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Applied Economics Teaching Resources

Applied Economics Teaching Resources (*AETR*) is an online, open access, and peer-reviewed professional publication series published by the Agricultural an Applied Economics Association (AAEA).

The aim is to provide an inclusive outlet for research, teaching and Extension education scholarship encompassing but not limited to research articles, case studies, classroom games, commentaries, experiential learning, and pedagogy. The goal is to support and advance teaching and Extension education within the scholarly areas of agricultural and applied economics, and agribusiness economics and management. AETR seeks to publish articles that are diverse in both scope and authorship. It serves as a platform for addressing and contributing to our understanding of important societal issues, including inequality and discrimination, as well as how shifts in pedagogy (e.g., growing reliance on remote and hybrid learning modalities) may impact accessibility and inclusion.

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Research Article

Game-Based Learning in Extension Education: An Assessment of the Impact on Consumer Learning and Behavior

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Abstract

Despite clear science-based evidence of the benefits of bioengineering, consumers hold a negative attitude toward genetic modification that has been increasing over time. As a consequence, the market for food labeled as not genetically modified continues to grow, with price premiums ranging from 10 percent to 62 percent. The mixed messaging consumers receive can cause them to doubt their own food choices and harm them economically. Extension educators are increasingly focused on developing participative activities and game-based learning that can improve Extension programming methods. We created a learning game that simulates a shopping experience. In an online survey, compared to those who viewed an Extension website providing information on genetic modification, consumers who played the game were more likely to believe they learned something and correctly answered a question regarding deceptive labeling. While those who viewed the website were more likely to accurately characterize foods as having a genetically modified version, they were also more likely to select a carrot labeled as not genetically modified, even though no genetically modified alternative exists. Our results suggest a role for game-based learning in Extension programming, though there are cost tradeoffs.

1 Introduction

Despite clear science-based evidence of the benefits to human medicine, animal welfare, food security, agricultural production, and the environment (National Academies of Sciences, Engineering, and Medicine 2016), engineering an organism's genetic makeup is often misunderstood and rejected by the public (Kampourakis 2017). Surveys conducted by the Pew Research Center in 2016 and 2018 suggest that nearly 50 percent of consumers fear the impact of genetically modified organisms (GMOs) on human health, an attitude that has increased over time (Funk and Kennedy 2016; Funk, Kennedy, and Hefferon 2018). Additionally, a majority of respondents believed that scientists disagreed on the safety of genetic modification, despite the fact that scientists overwhelmingly agree on the safety of bioengineered food (Plumer 2015). While consumer perceptions of genetic engineering impact their purchasing decisions (Funk et al. 2018; Wunderlich, Gatto, and Smoller 2018; Zhu et al. 2018), providing knowledge or education can ameliorate these effects (Funk et al. 2018; Maes et al. 2018; Farid et al. 2020). In this study, we measure the impact of providing different modes of education resources on consumer knowledge and preferences.

Economic research has demonstrated a clear consumer willingness to pay for food labeled as non-GMO, even as they remain confused about the technology and its implications (Lusk et al. 2005; Bernard and Bernard 2010; He and Bernard 2011; Funk et al. 2018; Drugova, Curtis, and Akhundjanov 2020). Additionally, the non-GMO market is expected to continue growing at over 16 percent annually between 2019 and 2025, to an overall size of $948 million (Grand View Research 2019), and food labeled as GMO-free can command price premiums ranging from 10 percent to 62 percent, depending on the product category (Kalaitzandonakes, Lusk, and Magnier 2018). One consequence is that foods

without a GMO version are also labeled as non-GMO, either to address consumer concerns or to reap economic benefits. This can harm consumers economically, regardless of the label's motive (Wilson and Lusk 2020), which is especially salient for low-income consumers facing strict budgetary tradeoffs. Additionally, the mixed messaging consumers receive can cause them to doubt their own food choices (International Food Information Council Foundation 2018), and consumers generally overestimate the attributes promised by a food label (Priven et al. 2015; Song and Im 2017; Dominick et al. 2018; Syrengelas 2018). In order to address consumer spending on labeled products resulting from misinformation or a halo effect, the University of Connecticut Extension developed a learning game providing facts about genetically modified food.

Extension educators are increasingly focused on developing participative activities, and game-based learning can improve Extension programming methods by providing entertaining and consumable educational tools (Worker, Ouellette, and Maille 2017; Erickson, Hansen, and Chamberlin 2019). Multimedia learning theory suggests that people learn better through multimodal materials, and online games allow consumers to interact with the material in cognitively engaging ways, leading to improved learning outcomes and behavioral change (Gee 2003; Dede 2009; Mayer 2009; Clark and Lyons 2010; Plass, Mayer, and Homer 2019). Online games are also appealing as consumers can engage with the material on their own time, allowing access to learning without an educator being present. However, they are also expensive to develop, and efficacy uncertainties can impact the decision to devote scarce funds to this new learning form. For instance, while studies suggest that game-based educational materials can improve student learning outcomes and confidence, especially for moderately complicated topics (Trujillo et al. 2016; Hsiao, Tsai, and Hsu 2020; Ulery et al. 2020), research is less clear on the use of game-based learning for college students (Ebner and Holzinger 2007; Wardaszko and Podgórski 2017) and the elderly (Jin, Kim, and Baumgartner 2019; Wang, Hou, and Tsai 2020).

In this paper, we explore the impact of providing information on genetic engineering to adult consumers through a traditional Extension website or a newly developed learning game. Through an online survey, Connecticut respondents are directed to either an Extension website on genetic modification or a food shopping game about GMOs. Respondents then answer several knowledge questions about GMOs and participate in a hypothetical choice experiment. We find that respondents who played the game were more likely to believe they had learned something new and less likely to select carrots labeled as non-GMO for purchase. Our results suggest a potential role for game-based learning in Extension education programming, though its efficacy may depend on the type of information presented.

2 Game Design

Developing a full digital game is expensive and can take months or years, depending on the game (Cezarotto et al. 2021). In collaboration with the New Mexico State University (NMSU) Learning Games Laboratory, we developed an interactive game prototype that simulates a shopping experience to teach consumers about what a non-GMO label does and does not mean. Successful educational games cannot merely be electronic versions of traditional worksheets or rote learning, but instead must transport players to contexts that require them to use their academic knowledge to progress in the game world (Barab, Gresalfi, and Ingram-Goble 2011; Lester et al. 2013). We outlined the content and key learning objectives for the game, which was then reviewed with stakeholders, including dietitians, before our game jam. Game jams are typically two- to three-day events where designers collaborate to create a game, but we modified the model for an Extension context (Cezarotto et al. 2021). Through a one-week game development session, we rapidly prototyped the food marketing label game, with two weeks of follow-up development (Cezarotto et al. 2021).

Game engagement theory has five factors that impact motivation and learning: challenge, control, immersion, interest, and purpose (Whitton 2011). A noir theme was selected in part to enhance interest

and purpose from game engagement theory. Players collect clues at three different locations to address the immersion, challenge, and control factors. Motivation and learning are met through helping the consumer answer their question. Flow theory was incorporated to set clear goals for players and provide immediate feedback during the game (Whitton 2011).

We followed an iterative design process, including multiple formative assessments (Ulery et al. 2020). Relative to youth players, adult learners are less engaged by games that are complicated to learn or have complex puzzles that are difficult to solve (Whitton 2011), and we made changes to our game such as highlighting only playable books in the library scene to reduce the time players spent searching for them. After the game jam and further development, we conducted formative testing through multiple approaches, using both our 4-H and Expanded Food and Nutrition Education Program (EFNEP) audiences, and to a broader audience through social media marketing. A Qualtrics survey at the end of the game asked respondents if they thought the game was enjoyable, if they learned something, their opinion on the length, and if it was easy to play. Open-ended questions asked respondents to state one thing they learned and for suggested changes. We also collected demographic information so that we could segment respondents and weight answers from our target audience—young mothers who are the primary grocery shoppers. Additionally, the game was presented at the Association for Communication Excellence conference, and feedback was gathered from instructional designers and other communications specialists. This data was analyzed and used to make additional development changes before the game officially launched.

The final game incorporates a noir mystery theme, where the players follow Maya (Figure 1), a food detective helping solve a confused shopper's dilemma about whether to purchase conventional orange juice, or one labeled non-GMO (Stearns et al. 2021).

The noir theme was popular in the World War II era and includes cynicism and contrasts lights and shadows (Conrad 2005). We selected the noir theme because we could add elements of play into a more serious character, making Maya McCluen a detective and having each food label become a case. Players visit locations such as a library for reference materials, an orange grove where they meet with a farmer, and a grocery store to speak with a registered dietitian (Figure 2).

Figure 1: Maya McCluen, the Noir Detective in the Unpeeled Game

Figure 2: The Map in the Game Where Players Select Locations to Visit

At each of these three locations, the player, through the noir-detective character Maya, collects clues to learn the facts about genetically modified food and the non-GMO food marketing label as it pertains to orange juice and salt (Figure 3). These products were chosen as salt does not contain DNA, and thus cannot be genetically modified, while oranges do not have a genetically modified alternative.

When the game was first released, it included a short survey to measure player engagement. In

Figure 3: A Clue Collected After Visiting the Farmer at the Orchard

total, 92 percent of respondents stated they learned something about GMOs, and 82 percent thought the game was enjoyable. In the open-ended question, many respondents said that they learned about the GMO crop list, that salt does not have DNA, and to look into their food labels. We asked respondents what they thought about when they do think about GMOs, and responses included, "genetically made, might be unhealthy"; "better for you, less pesticides used"; and "the marketing gimmick," among others. Garris, Ahlers, and Driskell (2002) describe three types of learning outcomes: skill-based (technical or motor skills such as flying), cognitive (knowledge about facts or how to perform a task), and affective (attitudes or behavior). This game addresses cognitive and affective learning outcomes, and the questions on learning indicate the game impacted cognitive learning. However, the question about GMO perceptions suggests the game may not have significantly altered the affective realm—their attitudes or behavior.

3 Survey Methodology

In order to assess the impact of the newly developed game on cognitive and affective outcomes, in comparison to traditional website materials, a survey was distributed to Connecticut consumers through a Qualtrics research panel. Respondents were divided into treatment and control groups. Baseline knowledge was assessed using a pre-intervention question concerning GMOs and the certified organic label. Treatment participants then played the game while control consumers were provided the link to a Connecticut Extension website "Science of GMOs" that provides consumers with information on genetic modification, its applications, and its impacts. To measure cognitive outcomes, all participants were asked whether they learned something new from their assigned resource, followed by four additional questions that measured knowledge about GMOs (Zhu et al. 2018; Hasell and Stroud 2020).

To measure changes in behavior (affective outcome), each respondent then completed a choice experiment consisting of one choice question, where they were asked to decide between two packaged carrots, one of which had a non-GMO label. Carrots were selected for the product as they are a commonly purchased item that has no genetically modified alternative but can often be seen in stores carrying a non-GMO label. The only attribute that differed between respondents was the price of the non-GMO labeled product. The baseline unlabeled price of $1.26 was selected based on the average grocery price of five retailers. The package labeled as non-GMO had either a 29 percent or 49 percent premium, representing the average values identified in a meta-analysis of willingness to pay studies (Lusk et al. 2005). To adjust for potential primacy bias, the order in which the labeled and unlabeled version appeared was randomized. As our choice task is relatively simple, we employed a dual response design for the opt-out alternative (Brazell et al. 2006; Schlereth and Skiera 2017; Mohammadi et al. 2020). An example of the choice question is shown in Figure 4.

