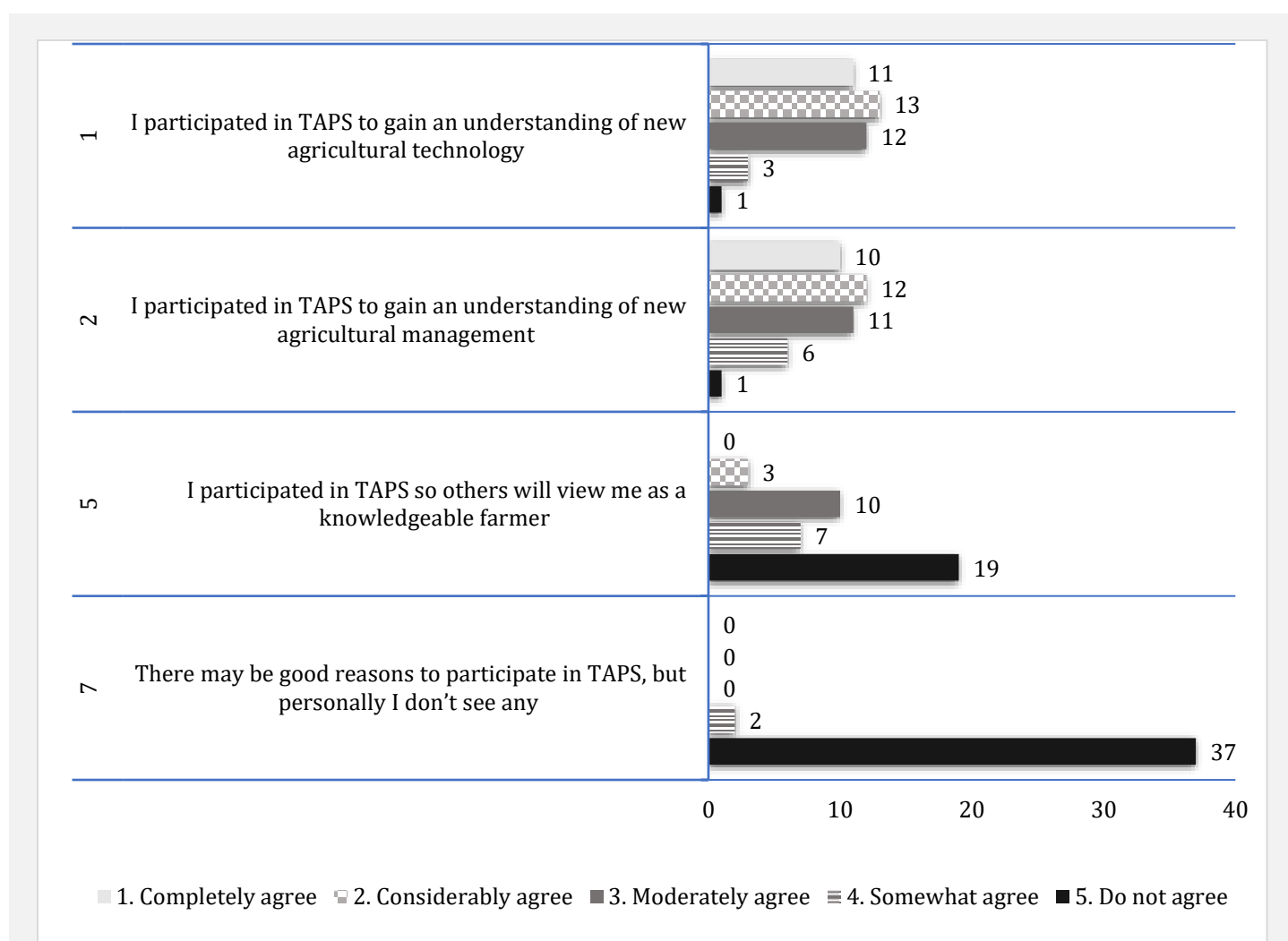


Figure 2. The four queries relating to the decision to compete in TAPS show the number of past competitors for each of the five designated agreement levels

Notes: The first two queries (1 and 2) relate to expected exposure to new technology and management practices. The third statement (5) relates to being positively viewed by others. The fourth and last query (7) relates to the perceived values of TAPS prior to competing

We conclude the discussion of the KBS findings with three competitor quotes.