The survey ended with five demographic questions, including age, education, income, gender, and shopping behavior, which can be found in Table 1.

Discrete choice experiments traditionally use the stated preferences of survey respondents to assess willingness to pay for various attributes of multi-attribute products (Green 1974; Green and Srinivasan 1990), and this method has also been used by economists to measure consumer preferences for food labeled as free from genetically modified ingredients (Burton et al. 2001; Lusk et al. 2005; Drugova et al. 2020; Zhang et al. 2021). Under this model, according to random utility theory, a consumer's utility-maximizing product choice can be decomposed into an observable and stochastic component:

$$U_{ij} = v_{ij} + \varepsilon_{ij} \tag{1}$$

where v_{ij} is the indirect utility function and ε_{ij} is the random component. A consumer's choice can then be used to estimate preferences, with willingness to pay serving as a proxy for utility.

Figure 4: Example Question for the Choice Experiment

Our intent is not to measure willingness to pay, which is a well-studied topic. Instead, as the purpose of the game is to combat misinformation, our behavioral measure is willingness to pay any type of premium for a food labeled as non-GMO, even when there are no genetically modified alternatives. Specifically, both the game and the website provide information on what products have genetically modified versions; there are no genetically modified carrots commercially available. In this case, the non-GMO label could be considered misleading or superfluous. As such, we instead estimate a logistic regression model of consumer preferences:

$$Y_i = \beta_0 + \beta_1 * GMOPrice + \beta_2 * Treatment + \beta_k * X_k + \varepsilon_i \tag{2}$$

where Y_i = 1 if the respondent selected the non-GMO labeled carrot package. Each respondent saw the unlabeled carrot package for $1.26 and one of two potential non-GMO packages, priced at either $1.63 or $1.79. Our primary variable of interest is Treatment, which is equal to 1 if the respondent played the game. X_k is a vector of demographic attributes, and the beta coefficients represent marginal utility parameters.

4 Results

Data was collected from Connecticut residents through a Qualtrics survey panel between the dates of May 27 and July 29, 2022. While 2,349 respondents began the survey, our final sample consists of the 418 respondents that completed the survey and passed all attention checks. Respondent demographics are in Table 1.

The mode age category was 25–40 years old, followed by 41–64, which is consistent with the Connecticut median age of 41; however, we have a lower percentage of those over the age of 65 than seen in the general Connecticut population (18 percent). A total of 39.71 percent of our respondents have a bachelor's degree or higher, which perfectly mirrors the Connecticut rate (40 percent). While the median income in Connecticut is $79,885, we specifically sought to ensure a high response rate from those in the lowest income bracket as they are the most income-constrained shoppers. In line with other survey populations (Wu, Zhao, and Fils-Aime 2022), we have fewer male respondents than the general population (49.1 percent). Of note, over 75 percent of our respondents are the primary grocery shopper in their household.

Table 1: Demographics of Survey Respondents

Variable	N	Frequency (%)
Categorical Demographic Variables		
Age		
18 – 24	88	21.1 %
25 – 40	158	37.8 %
41 – 64	124	29.7 %
65+	48	11.5 %
Education		
Some high school, no diploma	16	3.8 %
High school diploma or GED	95	22.7 %
Some college	93	22.2 %
Associate's degree	48	11.5 %
Bachelor's degree	103	24.6 %
Master's degree	45	10.8 %
Professional degree	11	2.6 %
Doctorate	7	1.7 %
Annual Household Income		
Less than $20,000	58	13.9 %
$20,000 - $29,999	49	11.7 %
$30,000 - $39,999	43	10.3 %
$40,000 - $49,999	37	8.9 %
$50,000 - $74,999	77	18.4 %
$75,000 - $99,999	73	17.5 %
Greater than $100,000	81	19.4 %
Dummy Demographic Variables		
Primary Shopper (= 1 if primary grocery shopper for household.)	317	75.8 %
Male (= 1 if identifies as male.)	165	39.5 %
Older (= 1 if age is 41 or greater.)	172	41.1 %
High Income (=1 if income is greater than $100,000.)	81	19.4 %
College (=1 if has at least a Bachelor's degree.)	166	39.7 %

Extension programming seeks to impact both knowledge and behavior, so respondents were given several questions concerning their knowledge of genetic modification, the results of which can be seen in Table 2. While participants were randomly assigned to either the website or game treatment, there was some heterogeneity in survey completion. Specifically, 54 percent of our final sample ended up playing the game, compared to 46 percent that were shown the website. Looking at the pre-treatment question, a test on the equality of proportions demonstrated no difference in respondent knowledge concerning whether organic certification implied non-GMO status, measured as the percentage that answered the question correctly. In terms of perceived knowledge post-intervention, those who played the game were significantly more likely to believe they learned new information. However, they were not more likely to know that regular food contains genes, and GMO foods do not lead to chronic health problems, though they did correctly answer a question concerning labeling at a higher rate.

The most difficult question concerned correctly selecting the three products with a genetically modified version (corn, soy, and papaya) of five agricultural products (wheat and grapefruit). Those who saw the website were more likely (at the 10 percent level) to select only the correct three. We hypothesize this is because information in list form, such as agricultural products, may not be best displayed in a game format; the website allows you more time to consider the list. However, given our

Table 2: Baseline and Post-Treatment Knowledge of Genetic Modification

Question	Website Treatment		Game Treatment		P-value
	N	(%)	N	(%)	
Overall response.	191	45.7 %	227	54.3 %	
Pre-Treatment Knowledge Question					
All organic food is also non-GMO (T).	59	30.9 %	72	31.7 %	0.8557
Perceived Knowledge Gain					
Strongly agree that learned something new about GMOs.	80	41.9 %	119	52.4 %	0.0316
Post-Treatment Knowledge Question					
Regular food does not contain genes, but GM food does. (F)	138	72.3 %	160	70.5 %	0.6908
Eating GM foods can lead to chronic health problems. (F)	110	57.6 %	126	55.5 %	0.6684
Products without a GM version can be labeled non-GMO. (T)	133	69.6 %	195	85.9 %	0.0001
Select which foods have a GM version. (Selected 3 correct.)	32	16.8 %	24	10.6 %	0.0646
Select which foods have a GM version. (Selected less than 3.)	80	41.9 %	95	41.9 %	0.9943

concern that consumers incorrectly perceive items as having a genetically modified version, and are correspondingly confused by non-GMO labeling on these products, we also calculate the percentage of respondents that only selected food items with a genetically modified version, even if they did not select all three. Slightly more than 40 percent of respondents only selected products with a genetically modified alternative, and this did not differ between the two treatments.

We next assessed whether playing the game had an impact on behavior, specifically the willingness to pay more in a choice experiment for a package of carrots with a non-GMO label. Table 3 provides results from our logistic regression on the factors that impact the probability of selecting the carrot package with the non-GMO label. We find that those who played the game were 10 percentage points less likely to select the non-GMO label than those that viewed the website. Meanwhile, those who were more knowledgeable about genetic modification (defined as correctly answering the pre-intervention knowledge question), as well as those who identified as male, were more likely to select the carrots with a non-GMO label. As a robustness check, we ran a second model using dummy variables for demographics, specifically being older than the median age of 4, having an income above $100,000, or having at least a college education. The results are generally similar.

To further assess the robustness of our findings, Table 4 includes only those respondents who stated they would actually purchase their chosen package. We still see that those who played the game are significantly less likely to select the non-GMO option, though the results are slightly attenuated. Those residents above the median age are more likely to select the non-GMO label in our second specification, which mirrors findings that those who are younger are more likely to approve of genetic modification (Hassell and Stroud 2020). Of interest, baseline knowledge no longer impacts the decision to select a non-GMO label.

Our results suggest a potentially complex relationship between knowledge and behavior. Hassell and Stroud (2020) found that consumers who knew the science of GMO foods had more positive attitudes toward their safety, while the converse was true for consumers who could accurately name which products have genetically modified versions. These potentially represent two different types of knowledge. Similarly, our baseline knowledge question concerned labeling around organic and non-GMO, which could be considered political, rather than scientific, information. Our resources provided science-based information, and the finding in our primary model that those who played the game were less likely to select a product with a misleading label suggests the resource was successful in imparting knowledge. However, those

with a baseline knowledge of organic and non-GMO labeling were still more likely to select the non-GMO product. Presumably, these well-informed consumers may also have a stronger interest in, and pre-existing attitude toward, genetically modified foods. Thus, it could be that our science-based game was successful at imparting information and impacting attitudes for the average consumer, but not those with strong or politically held beliefs.

Table 3: Logistic Regression Results Predicting Selection of Non-GMO Choice (Full Sample).

Variable	Model 1		Model 2	
	Marginal Effect	P-Value	Marginal Effect	P-Value
Played Game	-0.103**	0.030	-0.100**	0.035
Price of Non-GMO Choice	0.284	0.336	0.283	0.340
Baseline Knowledge Correct	0.111**	0.035	0.113**	0.031
Primary Shopper	-0.003	0.954	0.002	0.975
Male	0.097**	0.046	0.093*	0.057
Age	0.042	0.115		
Education	-0.008	0.656		
Income	-0.015	0.235		
Age is 41 or Greater			0.080	0.105
Income is Greater than $100,000			-0.031	0.614
Has a College Degree			-0.026	0.603
Observations (N)	418		418	
Pseudo-R²	0.034		0.032	

Note: *** p < 0.01, ** p < 0.05, and * p < 0.1.

Table 4: Logistic Regression Results Predicting Selection of Non-GMO Choice (Subset).

Variable	Model 1		Model 2	
	Marginal Effect	P-Value	Marginal Effect	P-Value
Played Game	-0.090*	0.070	-0.089*	0.073
Price of Non-GMO Choice	0.336	0.277	0.33	0.286
Baseline Knowledge Correct	0.083	0.125	0.086	0.114
Primary Shopper	0.003	0.967	0.008	0.890
Male	0.113**	0.027	0.108**	0.034
Age	0.047*	0.092		
Education	-0.007	0.694		
Income	-0.019	0.140		
Age is 41 or Greater			0.100*	0.055
Income is Greater than $100,000			-0.044	0.493
Has a College Degree			-0.035	0.508
Observations (N)	383		383	
Pseudo-R²	0.033		0.032	

Note: *** p < 0.01, ** p < 0.05, and * p < 0.1.

5 Conclusion

In order to address consumer misinformation surrounding bioengineering that leads to overpaying for products labeled as non-GMO, we created a learning game that simulates a shopping experience. Compared to those who viewed an Extension website providing information on genetic modification, consumers who played the game were more likely to believe they learned something and correctly answer a question regarding deceptive labeling. While those who viewed the website were more likely to accurately characterize foods as having a genetically modified version, they were also more likely to select a carrot labeled as non-GMO, even though no genetically modified alternative exists. Thus, playing the game appears to have had a more salient impact on adult learners than the website learning resource.

The relationship between information and attitudes is not linear. While both objective and subjective knowledge measures are correlated with improved perceptions of bioengineering, Hasell and Stroud (2020) found that knowing that genetically modified foods do not change a consumer's genetic makeup increased the perceived safety of these foods while knowing which types of foods have GMO alternatives was negatively associated with their perceived safety. We provided similar information in our game and website, with disparate effects. Though most of our respondents understood that all food contains genes after viewing our resources, more than 40 percent still believed that eating genetically modified foods can lead to chronic health problems. Similarly, a pilot study among undergraduate students at UConn found that willingness to consume GMO products decreased when knowledge about GMOs increased (Chase et al. 2023). Regardless of the type of resource, combating misinformation among consumers is difficult, especially when attempting to overcome strongly held biases.

Our results suggest a role for game-based learning in Extension programming for adult consumers. While the website and game were better at imparting different types of knowledge, the game environment may have had more of an impact on behavior. As the game was designed to be accessible to those with an 8th-grade education, in order to reach all consumers, it could also be targeted toward a youth audience because this population similarly lacks knowledge on genetic modification (Ozel et al. 2009; Jurkiewicz et al. 2014; Ruth et al. 2016; Lachowski et al. 2017; Niankara and Adkins 2020). However, developing a game is costly. Our game prototype was created as part of the New Technologies for Agricultural Extension program, which provided $10,000 in funding, which was directly spent on the game creation at New Mexico and was augmented by an additional $5,000 in funds from other sources, as well as $20,000 in mentorship activities in developing and marketing the game. These costs must be compared to the benefit of a 10 percentage point reduction in the number of consumers purchasing a product with a misleading label. While game-based learning provides a different format for education, and can successfully change both knowledge and behavior, there are clear cost tradeoffs.

Future research on the impact of game-based learning in Extension education could include observational studies to measure true behavioral change, such as partnering with a grocery store to disseminate food-based games and track purchase behavior. Our primary audience of interest was low-income households, and game designers included educators from our Supplemental Nutrition Education Program and Expanded Food and Nutrition Education Program. While our survey oversampled low-income consumers, there are many more areas for research within this population. Additionally, design cost constraints did not allow us to track game engagement rates, such as completion rate or number of locations within the game visited, which could provide future insights for game design.

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Teaching and Educational Method

Bringing Behavioral Change Education to Life: Incorporating Healthy Eating into College Classroom Teaching

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Abstract

This study evaluates the impact of implementing a Healthy Eating Challenge within the classroom setting. The activity integrated nutrition education, self-discovery/reflection, and community support. The findings underscore the potential of this approach to effectively educate college students about healthy eating and behavioral change models. This personalized active learning classroom project utilized a diverse array of effective educational strategies, including personalized goal setting, self-discovery and assessment, and creative expression of the Challenge experience. These strategies were employed to align behavioral change goals with an individual's readiness to embrace change. They served to foster a more comprehensive understanding of behavioral modification concepts and strengthen their reinforcement among college students. Throughout the Challenge, participants identified modifications that they would like to incorporate, such as enhancing meal balance, adding food variety, preparing food in advance, and eating breakfast earlier. This Challenge not only reshaped participants' perception of influential factors guiding behavioral transformations but also notably reduced the perceived barrier of inadequate cooking skills.

1. Introduction

Skipping breakfast has become a prevalent practice among college students worldwide (Wengreen and Moncur 2009; Neslişah and Emine 2011; Wright et al. 2015; Pendergast et al. 2016; Musaiger et al. 2017; Omage and Omuemu 2018; Sayed and Nagarajan 2022). This practice is associated with an increased risk of obesity (Kant and Graubard 2015), type 2 diabetes mellitus (Odegaard et al. 2013), hypertension (Lee et al. 2016), hypercholesterolemia (Ballon, Neuenschwander, and Schlesinger 2019), metabolic syndrome (Cahill et al. 2013), and coronary heart disease (Rong et al. 2019). Conversely, a meta-analysis by Li et al. (2021) finds that maintaining a regular daily breakfast routine benefits the cardio-metabolism which can reduce risk of cardiovascular diseases, type 2 diabetes mellitus, obesity, hypertension, stroke, metabolic syndrome, cardiovascular mortality, low high-density lipoprotein. However, future research is needed as gender may affect the results.

Several studies have evaluated the breakfast habits of college students. Pengpid and Peltzer (2020), using data from more than 20,000 college students across 28 countries, find that skipping breakfast is associated with ten health risk behaviors (e.g., inadequate intake of fruit and vegetables, frequent soft drink intake, binge drinking, and tobacco use), nine poor mental health outcomes (e.g., depression and sleep problems), and poor academic performance. Thiagarajah and Torabi (2009) find significant associations between irregular breakfast eating and health-compromising behaviors such as substance use, soda consumption, smoking, lack of sleep, and limited physical activities among 1,257 U.S. college students. In addition, more than 60 percent of the students attribute regularly skipping breakfast to poor time management (Thiagarajah and Torabi 2009). The literature consistently underscores the adverse effects of poor eating habits on the academic performance of college students (Thiagarajah and Torabi 2009; Wald et al. 2014; Reuter, Forster, and Brister 2021), while highlighting the cognitive benefits associated with a nutritionally balanced breakfast (Brandley and Holton 2020).

Various factors contribute to meal skipping in young adults. A review of 331 studies identifies individual influences (e.g., sex, age, ethnicity, body mass index, education level, physical activity, internet use, fatigue, psychological well-being, and cooking skills), social environmental influences, and physical environment influences (e.g., living environment and housing type) as risk factors for meal skipping (Pendergast et al. 2016). Other factors include meal cost and time constraints (Pendergast et al. 2016; Seedat and Pillay 2020) and being a college student (Wengreen and Moncur 2009). The transition to college or university marks a pivotal period for young adults, because it presents them with the first significant opportunity to independently make their own food decisions and translate their preferences into eating behaviors (Marquis 2005; Deshpande, Basil, and Basil 2009). However, college students are well-known for their suboptimal dietary habits (Deshpande, Basil, and Basil 2009) and disregard for food group recommendations (Dinger and Waigandt 1997), relying on quick and convenient meals (Marquis 2005; Morse and Driskell 2009). Unfortunately, existing health promotion strategies have largely overlooked college students (Hilger, Loerbroks, and Diehl 2017).

This paper investigates how education, self-reflection, and community support can be leveraged to promote behavioral change in eating habits among college students by integrating a Healthy Eating Challenge into classroom teaching. The objectives of this innovative classroom research project are as follows: (1) empower college students to self-discover their eating behaviors, gaining insights into how these behaviors influence both their physical and mental well-being; (2) cultivate awareness of effective strategies for healthy eating and provide support for the adoption of dietary habits; and (3) promote personalized learning and exploration. We envision, in the long run, these student participants will be empowered to develop confidence in discussing food-related matters, applying behavioral modification models to improve various aspects of individual well-being, and utilizing this model to educate others about healthy eating and behavioral modifications.

Despite the limited sample size of student participants determined by class enrollment, this paper showcases the potential of incorporating well-designed research activities in the classroom to not only encourage behavioral changes among college students, but also enhance engagement and foster immersive and experiential learning of food-related issues. The integration of the Healthy Eating Challenge project into the classroom holds promise for instructors and educators aiming to convey knowledge about eating behaviors and modification to college students, particularly those teaching courses at the intersection of food and nutrition.

2. Procedures: Integration of the Research Project into Classroom Teaching

This study was approved by the Rutgers Institute Review Board (IRB), ensuring adherence to ethical research standards for human subjects. Informed consent was obtained from student participants.

During the fall semester of 2022, undergraduate students who enrolled in two courses—"Food, Nutrition, and Health" and "Price and Demand"—were selected as a potential cohort for this study. Within the "Food, Nutrition, and Health" course, the Challenge was integrated as a required class project aligned with the course modules. Conversely, students in the "Price and Demand" course were offered the option to participate in the Challenge, while those who opted out were offered an alternative project opportunity. A total of 20 students undertook the Challenges in ten consecutive days. Two participants opted out of having their data utilized for research purposes, and the other two had considerable missing values in the pre- and post-challenge surveys, leading to a total of 16 student participants for the analysis. The small sample size warrants caution when generalizing the findings and constraining out ability to explore relevant questions.

3, The Design of the Healthy Eating Challenge

We collaborated closely with Eating for Your Health (EFYH), a nonprofit organization in New Jersey with a mission centered around promoting healthy eating across various demographics. Through this partnership, we have adapted and customized their renowned program, the Health Eating Challenge program, to effectively address the unique requirements and attributes of college students and align them with the curriculum, modules, and schedules of the two courses. Figure 1 depicts the activities designed for various components of the project, including daily activities for the project participants, initiatives to foster community support, activities to enhance immersive and creative learning, tasks for learning goals and progress assessment, and activities to collect data for program evaluation. Details of each component are discussed in the following sections of this paper.

Daily Activities for the Challenge Participants	• Follow the breakfast schedule • Keep daily tracking sheets • Complete assigned reading sent by emails
Activities to Enhance Knowledge and Foster Community Support	• Attend three group discussions • Create inputs for the dedicated Blog
Activities to Enhance Immersive and Creative Learning	• Create creative expressions of indvidual experience • Celebration party featuring culturally rich and healthy food in the end of the project
Activities for Individual Goal Setting and Progress Evaluations	• Establish goals and challenges before the Challenge • Revise goals during the Challenge • Evaluate learning goals after the Challenge
Activities to Collect Data for Research	• Complete pre-, post-, and reunion surveys • Complete additional questions in the student teaching evaluation

Figure 1: Activities Designed for Different Components of the Project

Participants were required to follow the breakfast schedule (see Table 1) and utilize the provided daily tracking sheets to facilitate self-discovery. This tracking sheet served as a tool for participants to document their post-breakfast experiences, encompassing aspects such as physical vitality, mental energy, concentration levels, hungry cues, and food cravings.

Throughout the Challenge's duration, participants received daily emails containing assigned readings. The assigned readings encompassed a variety of materials, such as short academic papers, previous Challenge participants' stories and narratives, cooking videos, or educational articles. Each reading was meticulously curated by EFYH and the research project investigators, ensuring that two vital objectives were achieved: (1) conveying pertinent nutritional knowledge and (2) motivating participants to engage in self-exploration of their eating behaviors and overall well-being. Additionally, a daily checkup quiz was accessible on Canvas (the official learning management system for teaching and learning at Rutgers) throughout the Challenge period to serve as a mechanism to gauge and maintain participants' engagement.

To ensure a continued thread of awareness and support throughout and beyond the Challenge, participants created an interactive blog page where they posted pictures and videos of the breakfast foods they made. The Challenge facilitators took on the role of both cheerleaders and sources of information. They were readily available to address participants' questions and concerns. Furthermore,

Table 1: Recipes and Readings for the Healthy Eating Challenge		
Day	Breakfast Schedule	Reading Materials
1	Usual Breakfast	Food Flavor
2	Usual Breakfast	Food and Mood
3	Egg or Tofu Scramble	Lucia's Story About Dark Chocolate
4	Egg or Tofu Scramble	Video: Making Breakfast Chili
5	Chili for Breakfast with Turkey/Tofu	Journal Article on Chili Pepper
6	Chili for Breakfast with Turkey/Tofu	Food and Dehydration
7	Magic Muffin or Oatmeal	Oils
8	Magic Muffin or Oatmeal	Dirty Dozen and Clean 15
9	Chia Seed Pudding or Smoothie	Flaxseed
10	Chia Seed Pudding or Smoothie	Journal Article on Breakfast Skipping and Late-Night Eating

the Challenge organized three group sessions on Days 1, 5, and 10. An orientation was provided in the first group session. In the second group session, the facilitators presented information on carbohydrates, sugar, and dietary fiber to dispel myths and highlight facts. The third group session, held upon the Challenge completion, focused on revealing the nutritional value of the provided recipes and emphasized the importance of self-journaling and self-discovery in eating behaviors. During these group sessions, participants were encouraged to share their stories and ask questions. In addition, the research investigators allocated 5–10 minutes either before, during, or after class to engage participants in a brief discussion about the Challenge. This frequent interaction nurtured a dynamic and supportive learning environment.