Attitude change: “The first I think I put on 240 lbs of nitrogen, and I figured I wasn’t going to be anywhere close to where I needed to be. The person that won it went with 180 lbs. So, it blew me out of the water. So that’s kind of when everything changed, the way I looked at things” (Kennedy and Burbach 2023, p. 10).

Easier on their dime: “It’s a lot easier to try it at the TAPS level... [I]f it kind of works up there, then we feel like we can try it on our farm.... But it’s a lot easier to try something on their dime” (Kennedy and Burbach 2023, p. 10).

Keep up or get out: “I think if you’re not looking for new strategies or new ways, then you won’t succeed. I think you’ll just plateau.... Yeah, some things work, some things don’t. But you have got to adapt or you’re not going to stay around too long. I don’t think business-wise” (Kennedy and Burbach 2023, p. 10).

5 Future Planned Endeavors

The TAPS program is in a state of growth and has already expanded into multiple contests at varying locations both within Nebraska and in other states, including Oklahoma, Kansas, Colorado, and Florida.

5.1 Existing Program Expansion

The original sprinkler corn competition was offered at the UNL WCREEC in North Platte, Nebraska, starting in the 2017 season. At this same site, an SDI corn contest and grain sorghum contest have been conducted. Recently, the SDI corn contest has been replaced by a continuous corn (corn planted after many years of corn) contest starting in the growing season of 2024. The grain sorghum contest was also subsequently relocated to UNL’s Stumpf International Wheat Center in Grant, Nebraska, where conditions more closely match those where it is more frequently grown within the state, and has become a purely irrigated endeavor. During the 2024 growing season, a soybean contest was introduced at UNL’s Eastern Nebraska Research, Extension, Education Center (ECREEC) near Mead, Nebraska. Colleagues at UNL’s Panhandle Research, Education, and Extension Center (PREEC) continue with their annual TAPS winter wheat contest at the High Plains Ag Laboratory (HPAL) in Sidney, Nebraska. TAPS continues to prosper with programs near Eva, Oklahoma, for both sprinkler corn and cotton. Faculty at the University of Florida have adopted a copycat program, marketed under the guise of the Stakeholder Engagement Program (STEP). Colorado State University (CSU) acquired grant funds and implemented TAPS in Colorado starting in 2023. This program is linked to the Irrigation Innovation Consortium (IIC). Most recently, Kansas State University (KSU) hired one of the original UNL-TAPS executive team members and creators with the intention of building their own program. In 2020, the TAPS executive team secured a multistate Conservation Innovation Grant (CIG) through the US Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) to encourage expansion of TAPS programming regionally. The CIG TAPS team included faculty from UNL, Oklahoma State University, KSU, and CSU. Working collaboratively, the CIG-funded TAPS initiative has seen multiple crop production and management specialists across the High Plains region come together to improve existing offerings as well as develop new opportunities for participation, such as the IIC’s collaborative implementation of TAPS in Colorado. Innovation and additions to the TAPS effort continue to emerge, some are successful while others may need revamping. One such program was UNL’s online “2022 TAPS Crowdsourcing Team” practicum that allowed anyone with phone access to make management decisions. These decisions were pooled to create a single competing team. These decisions were actively applied to the designated crowdsources team’s plot designating them as a single competitor. Furthermore, TAPS has engaged an increasing number of high school and secondary agricultural

education programs as participant teams. As they compete in TAPS, the instructors incorporate information into their curriculum that helps them make decisions about their farm.

5.2 Planned Program Expansion

Current sponsorship and involvement engage external interest in the TAPS effort including federal, state, and local government agencies and entities; nongovernmental organizations (NGOs); agricultural businesses, including supply, technology equipment, consulting, business and financial firms; farms; and others. Figure 3 captures the current entities that support the state of Nebraska.