4. Evaluation of the Healthy Eating Challenge
Using the survey data, we present information of demographics and eating behaviors prior to the Challenge in Table 2, and participants' frequencies of eating breakfast, perceived facilitating factors and barriers, level of readiness to change, and desirable behavioral changes in Table 3.

Participants were evenly distributed by gender, with a higher representation of seniors (81 percent). A significant portion of them were pursuing studies in environmental and business economics (79 percent). Regarding ethnicity, the cohort was predominately non-Hispanic white (44 percent), followed by Asian (25 percent), Hispanic (19 percent), and multi-race (13 percent) participants.

As for living arrangements, over two thirds of participants resided in apartments within walking distance to campus (69 percent). When it came to budgeting, participants reported an average weekly expense on groceries of $81, with nearly half provided by their parents ($40). Participant aspirations for the Challenge were to gain nutritional knowledge (88 percent), self-evaluate eating behaviors (75 percent), improve health conditions (38 percent), and improve cooking skills (25 percent).

As shown in Table 3, before the Challenge, a quarter of participants reported that they never prepared or cooked breakfast, and only one third ate breakfast at least 3–4 times per week. After the Challenge, approximately 88 percent of participants reported having breakfast at least 3–4 times per week. This post-Challenge frequency significantly surpassed the pre-Challenge rate. Table 2 also shows that a quarter of participants expressed dissatisfaction with their eating behaviors prior to the pre-

Table 2: Demographics of Survey Participants (N = 16)

Demographic	Mean	Standard Deviation	Min	Max
Age (years)	21	1	19	23
Weekly grocery expense ($)				
Paid by oneself	43	36	0	100
Paid by parents	39	35	0	100
Gross	82	33	0	150
	Percent			
Female	50			
Class Rank				
Senior	81			
Junior	19			
Race				
Non-Hispanic White	44			
Hispanic	19			
Asian	25			
Multi-Race	13			
Major				
Environmental and Business Economics	79			
Nutritional Sciences	11			
Agricultural and Food System	5			
Political Sciences	5			
Living Arrangement				
Apartment/house away from campus	6			
Outside within walking distance to campus	69			
On campus	13			
Living with parents	13			
What Students Want to Learn from the Challenge				
Nutritional knowledge	88			
Self-assessment of eating behaviors	75			
Improve cooking skills	25			
Improve health condition	38			

Challenge. This dissatisfaction was likely to encourage participants to modify their eating behaviors throughout the Challenge.

To validate participants' readiness for behavioral change, they were asked to evaluate their readiness on a scale of 0 to 100, and to indicate whether they were ready to make changes. Table 3 reveals a notable inclination toward lifestyle changes after the Challenge. Specifically, participants indicated a greater readiness for change after the Challenge (80 percent) compared to before the Challenge (64 percent), as measured by their readiness scale. The difference was statistically significant at the 10 percent significance level. This difference showed the efficacy of the Challenge in cultivating a mindset conducive to change among participants. Based on their recorded binary preferences, the majority reported their intention to either maintain the changes they had already made during the Challenge or embrace new modifications in the post-Challenge period (94 percent), which was statistically significantly higher than the pre-Challenge level (57 percent) at the 1 percent significance level. This observation underscores the potentially transformative impact of the Challenge on

Table 3: Breakfast Frequencies and Perceived Facilitating Factors, Barriers, Readiness, and Identified Areas for Behavioral Changes

	Pre-Challenge (%)	Post- Challenge (%)	Difference (%)
Satisfaction with What and How You Eat Breakfasts			
Dissatisfied	25	0	-25**
Neutral	25	7	-18**
Satisfied	50	93	47***
Frequency of Breakfast Preparation or Cooking in a Typical week			
Never	25	0	-25**
Only on weekends	0	0	N/A
1–2 times per week	44	9	-35**
3–4 times per week	13	55	42**
5 and more	19	36	18
Factors Facilitating Behavioral Changes$			
Nutrition Knowledge/Information	63	69	6
Cooking Skills	63	69	6
Community Support	44	6	-38***
Health Considerations	69	31	-38**
The Healthy Eating Challenge	N/A	56	N/A
Barriers to Behavioral Changes$			
Affordability	38	31	6
Cooking Facilities	13	13	0
Cooking Skills	38	19	19*
Time Constraint	81	88	6
Readiness for Behavioral Change			
Based on a 1–100 scale	64	80	15**
Based on indication (yes/no)	57	94	38***
Anticipated Changes to Breakfast after the Challenge$			
Improve meal balance		57	
Increase food varieties		57	
Prepare food in batches the night before		50	
Increase fiber consumption		32	
Eat breakfast earlier		38	
Take time to enjoy breakfast		25	

Notes: $Student respondents can choose all applied when answering these questions. *** 1%; ** 5%, * 10%

participants' commitment to long-term change. The Challenge not only significantly increased participants' readiness for change, as evidenced by their higher average readiness rating, but it also inspired participants to commit to sustaining or further enhancing their positive changes. Despite its small sample size, this transformation in readiness and intention represents a potential of the Challenge in fostering a proactive and empowered approach to dietary and lifestyle improvements among college students.

Following the challenge, participants identified a common priority in terms of preferred behavioral changes. This stage was critical in understanding the specific areas where participants felt they could make meaningful adjustments to their eating habits. Enhancing meal balance and varieties, preparing food in batches in advance, and eating breakfast earlier emerged as the predominant choices.

Participants were also asked to identify facilitating factors and barriers to behavioral changes in the pre- and post-Challenge surveys. Common facilitating factors for behavioral changes were nutritional knowledge and cooking skills before and after the Challenge. Initially, participants perceived community support in the shared student-led blog and discussion in and out of the classroom as a facilitating factor (44 percent). However, the perception diminished after the Challenge (6 percent), with statistically significance at the 1 percent level. Similarly, a greater number of participants perceived health considerations to help make behavioral changes before the Challenge (69 percent) compared to after the Challenge (31 percent), with statistical significance at the 10 percent level. The differences relating to community support and health considerations could be attributed to improved autonomy relating to eating behaviors. Moreover, more than half of participants perceived the Challenge itself as a facilitating factor for behavioral changes (56 percent). The participants' evolving perceptions of facilitating factors and barriers to behavioral changes reflected their growth and empowerment throughout the Challenge. The Challenge not only equipped participants with knowledge and skills but also instilled a sense of self-reliance and motivation. This shift from external to internal motivators underscores the lasting impact of the Challenge as a catalyst for sustainable behavioral change. In accordance with the Transtheoretical Model of Change (TTM), participants' enhanced autonomy and self-efficacy in managing their eating behaviors position them to continue their journey toward improved nutrition and well-being beyond the confines of the Challenge (Horwath 1999; Spencer et al. 2007)

A common barrier to behavioral changes, both before and after the Challenge, was the constraint of time. This finding is consistent with the existing literature that underscores how time constraints often drive college students to rely on quick and convenient meal options (Marquis 2005; Morse and Driskell 2009) and to frequently skip meals (Wengreen and Moncur 2009). Conversely, the perception of cooking skills as a barrier diminished post-Challenge, suggesting increased confidence in this aspect. The percentage of participants considering affordability and lack of cooking facilities as barriers was not statistically different before and after the Challenge. The barriers identified in this study illuminate the complex interplay of factors influencing college students' eating behaviors. While the Challenge succeeded in improving cooking skills and potentially boosting participants' confidence, it did not fully mitigate the time constraints they faced. This underscores the need for multifaceted interventions that not only educate students about healthy eating but also offer practical solutions for addressing time-related challenges, affordability issues, and cooking facility limitations. By comprehensively addressing these barriers, educational institutions and health promotion initiatives can better support college students in their journey toward improved nutrition and well-being.

5. Educational Tools for Behavioral Changes Embedded in the Challenge

As Figure 1 indicates, we used several educational tools employed to fulfill the stated three primary objectives, including self-journaling and personal discovery, goal setting and assessment, community support, and creative expressions of the Challenge experience. In this section, we examine the effectiveness of these education tools and provide insights into optimizing the effectiveness of these tools. Our analyses draw from qualitative data obtained through students' learning goals, self-evaluation of these goals, and final reflection projects, along with quantitative data provided by the additional questions in the student teaching evaluation.

5.1 Self-Journaling and Personal Discovery

Self-regulation theory suggests one may have the ability to adaptively regulate their attention, emotion, cognition, and behavior to respond adaptively to both internal and external demands (Baumeister, Tice, and Vohs 2018). One important component of self-regulation ability is self-assessment and discovery. During the challenge, participants were asked to observe, document, and contemplate their post-breakfast experiences with the provided recipes provided using tracking sheets. The suggested items for self-journaling were physical vitality, mental energy, breakfast satisfaction, hunger cues, food cravings, and any other pertinent observations.

Tracking sheets facilitated the completion of the post-Challenge survey. Within these surveys, participants were asked to report hours they experienced hunger, rate their energy level, food cravings, and attention on a scale from 1 (lowest) to 5 (highest), and rank their mood from 1 (worst) to 5 (best) after each breakfast during the Challenge. Based on the survey data, we conducted student t-tests to compare self-reported feelings after eating the provided recipes vs. after eating their typical breakfast. The results are summarized in Table 4.

Table 4: Feelings After Having Breakfasts and Macronutrient Contents of the Provided Recipes

	Self-reported feeling after breakfast				
Recipes	**Hours feeling hungry**	**Energy** 1 = lowest 5 = highest	**Mood** 1 = worst 5 = best	**Food Craving** 1 = lowest 5 = highest	**Focus/Concentration** 1 = lowest 5 = highest
Pre-challenge breakfast	2.17	2.77	3.54	2.77	2.77
Breakfast during the Challenge					
Egg Scramble	2.64**	3.23*	3.77	3.23**	3.23**
Tofu Scramble	2.20	3.20*	3.40	3.20*	3.20*
Breakfast Chili	**3.33*****	**3.62****	3.43	**3.62****	**3.62****
Magic Muffin	1.83	3.33	3.50	3.33	3.33
Overnight Oats	2.64	3.33*	3.69	3.33*	3.33*
Smoothie for Challenge	2.15	3.15	4.08	3.15	3.15
Chia Seed Pudding	2.17	3.20	**4.33***	3.20	3.20

Note: The statistical significance, *** 1%; ** 5%; * 10%, pertains to the comparison between a specific breakfast recipe and pre-challenge breakfast. The numbers bolded indicate the highest value in the category.

Table 4 shows that the provided recipes had varying effects on self-reported experiences. When compared to the pre-challenge breakfast, both breakfast chili and egg scramble demonstrated better satiety, increased energy, and enhanced concentration, along with shortened hours of hunger after consumption. Additionally, compared with the pre-challenge breakfast, both egg scramble and breakfast chili sustained participants longer at the 1 percent and 10 percent significance levels, respectively. Egg/tofu scramble, breakfast chili, and overnight oats yielded higher energy and improved concentration, albeit increased food craving. Notable, among all the provided recipes, only the chia seed pudding demonstrated a statistically significant improvement in mood at the 10 percent significant level when compared to the pre-Challenge breakfast.

In the third group session after completing the Challenge, participants were presented with the nutritional profiles of the provided recipes, including the percent daily value for total fat, total carbohydrates, dietary fiber, protein contents (gram), and total calories. They were guided to explore the reasons behind variations in how they felt after eating different breakfasts during the Challenge. For example, through this exercise, participants better understood the reasons behind breakfast chili yielding the highest level of energy and concentration, while also sustaining them for the longest time among all the recipes.

We employed these exercises to achieve three goals. First, it offered students a valuable opportunity to learn about the notion of balanced meals. Balanced meals containing the appropriate macronutrients — carbohydrates, fat, and protein — can potentially improve cognition, memory, and attention in young adults. For example, meals rich in complex carbohydrates have been linked to improved attention (Fischer et al. 2002), facilitating verbal declarative memory (Smith et al. 2011), improving working memory performance (Scholey, Harper, and Kennedy 2001), and amplifying prospective memory (Riby et al. 2011). High-fat meals have demonstrated the potential to enhance attention, while protein-rich meals have shown to improve cognitive improvements (Fischer et al. 2001). Second, these exercises provided students with first-hand insight into how the composition of their meals could significantly influence cognitive functions and contribute to their overall well-being. Last, these exercises served as an instructive platform for students to better understand the importance of paying attention to nutritional profiles of their dietary choices, cultivating mindfulness, and engaging in self-journaling. A growing body of literature suggests that mindfulness, characterized by embracing and non-judgmental acknowledgement of past and present experiences, contributes to transformative and profound changes in health behavior (Shapiro et al. 2006; Schuman-Olivier et al. 2020). In addition, during the third group discussion, participants also learned how to use online resources, such as the Recipe Nutrition Calculator from www.verywellfit.com, to engage with nutritional labeling and evaluate nutritional profiles of their dietary choices. This aspect of the exercise equipped students with essential proficiencies to adeptly navigate their dietary choices through contemporary technological tools.

Students' reflections on their experiences suggest that they have gained insights into the importance of balanced meals with variety. One student expressed, "...by expanding the nutrients within my day-to-day breakfast, I increased my energy level partially... like to increase varieties in my meals." Another highlighted "the importance of practicing balance and flexibility within your eating..., especially the need for consuming more calorie-dense meals within an active lifestyle." Another noteworthy example involves a student providing a detailed reflection of her relationship with food, strategies for weight control, and her transition to a vegetarian and vegan diet since high school. She acknowledged acquiring knowledge from this experience and highlighted modifications in her eating habits, such as incorporating more whole foods and reducing snacking, despite facing challenges in maintaining healthy eating in the long run.

5.2 Goal Setting for Behavioral Modifications

Goal setting is widely acknowledged as a potent technique for behavioral changes, with the capacity to serve as a cornerstone in the success of interventions (Epton, Currie, and Armitage 2017). This technique has shown some promise in promoting dietary behavior changes (Shilts, Horowitz, and Townsend 2004). Individuals face different challenges when it comes to goal setting. For example, identifying suitable goals effectively translates their goals into actionable steps (Bailey 2019).

At the outset of the Challenge, participants were asked to establish their learning goals, with an option to revise these goals. These goals served as reference points for participants to assess their progress and accomplishment throughout and after the Challenge. Throughout the duration of the Challenge and beyond, participants were provided with chances to communicate and deliberate on their goals with the course instructor who served as one of the research investigators. This process encouraged an adaptable and reflective assessment of their personal growth, ultimately inducing behavioral changes.

Appendix A provides a summary of individual students' learning goals before the Challenge and their self-evaluation afterward, indicating the achievement of most learning goals. The majority highlighted their exposure to and acquisition of knowledge regarding nutritional values, micronutrients, balanced meals, and the importance of serving size and having breakfast. Many reported a shift from rarely or never cooking breakfast to doing so more frequently; incorporating healthier ingredients, including non-processed ones, in meal preparation; organizing ingredients to ensure balanced meals;

and preparing large portions for future meals. Most participants reported increased awareness of their eating habits and the impacts of breakfast on their well-being. Some mentioned prioritizing health and translating gained knowledge into behavioral modifications. A few reported improvements in time management. Two students indicated enhanced media creation skills. Notable, one participant acquired knowledge in food safety, and another pleasantly discovered an unexpected enjoyment and aptitude for cooking. Two students recognized cost saving when preparing breakfasts themselves. Additionally, one participant started to recognize and appreciate the influence of her Asian heritage on dietary preferences and behaviors.

5.3 Creative Expression of Individual Challenge Experiences
Existing research has consistently shown that creative expression promotes active and personalized learning (Kousoulas 2010; Brown 2015; Beghetto 2021). Student participants were given an opportunity to create creative and artistic expressions of their individual Challenge journey. As shown in Appendix B, students submitted a diverse range of introspective expressions, including written narratives accompanied with photos (N = 4), videos of storytelling or breakfast cooking (N = 3), blog posts (N = 2), and infographics (N = 7). This exercise not only made this experiential learning enjoyable, but also stimulated reflections that are important in active and personalized learning. As shown in Appendix A, nearly all the participants acknowledged an enhanced self-discovery and reflection of their eating habits and the impact of breakfast on their well-being. Among the two students who reported an improved media creation skill, one recognized such skills could enhance employability.

5.4 Community Support
Community support comprises several components, such as three group meetings, and a shared blog, as well as both informal discussion with the instructor and among peers within and outside the classroom. During the group meetings and informal discussions, participants demonstrated a willingness to share their experiences and pose questions. Despite many posted photos of their breakfast preparation, cooking, and consumption in the shared blog, the investigator noted a lower level of enthusiasm among student participants for this aspect. As we discussed in Section 4, there was a notable decrease in the perceived importance of community support among student participants, in contrast to their pre-Challenge perceptions. The shift may be attributed to improved autonomy regarding eating behaviors and/or a diminished interest in this specific component.

6. Students' Perception of the Role of this Challenge Project in their Active and Personalized Learning
Overall, the project investigators perceived that self-journaling and personal discovery, goal setting and assessment, three group discussions, and creative expressions of the Challenge experience collectively engaged and empowered student participants. They empowered student participants to self-discover their eating behaviors and gain insights into how these behaviors influence both their physical and mental well-being. These tools also cultivated awareness of effective strategies for healthy eating and provided support for the adoption of beneficial dietary habits.

To assess students' perceptions of the project's role in their active and personalized learning, five questions were incorporated in the Rutgers student teaching evaluation survey for the course titled "Food, Nutrition, and Health", where the Challenge was integrated as a required class project. Participants were asked to express their agreement with the statements listed in Table 5 on a scale from 1 (strongly disagree) to 5 (strongly agree). Although only four students completed the evaluation, their responses offered some insights. As shown in Table 5, all of them reported that the project engaged them in active learning both individually and collectively, and it also improved their personalized learning. They also noted that the project integrated learning into their daily lives and assisted them in modifying behaviors in eating habits.

Table 5: Students' Perception on Active and Personalized Learning

Statement	4 (agree)	5 (strongly agree)
Learning goals specified by individual students were helpful for personalized learning.	75% (N=3)	25% (N =1)
The project improved personalized learning.	25% (N=1)	75% (N=3)
The project engaged students in active learning individually as well as in a group.	0% (N =0)	100% (N=4)
The project brought learning into students' daily life.	50% (N=2)	50% (N=2)
The project helped me modify my eating behaviors.	50% (N=2)	50% (N=2)

Note: Four students completed the student teaching evaluation in the end of the semester.

Two educational strategies, not implemented in our project but potentially beneficial for those considering adopting this integrated project in their classroom, deserve mention. First, we observed that student participants often faced challenges when attempting to refine their ambitious learning goals into practical and accountable objectives. SMART objectives, a systematic framework known for being Specific, Measurable, Achievable, Relevant, and Time-Bound, can empower individuals to focus on well-defined goals, track their progress, and align their aspirations with measurable outcomes (Centers for Disease Control and Prevention 2003; Pearson 2012). Incorporating SMART objectives into this project could further enhance learning and increase success. Second, beyond the diverse creative expressions of the Challenge experience, student participants can work collaboratively to create a script for a podcast or TED talk. Such collaborative endeavors not only foster teamwork but also reinforce ownership of learning experiences and outcomes.

7. Conclusions

This study demonstrates the effectiveness of a well-designed project that integrates nutrition education, self-discovery and reflection, classroom-based community support, and creative expression in educating college students about healthy eating, promoting behavioral changes, and fostering active, personalized experiential learning. This study made optimal use of quantitative data from the pre- and post-Challenge surveys and student teaching evaluation surveys. In addition, we leverage various qualitative data sources, such as goal setting and evaluation, final reflection projects, group discussions, and blog posts. We find that college students were more likely to enhance behavioral changes after the Challenge, and they identified their desired changes toward healthy eating such as enhancing meal balance and varieties, preparing food in batches in advance, and eating breakfast earlier. The Challenge also reshaped their perception of influential factors guiding behavioral transformations.

The success of this project can be attributed to its incorporation of personalized goal setting, nutrition education, and daily tracking of breakfast experience to foster self-discovery, community support both within the classroom and through a shared blog, and the requirement for students to submit a final artistic reflection project based on their Challenge experience and in their own choice of format. Additionally, given that student participants enrolled in two courses in food consumption, nutrition, and health-related areas, the Challenge aligned well with the course content. This alignment played a significant role in the success of promoting a comprehensive understanding of behavioral modification concepts and effectively reinforcing changes among participants. This project demonstrates the potential for educators teaching courses at the intersection of food and nutrition to offer valuable and immersive learning on healthy eating to young adults.

Nevertheless, this study does have its limitations. First, the study sample is small (N = 16), necessitating caution when generalizing the findings and constraining out ability to explore relevant questions. For example, we collected sociodemographic information about student participants, including their major, ethnicity backgrounds, living arrangements, financial support, and project aspirations. This information could offer valuable insights into the diverse and multifaceted nature of college students' dietary choices and behaviors. Investigating the role of sociodemographic factors in

influencing behavioral changes among college students could inform interventions and educational strategies. Regrettably, our sample size does not permit us to conduct such a quantitative analysis. Second, a reunion survey conducted toward the end of the semester to assess the sustainability of behavioral changes faced low participation rates, primarily due to students' stress during the final exam week. The lack of data limits our ability to assess the long-term effects.

Despite the limitations, particularly associated with our small sample size, this comprehensive project offers college students the opportunity to learn about and practice behavioral changes, potentially enhancing their overall college experience and long-term health outcomes. It can be readily adapted by educators aiming to convey knowledge about eating behaviors and modification to college students, particularly those teaching courses at the intersection of food and nutrition.