Figure 3. TAPS 2024 sponsorship and partnership listing

Notes: This list varies by year. Many other companies and organizations have supported and collaborated with TAPS in the past. This list is unique to the Nebraska competitions and programs

As part of its CIG award, TAPS has worked closely with area media, including KRVN radio, *Nebraska Farmer Magazine*, *Irrigation Today*, *Midwest Messenger*, and local newspapers and television networks to provide wide coverage of the program, connected opportunities, and shared outcomes. This effort is amplified by the original monthly TAPS newsletter (468 subscribers) and the annual TAPS results report for each contest. Additional coverage includes the TAPS Facebook presence with 86 connections and a Twitter account with nearly 1,000 followers. TAPS programming has been honored with the support of many different grants, contracts, donations, and awards during its short tenure, in addition to the USDA-NRCS CIG support.

5.3 Development of VTAPS

Continuous effort has gone into establishing a virtualized TAPS program, formally labeled the Virtual Testing Agriculture Performance Solutions (VTAPS) program. In an effort with professionals across UNL, KSU, and others, the UNL-TAPS executive team is actively collaborating on the creation of the prototype, with contract funding through the Nebraska Department of Environment and Energy (NDEE). The aim of adapting TAPS to the virtual space is to provide quality interactive experiential education to a larger population of agriculturalists. This potentially includes high schools, community colleges, vocational centers, four-year institutions, and graduate programs who teach and or train on agriculturally related topics. These topics include agronomy, plant science, agricultural business, farm management, environmental science. VTAPS will also be available to Extension, outreach, and others to use, expanding its usefulness even further. This program provides portability, affordability, and flexibility, making it more versatile and applicable. The current real-time TAPS program is an expensive program to operate and maintain because it requires many physical resources (e.g., land, equipment, labor, and time), which can limit program participation, repeatability, and applicability. It is expected that VTAPS will eventually include many types of crops from many areas of the country and world.

Making a sizable number of virtual farms compared to the cost of creating their physical counterparts is relatively inexpensive to create and use. The number of contests and operators is only limited by computer capacity. In addition, VTAPS is conducive to being compressed in time. A complete season can be compressed into shorter lengths of real time; a complete season or a series of seasons can be simulated in hours, days, or weeks. The advantages of a virtual program are many. While the general framework of competition will remain, including key agronomic and economic management decisions, VTAPS participants will be allowed to test and grow their chosen crop using their production knowledge and skills on a digital interface, benchmarked against a defined set of peers, with an adjustable timeline. The VTAPS model is to be linked to an existing crop model. Currently, the crop growth simulation portion of VTAPS will be performed by the decision support system for agrotechnology transfer (DSSAT) model. VTAPS seeks to educate numerous students on the long-standing programmatic focus of the interrelationships among productivity, efficiency, and profitability in commercial crop operations. Virtualization is expected to play a key role in the future of education and training. This project is a step toward solidifying the TAPS program as an undeniably valuable, accessible and well-known resource in agricultural education, training, and skill building.

6 Conclusions

TAPS is an intensively concentrated program that requires the support and involvement of four groups of people: facilitators, competitors, integrators, and followers. The program is well-suited to increasing knowledge, experience, and acumen of all those willing to engage. It uses cutting-edge methods of cooperative education to enact change and learning among participants as well as across the agri-food industry. It is not only innovative, but it retains and reinforces traditional outreach components, which are associated with its website (portal) and inclusion of other Extension programs and efforts. TAPS is oriented toward solving both individual producers' and industry-wide issues and challenges. This program has been recognized by and received awards from UNL's⁴ Institute of Agriculture and Natural

⁴ Omtvedt Innovation Award for Team University of Nebraska Lincoln, Institute of Agriculture and Natural Resources, 2021, <https://taps.unl.edu/award>.

Resources (IANR), its Extension division,⁵ as well as through professional, regional, and national awards given by WAEA⁶ and AAEA.⁷

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⁵ University of Nebraska Lincoln's Excellence in Extension Team Award, 2018, <https://taps.unl.edu/awards>.

⁶ WAEA Extension Award: Coeur d'Alene, Idaho, 2019, https://waeonline.org/wp-content/uploads/2019/12/2019WAEAmeeetingandawardprogram_v1.pdf.

⁷ AAEA Extension Award: Virtual Event, 2020, <https://www.aaea.org/about-aaea/awards-and-honors/aaea-annual-awards/aaea-annual-award-winners/2020-aaea-annual-award-winners>.

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