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Appendix A: Individual Students' Learning Goals Before the Challenge and Their Self- Evaluation After the Challenge

Table A1: Individual Students' Learning Goals Before the Challenge and Their Self- Evaluation After the Challenge

Learning Goals	Achieved (yes/no)	Selective Quotes from Students
Panel A: Discovery and reflection		
Be more aware of my diet, eating habits, and how my body feels	Yes	Learned about serving size, calorie count, and preservatives
	Yes	Want to learn how my body feels when getting into a schedule of eating breakfast since it has never been part of my routine.
	Yes	Want to learn how my energy can change throughout the day and how breakfast can make me start the day with more energy.
	Yes	My physical energy was much better on days that I ate breakfast although it did not really help my mental fog in the morning.
	Yes	Learn how food affects my body's energy
	Yes	I have specifically noticed a difference with intake of vegetables and fiber. My increased intake of fiber has helped greatly with digestion throughout the day and overall.
	Yes	This challenge has also made me try to keep my breakfast at the same time each day.
	Partially	I did find myself being more aware of my eating habits and began to question myself when I'd crave unhealthy food and instead try to find something less processed and more nutrient-dense.
	Yes	It may be a challenge to observe my energy levels because many other factors may tie into why I would be more/less energetic throughout the day…To combat this challenge, for the duration of the Healthy Eating Challenge, I will try to keep my sleep and activity levels and other nutritional variables consistent.
	Yes	I was more aware of how breakfast foods immensely impacted my energy levels throughout the day.
	Yes	I learned that certain foods will give me more energy, and keep me full for longer.
Learn and document what works best for me in terms of eating	Yes	Daily journaling helped me to pay close attention to what types of foods affect me in certain ways.
See how different food affects body weight	No	There was not enough time to see an actual effect on body weight. If I continue these healthy eating habits, I'm sure I will notice a healthy change in weight.

Table A1 continued.

Learning Goals	Achieved (yes/no)	Selective Quotes from Students
Panel B: Gain knowledge of nutritional values		
Understand the importance of having breakfast	Yes	Expand my knowledge on why it's important to eat breakfast
Learn more about micronutrients	Yes	The project encouraged me to learn more about micronutrients and vitamins. For example, I chose to add spirulina powder to my smoothies to increase the vitamins and minerals, which was not part of the given recipe.
Learn about nutritional values and daily intakes	Yes	It was beneficial to know why certain foods we should have in one meal. The daily email and presentations explained well on that.
Learn about balanced meals	Yes	I always knew it was important to have balanced meals, but now I have a lot more knowledge of why it is important.
Understanding the composition of recipes	Yes	I learned a lot on what to have in a recipe and how to make it easy to follow. It was clear about the amount of food we need and proper cooking sequence.
	Yes	Since I'm used to eating frozen breakfast sandwiches or buying a bagel from somewhere, this project showed me cheaper and more nutritional ways I could utilize the ingredients I have at home to make my breakfast every morning.
Panel C: Behavioral modification of eating habits		
Incorporate healthier ingredients	Yes	
Prepare meals from non-processed ingredients	Yes	
Cook and eat breakfast more frequently	partially	My class schedule hasn't changed since the Challenge started, and it does not permit me to cook for myself every single day.
	Partially	I continue to struggle to eat breakfast consistently.
	Yes	I felt excited to try the new recipes in the morning. I rarely cook meals for myself in the morning, so it was a good opportunity.
	Yes	I found myself consistently eating real meals throughout the day. This is very unlike me because I often snack throughout the day instead of making full meals.
Learn about time management and health priorities	Yes	Learned about efficient time management and prioritizing cooking breakfast
Improve cooking skills	Yes	I learned several skills of meal preparing and cooking that are easy for me to incorporate into my everyday life.

Table A1 continued.

Learning Goals	Achieved (yes/no)	Selective Quotes from Students
Have a balanced breakfast	Yes	Having an assortment of ingredients is helpful to keep a balanced meal. I enjoyed how the large portions allow me to save it for future meals.
Maintain a healthy lifestyle during the Challenge and even after the Challenge	Partially	Did wake up a bit early to prepare breakfast. However, need efforts to maintain it.
Prioritizing health and transform knowledge into action	Yes	I never expected the things to come out of the Challenge to affect my daily life. Yet, I've started to put my health first and the knowledge I know from nutrition to action.
Panel D: Other skills learned		
Improve media creation skills	Yes	Gaining practice with TikTok and YouTube to upload and edit digital media content were all extremely helpful for the future, whether in classes or in the workplace. As the world of advertising and marketing moves digitally, these skills can help separate employees and brands from those without these proficiencies.
	Yes	Since I decided to make cooking videos for my deliverables, I also learned a lot in editing videos
Stay on top of scheduling and deadlines	Yes	I tried to edit and post all videos to TikTok and the class blog on the days we were eating them, to ensure that they were accessible to Dr. Jin and Dr. Wagner. Also, since they were instructional, they could help other students who struggled to make the dishes. This has built my daily routine to be a lot better and has even helped with my sleep schedule.
Time management	Yes	

Panel E: Unexpected learning and achievements

Food safety: Got food poisoning for failure to know that chili quickly spoils.

Food preference: The chili was so nice, and I was able to make it again after the Challenge.
          I didn't expect to like the chili, but I really enjoyed it and will make it again soon.
Cooking preference: I unexpectedly learned that I enjoy cooking. There is a sense of accomplishment when cooking a meal successfully.
Breakfast and snacking: I found that, when eating a nutritious and filling breakfast, I was less likely to snack throughout the day.
Budgeting: I was aware how much money I saved from just cooking/making my breakfast for the week!

Appendix B: Creative Expression of Individual Challenge Experiences

The Challenge participants provided a diverse range of introspective expressions, including written narratives accompanied with photos (N = 4), videos of storytelling or breakfast cooking (N = 3), blog posts (N = 2), and infographics (N = 7). Below we showcase some of them.

Format	Students' Creative Expression of Their Challenge Experiences
Video	https://youtu.be/7q7-Lm197j0
	https://youtu.be/Iv8FjdyhtoI
	https://youtube.com/playlist?list=PLo0P3BngvEXZXigf9ipC35biFFII6o4kw
Written Narrative with photos	

Infographic

Lynette
Vasquez

Healthy Eating Challenge Learning Results

These are some of the things I learned while doing the challenge and reinforced through my understanding if other classes affecting food and taste

Oatmeal benefits
↪ High in fiber
↪ Has soluble & insoluble fiber
↪ Rich in carbs
↪ Lower cholesterol
↪ Reduce blood sugar
↪ Boost immunity
↪ Zinc, Iron, Manganese filled
↪ Antioxidants, including phytic acid, vitamin E, phenolic compounds
↪ Improve digestive movements

Chia seeds benefits
★ Build muscles
★ Boosts Body Metabolism
★ Improves digestive health
★ Antioxidants
★ Rich in nutrients
★ High in fiber

Trans fats are fats that are hydrogened oils which can increase heart attacks, stroke, high cholesterol, and more. While Saturated fats are found in oils such as olive, sunflower, nuts, avocado, corn, and soybean.

Cultural indulgences/ cultural foods play a large factor in nutritional health, especially when meeting with a nutritionist or someone to talk about the food you are eating to have a balance of fruits, vegetables, fats, sodium, sugar intake, and etc.

The tastebuds have 5 different taste receptors; Sweet, Sour, Bitter, Umami, & Salty.

The Bitter, Sweet, & Umami have protein receptors, while the Sour & Salty most likely have ion channels.
The ion channels process is your body having to contain channels under the taste bud for salty & sour that open and close once having a food with salt or spices that touch your tastebuds.

The protein receptors is the process of having your taste buds stimulated, which then get processed through transduction mechanisms that then travel to the nerve endings, and end up in the frontal lobe of the cerebral cortex which is then decoded by neurotransmitters that send chemicals to the brain if you should eat it or not/ if its toxic or not.

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Case Study

Promoting Sustainable Products in Dry Consumer Packaged Goods: What Should a Grocer Do?

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Abstract

The objective of the decision case study is to make a recommendation on whether to introduce a new product into the planogram of an independent retail grocery chain that does not have a formal sustainability strategy. The decision maker is the chief operating officer of the retail grocery chain. The product is a fair trade-certified coffee produced by Equal Exchange, a worker cooperative. Information is presented about the retail grocery chain, an overview of fair trade, a description of Equal Exchange, and background reading on the coffee supply chain.

1 Introduction

Janice shut her office door. It was a Saturday morning, and the supermarket was full of shoppers. Her office was tucked behind the front of the store checkout area. She needs to get her thoughts together for a Monday meeting regarding carrying products from Equal Exchange, a cooperative that sells fair trade-certified products such as coffee, cashews, almonds, tea, and other dry consumer packaged goods. Janice has watched consumer trends about sustainability, and she wants to have the meeting. After graduating from college, Janice traveled to Central America and northern Africa for three months. She is sympathetic to help small farmers, especially those who sell products like coffee that do not compete with U.S. farmers. Her employer does not have an explicit plan for promoting sustainability, and she believes some of her customers are beginning to ask for such products. The National Grocers Association has begun including the topic in its February annual meeting program, but it is not a major topic of the program. It is Janice's call to make changes to a planogram for coffee in all stores. Her chief executive officer (CEO) tends to follow Janice's recommendations but what would her managers and customers think about such products? Her specific purpose is to introduce her managers and employees to how one might consider introducing a new product based on sustainability label claims.

2 Background on Barton's Foods

The retail grocery store chain, Barton's Foods, is part of a family-owned chain managed by a fourth-generation family member as CEO. There are twenty-seven stores with three different store banners. Barton's is the flagship store with twenty-one locations. Lakeview is a retail grocer acquired in 2011, and the name is retained on the four stores. Save-a-Bunch is a new concept of two stores with small square footage and a high volume of limited products.[1] Janice is the chief operating officer, and her responsibilities include planning what foods are sold in the stores within the store planogram. A planogram is a diagram, drawing, model, or plan for displaying and placement of store merchandise (Figure 1). It can be thought of as a linear programming problem that maximizes net income subject to store shelf space. For example, a planogram for coffee and related products might use brand, packaging size, flavor, and formulation in creating the planogram. A branded coffee might have its

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[1] Unless otherwise noted, Barton's is used to refer to all twenty-seven stores.

Top Shelf	Instant Coffees (Nescafe, etc.)	Dark Roast K Cups (Caribou, Green Mountain, Starbucks)	Dark Roast Coffee Beans (Equal Exchange, Peace, Starbucks, etc.)
	Instant chocolate and malted milk (Neskwik)	Medium Roast K Cups (Caribou, Dunkin, Green Mountain, Starbucks)	Medium Roast Coffee Beans
	3-pound coffee cans (Chock Full of Nuts, Folgers, Maxwell House)	Flavored roast and geographically located K Cups (Caribou, Dunkin, Green Mountain, Starbucks)	Flavored roast and geographically located coffee beans
		Light Roast K Cups (Caribou, Dunkin, Green Mountain, Starbucks)	Light Roast Coffee Beans
Bottom Shelf		Hot Chocolate K Cups	3-pound coffee can beans (Folgers)

Figure 1: Planogram for Coffee Section at Barton's

products displayed vertically in the planogram with larger volume containers on the bottom and single serve coffee K-cups in the middle. Flavors in each category might lie horizontally in this space. The most valuable space tends to be at eye level. Planograms for the center part of the store often have a planogram that is set up the same way with close substitutes on either side of the packaged food product to make it easier for consumers to make choices. Planograms are unique to a store because of a store's size, etc., but in this case, the coffee planogram is similar across stores.

Barton's is considered a chain store. Major and Chanil (2012) classify stores as independent, or chain retail supermarkets based upon the number of stores operated by the firm. In that study, chain stores are defined as firms that own more than ten stores under a single banner, and independent stores are defined as firms with ten or fewer stores. However, Barton's has its roots as an independent family-owned grocer and thought of itself in that way. In 2012, Major and Chanil (2012) reported that independent retail grocery supermarkets, with ten or fewer stores, account for 17.8 percent of all supermarkets and 5.46 percent of total supermarket sales.

The governance structure of conventional retail grocery supermarkets comprises mostly family or employee ownership, as opposed to supercenters, which are owned primarily by multinational firms (Volpe, Risch, and Boland 2015). Major and Chanil (2012) note that there are approximately 36,000 retail supermarket stores in the United States, including supercenters, convenience stores, and online grocers, with conventional supermarkets representing 65.6 percent of supermarket sales. Volpe and Boland (2022) report that Wal-Mart dominates this category with approximately 90 percent of supercenter stores and 80 percent of supercenter grocery sales. Other supercenters include Meijer and Target. Limited assortment supermarkets, such as Aldi and Save-A-Lot, provide a smaller selection at lower prices.

3 Barton's Food Products

Barton's has Wal-Mart, Target, Aldi's, and similar stores as geographic competitors. Similarly, its stores are located in a metropolitan area, and there are three food cooperatives in its area. Barton's stores have two broad sets of customer demographic segments that dominate its geographic footprint. Five stores comprise millennials and low-income parents, and sixteen stores have a predominance of baby boomers

and low-income singles. In 2023, Barton's has not spotlighted sustainability in its promotions. It does have a locally grown fruit, meat, and vegetable program, which is mostly seasonal in nature but most of its meat and produce are sourced from its wholesaler, Independent Grocers Alliance (IGA), and Barton's incorporates the IGA slogan of "Hometown Proud" into its advertising. The IGA is the largest organization devoted for independent grocers such as Barton's, and grocers who are affiliated with IGA have access to improved food purchasing, marketing services, and other resources. Barton's purchases large volumes of products from wholesalers such as IGA to sell directly to consumers because food wholesalers sell to retail grocers rather than consumers. The program consists mostly of sourcing beef and pork products from local farmers and vegetables such as root vegetables (potatoes, carrots, beets); and fruits such as strawberries, raspberries, blueberries, and apples. Janice believes the program volumes are about what could be expected and an option for consumers, but its shoppers do not necessarily come to Barton's stores because they have locally grown fruits, meats, and vegetables.

Barton's has organic options in its fruits and vegetables, but the volumes are lower than the conventional fruit and vegetable substitutes. Janice has seen a headline recently by a University of Minnesota study that found organic premiums have narrowed as supply has increased, and Barton's has seen an uptick in organic purchases (Çakır et al. 2022). The dairy department has many organic products in fluid milk and yogurt but not in cheese spreads and ice cream products. The frozen foods department does not have organic products apart from some entrees and soups.

Barton's built a reputation around several signature products that help attract consumers. Its butchers often have seasonal meat products that are popular and have a line of smoked meats that are sold under a Barton's label. In frozen foods, Barton's has a line of frozen soups that are popular using traditional recipes. In bakery, Barton's baked bread and rolls come to the store frozen and are partially baked. Its produce aisle features cut fruits that are available in single serve with various flavors containing antioxidants that are quite popular. Finally, its twenty-one flagship stores have grocerants that have ready-to-eat and heat-to-eat foods that are quite popular with differing menus by store depending upon ethnicity and cultural differences. Some modifications have been made post-COVID-19, but shoppers have come back to Barton's cafeteria style grocerants.

4 Barton's Sustainability Efforts

The issue of spotlighting sustainability is something Janice has brought up previously, but so far, the Barton family owners have not viewed it as important relative to advertising and promotions and personal services, such as offering a drive-up service for consumers to pick up their groceries, having a butcher in its meat department, and carrying its signature products. The locally grown and organic products are on the "outside" part of the store planogram in the produce and meat departments, but the "center" part of the store planogram, where dry packaged consumer goods are sold, do not have any such products for all practical purposes.[2]

The store planogram for the section with coffee, tea, and similar products is fairly typical of other competing retail grocery stores. Bulk coffee in bags for grinding, boxes of K-cups for single serve in various counts and brands and flavors, traditional ground coffee, accessories such as coffee filters, and similar products are available. Tea is a much smaller category and includes boxes of various flavors and brands. Some of the brands have various sustainability claims on their labels, but Barton's has not done anything to highlight sustainability labeling in its stores.

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[2] Produce, meat, dairy, and frozen foods departments are often on the outside of the retail grocery store planogram against a wall since they require an energy source to keep them refrigerated whereas foods that do not require refrigeration are in the center of the store.

5 The Monday Meeting

A member of Equal Exchange's Citizen Consumer Network introduced himself as Sean and enters Janice's office. Janice is not familiar with the program except that the citizens were customers and not employees or members of Equal Exchange's cooperative structure. The Citizen Consumers are volunteers who visit with retailers to discuss why they should consider carrying Equal Exchange products.

Janice asks Sean to educate her on fair trade concepts and who the potential consumers might be for Equal Exchange products. She explains that it is unclear whether Barton's customers would really purchase products that are considered "sustainable" from a fair trade supply chain. Specifically, because Barton's has organic and locally grown options for the outside part of the store, but there was little promotion and advertising, would a fair trade option for the center part of the store offer any advantages? Would consumers even notice?

6 What Is Fair Trade?[3]

Sean explains to her that fair trade was a social movement that encouraged the development of local communities in lower income countries. Fair trade is a labeling initiative, whose aim is to improve living conditions of farmers and workers in lower income countries. The emergence of fair trade labels dates back to 1988, when a faith-based non-governmental organization (NGO) from the Netherlands began an initiative to ensure coffee growers in low-income countries are provided "sufficient wages." The NGO created a fair trade label for their products called "Max Havelaar" after a fictional Dutch character who opposed the exploitation of coffee pickers in Dutch colonies. Initially, the label was only used for coffee sold in the Netherlands, but similar initiatives soon grew across the globe. According to Laura Raynolds (2009), fair trade "represents a critique of historically rooted international trade inequalities and efforts to create more egalitarian commodity networks linking marginalized producers in the global South with progressive consumers in the global North."

Sean points out that the fair trade movement has three main components: "(i) the organization of alternative trading networks; (ii) the marketing of Fair Trade labeled products through licensed conventional traders and retailers; and (iii) the campaign-based promotion of Fair Trade to change both purchasing practices and the rules of conventional trade" (Wilkinson 2007). Fair trade gives farmers better prices and long-term trade links, and it also gives consumers more options to buy products produced at high social and environmental standards. Both farmers and consumers are better off in the fair trade transaction. Essentially fair trade begins with a producer price that enables a producer and family to be paid a living wage, and the supply chain adds margins for value-added activities and services on top of this price, which may result in a consumer price that is greater than a similar product not produced under a fair trade program.

Janice asks how far upstream the fair trade certification extends in a supply chain. Sean explains that for a product to be sold under the fair trade label, all actors in the supply chain must be fair trade-certified, as described in Appendix A. Janice inquires whether there are other programs that accomplish the same goals as fair trade. Sean says there are other certification standards such as Rainforest Alliance and USDA Organic. For different products, there are similarly prominent labels, including the Forest Stewardship Council, Marine Stewardship Council, Roundtable on Sustainable Palm Oil, and GLOBALG.A.P (Meemken et al. 2021). However, he points out that the fair trade program has the deepest knowledge among consumers.

Cocoa is used as an example. Fairtrade International has taken significant steps toward improving the lives of cocoa farmers. In 2018, they announced an increase in their minimum price for cocoa and are currently piloting a plan that pays farmers based on production costs and fair livelihoods.

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[3] Fair trade is capitalized when referring to a specific program and not capitalized when used in a generic sense.

In contrast, Rainforest Alliance has yet to implement any such measures or even require a minimum price for cocoa despite claiming to be reimagining certification and improving it in 2023. But if there is no commitment to ensure a minimum livable price, then calling something "ethical" and labeling it is simply rebranding poverty and exploitation, Sean suggests.

7 The Use of Fair Trade in Supply Chains

Janice asks what consumers think about fair trade labeling and whether they really believe that fair trade balances the power of economic agents in supply chains. Sean explains that supply chains are now characterized by massive concentrations of purchasing power at the level of retailers who are referred to as chain captains and large traders. Janice knows this because she deals with it every day in her job. Small producers in lower income countries have little bargaining power and often face a choice of whether to sell at a low price or not to sell at all. In addition to low profits, they may work for hours in unsafe conditions, such as forced labor, child labor, and discrimination. By paying producers a sustainable price and giving them safe working conditions, fair trade strengthens the bargaining power of marginalized producers, who suffer most from unequal power in supply chains.

Fair trade helps brands monitor potential risks in their supply chains. Certain product categories are at high risk of serious problems like child labor. Fair trade assists brands in selling those goods to monitor risks. For example, the Fairtrade International system has a strong track record of combating child labor by investing in a youth and community approach. Sean shares how fair trade makes most economic agents in supply chains economically better off because they achieve profitability and sustainability. Consumers receive ethical and sustainable products they want, and have assurance that there is compliance in the labeling. Janice asks whether there is a premium for fair trade products such as Equal Exchange. Brands earn higher profits by selling fair trade products that are highly competitive on the shelf. According to a Nielsen (2018) sustainability study, fair trade coffee sells five times faster than conventional coffee, outperforming conventional coffee sales by 22 percent. In addition, Naegele (2020) estimates consumers pay about $1.50 extra per pound of fair trade-certified coffee compared to non-labeled. Fair trade seeks to transfer wealth from consumers to farmers, but it is hard to realize. According to Naegele's (2020) research, most of the fair trade premium paid by consumers goes to coffee roasters. Sean says in his experience, retailers make smaller profits on fair trade-certified coffee compared to conventional coffee. If that is the case, why would Barton's sell a coffee produced by Equal Exchange, asks Janice?

8 What Made Equal Exchange Unique Among Fair Trade Products?

Equal Exchange was the first company to bring fair trade coffee to the United States in 1991 and remained the only organization using the fair trade model until 1998. All Equal Exchange coffee is fair trade. Janice is told that for other companies, fair trade coffee usually constitutes only a small percentage of their total sales. In such cases, fair trade coffee products are something added on to, and possibly subsidized by, a much larger conventional coffee operation. Equal Exchange offers fair trade products in wholesale case pricing, so consumers can access lower prices on coffee, tea, and chocolate for serving and fundraising. As a worker cooperative, Equal Exchange operates in the same democratic, equitable, and transparent manner that the fair trade certification system requires of participating farmer cooperatives. Conventional companies are neither obliged to, nor do, operate in accordance with these fair trade principles.

Janice asks again about coffee. It is the largest shelf item in the planogram for that section, and Barton's sells coffee in various forms. She explains how their local sourcing of meat produce and fruits worked, and discusses the organic products they sell. How can Equal Exchange help a retail grocer like Barton's introduce sustainability concepts into the center part of their store? Sean explains the unique features of coffee production and how consumers might want to know more about coffee production.

That information is shown in Appendix B. Janice is surprised at how labor-intensive coffee production is and how different production methods help dictate the quality of coffee and where value creation occurs. Janice is curious to know more about the coffee producers and how Equal Exchange decides whom to partner with in the supply chain. She learns that Equal Exchange trades directly with small-scale farmer cooperatives. They partner with farmer cooperatives who are democratically organized, sharing resources and decision making among their members.

She is told that Equal Exchange locates farmer groups and sources coffees from cooperatives in Latin America and Africa. Equal Exchange had become part of the European Fair Trade network—aligning with groups that were at least a decade ahead of what was happening in the United States. That movement in Europe is growing rapidly, and counterparts there help the cooperative to establish links with farmer cooperatives worldwide. Tea also seems like a step in the right direction. It is a commodity consumed by millions and is a natural complement to coffee. In 2023, Equal Exchange is working to establish markets for small-scale tea farmers from India, Sri Lanka, and South Africa. Finally, Equal Exchange is currently expanding into pecans, cashews, peanut butter, and cheese. Janice learns that these products should be available for purchase in 2024.

9 Issues to Consider

Janice knows that to carry Equal Exchange products on the store shelf, Barton's needs to displace a competitor's product from the planogram. There is not enough space to add an additional item. Existing competitors include Peace Coffee, BLK & Bold, Kicking Horse Coffee, and Peet's. Peace Coffee and Kicking Horse Coffee sell whole bean and ground coffee. BLK & Bold's product line includes whole bean, K-cup, and ground coffee. Barton's sells light, medium, and dark roasted coffee and various flavors. In addition, Folgers, Maxwell House, Chock Full o'Nuts, and Nescafe are sold by Barton's.

In addition, Barton's needs to promote the product to educate consumers because the overall price is likely to be higher. Barton's promotes the unique features of Equal Exchange's products. Sean mentions that Citizen Consumers like himself help retailers through a variety of methods, including working with local faith-based groups, NGOs, and other entities to build awareness within the store. Janice believes that Barton's can promote the products to consumers from five aspects.

- Equal Exchange products are fairly traded. Fair trade products are better for farmers, better for the environment, and better for consumers. Sean says, if you want to promote social justice, environmental sustainability, and fair trading relationships, buying from Equal Exchange is a way to connect your values with your actions as a consumer without sacrificing taste or quality.
- Consumers are supporting a different kind of business model based on dignity and transparency by choosing fair trade products.
- Equal Exchange has a track record for market access using fair trade for small-scale farmers from the moment they were founded in 1986. They are a worker-owned cooperative whose mission is tied to building a food system where consumers have choices and feel connected to the people in the supply chains. Equal Exchange works only with other democratically organized farmer groups. This might be used as a point of differentiation, he notes.
- Consumers do not need to worry about quality and freshness of products from Equal Exchange. Quality might be another source of promotion. Equal Exchange roasts their own organic coffee in Massachusetts daily with a team of quality control professionals. Each batch of coffee is "cupped" to make sure it meets the consistent and high-quality standards Equal Exchange set for their coffees. They seal in the freshness on each package, so it arrives directly to the consumers' door fresh.
- Fair trade products usually cost about as much as other organic and specialty-grade products of similar quality. They also offer wholesale case pricing to consumers.

The Citizen Consumers explain that none of Barton's direct competitors carry Equal Exchange products except two of the three food cooperatives. In addition, there is a wholesale cooperative warehouse being built in the area, and Equal Exchange can rent space so distribution and inventory issues should not be an issue. Sean leaves a box of chocolate and coffee samples, and Janice says farewell noting that she will discuss this with her team.

10 Barton's Decisions to Make

Janice needs to decide whether it was worth recommending that Barton's place Equal Exchange's fair trade-certified products in its planogram in coffee, tea, and hot cocoa. In doing so, she knows that it is likely that the products are higher priced and require a certain amount of promotion dollars. She knows that local food cooperatives carry Equal Exchange's products, but she believes that these stores carried organic and locally grown meat and produce before Barton's implemented such programs. The center part of Barton's stores does not have a theme built around sustainability, but the theme of linking with small-scale farmers in lower income countries appeals to her altruism. Coffee and tea can be a start. Barton's needs to promote it to make it visible and work with the Citizen Consumers on education. Would that be enough to convince consumers to buy it? There is not any data to plan a decision like this, and Janice needs to convince the store owners that this is a logical next step to try and build a small program in sustainability.

The twenty-seven store managers meet weekly in person or via Microsoft Teams. Although the store managers do not have authority to make their own buying decisions, their opinion is considered regarding changes to the store planogram. Janice wants their opinion because sustainability is something that was not easy to communicate, and it is likely that not every manager will buy into the concept of trying to promote this in the center part of the store. And each store has different ethnic and cultural characteristics as well as different sets of consumers. It is likely that these individuals will have different approaches to Equal Exchange's story.

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Appendix A: Historical Background and Concepts of Fair Trade

In 1997, the various national labeling initiatives formed an umbrella association called Fairtrade International or Fairtrade Labelling Organizations International (FLO), along with three other organizations including TransFair USA. "Fairtrade" is used by Fairtrade International for their specific certification mark, which is different from the general initiative. A common "Fair Trade" certification mark was launched in 2002. In 2012, Fairtrade International's largest adherent, TransFair USA, split from the organization and launched a parallel label, Fair Trade USA. Fairtrade International, Fair Trade USA, Fair for Life, World Fair Trade Organization (WFTO), and Fair Trade Federation are five widely recognized fair trade labels. According to Dragusanu, Giovannucci, and Nunn (2014), the mechanisms of fair trade standards consist of six aspects.

- *Price floor*: Fair trade's central characteristic is setting a minimum price for fair trade-certified products to ensure sustainable production costs and a living wage for producers. When the world price is below this, fair trade buyers must pay at least the minimum price, but higher prices can still be negotiated based on quality and other factors. The guaranteed minimum price serves as a safety net for growers, reducing their risk.

- *Fair trade premium*: Fair trade involves a price premium paid by buyers to cooperatives in addition to the sales price, with a portion earmarked for productivity improvement. The premium is meant to promote democracy and association, with producers deciding democratically how the premium should be used. The premium funds a variety of projects, including those aimed at increasing farmer productivity, building community infrastructure, offering training for members of the community, improving water treatment systems, and so on.

- *Stability and access to credit*: Fair trade buyers agree to long-term contracts for at least one year, and usually multiple years. They may also offer advance crop financing to producer groups, providing up to 60 percent of the financing if it is requested.

- *Working conditions*: Fair trade standards require safe working conditions, freedom of association for workers, and payment of wages that meet or exceed legal minimums or regional averages. Certain forms of child labor are prohibited.

- *Institutional structure*: Fair trade encourages farmers to form associations or cooperatives with transparent administration and democratic decision making, while larger enterprises for certain products, such as tea, bananas, and flowers, must have joint committees of workers and managers that are democratically structured.

- *Environmental protection*: Fair trade prohibits the use of certain harmful chemicals in production, and requires members to adopt good environmental practices, including minimizing or eliminating the use of less-desirable agrochemicals and using natural methods. Producers must provide basic environmental reports summarizing their impact on the environment. The production of genetically modified crops is not allowed.

- The standards are tailored for each crop and for the different actors involved in the supply chain.

Appendix B: Overview of Coffee Supply Chain

Coffee is typically grown in regions with warm, moist climates, which provide ideal conditions for pests and diseases to thrive. As a result, farmers often resort to using chemical pesticides and herbicides to protect their crops. In addition, chemical fertilizers may be used to boost yields and replace the nutrients lost from the soil due to intensive farming practices.

1 Coffee Production

Equal Exchange coffee is fair trade and certified organic, produced without the use of synthetic fertilizers or chemicals, which means cleaner beans, air, land, and water. The coffee is grown with only organic fertilizers, like coffee pulp, chicken manure, or compost. As a bonus, fair trade coffee beans are richer in healthful antioxidants, and many people can even taste the difference. In addition, most conventionally grown coffee plants are hybrids developed to flourish in open sun. Forests are cleared to make room for open fields in which to grow mass amounts of this sun-loving coffee variety. In contrast, Equal Exchange coffee is shade-grown. Shade-grown coffee is grown within the shade of lush forests, providing a home for wild plants and animals, sustaining soil fertility, and producing a richer and more flavorful cup of coffee.

Coffee is grown on trees that thrive in tropical and subtropical climates, usually 1,000 miles from the equator or less and at altitudes of up to 7,000 feet above sea level. Coffee trees begin their lives in a nursery and are transplanted to farms about a year later. The coffee tree then matures for another four to five years before it begins its annual cycle of production, starting as small white flowers and developing into small green cherries. The green cherries ripen into a deep red color inside of which are two coffee seeds. These seeds are eventually used to plant more coffee trees or processed into green coffee beans that are later roasted and ground into coffee ready to be brewed.

Once coffee cherries are red and ripe, a series of processing events take place before the green coffee beans are moved to the next stage of the commodity value chain. The manual labor needed for these processing events is intensive. Coffee beans must first be harvested from the trees. Harvesting is done by hand in an effort that can require up to seven gathering cycles since not all coffee cherries ripen at the same time. In large, commercial farms located on relatively flat land, mechanical harvesters are increasingly used to harvest the crop. Most specialty coffees are picked exclusively by hand and are only taken from the middle part of the crop for the highest quality of beans.

Although production advancements have been made, most of the 25 million coffee farmers work in small family farms with less than 6 hectares, or about 15 acres, without access to information on improved cultivation techniques and market conditions. In larger, wealthier coffee-producing countries such as Brazil and Colombia, farmers are organized into cooperatives that provide and share information and resources for improving production and marketing decisions.

2 Coffee Harvesting and Processing

Coffee ripens depending on the climate, the altitude, the type of soil, and the variety of coffee. Some areas and farms have their own microclimate. In remote areas, the coffee produced has its own particular and quality flavor. To guarantee a high-quality coffee, the ripe cherries are hand-plucked from the tree or bush. Immediately after harvesting, the outer skin is peeled off the cherry using a pulping machine. To make the process smooth, water is poured while pulping. After this process is done, the pulp is used as nutrition for new coffee trees.

After pulping, the cherries are submerged in water pools. This cleans them and also removes any remaining layers. The beans that sink are considered good quality and kept, while the floaters are

separated from the rest of the bunch. Before coffee beans end up on the drying trays, they are washed several times to remove the sweet sugar coating on their outside, that would otherwise create a bitter flavor.

The beans are dried in the sun for several days until the moisture is approximately 11 percent. The farmer chooses an area that's wide, flat, and clean, and spreads the beans out with a rake. They turn the beans with this rake while the sun shines, and then hurry to cover them with a huge sheet if there is a hint of rain or moisture about. Farmers cover the beans every night, to keep off the dew.

Once the coffee has dried, parchment beans are formed. The farmers sell the parchments off to the coffee cooperative. Once the parchment beans arrive at a fair trade cooperative, they are then turned into green beans. This involves the beans being judged by their weight and appearance. They are being "polished," which means removing the last layer of skin covering the coffee beans. Then, the beans are sampled by buyers, which they call "coffee cupping." These samples are sent to the cooperative, so they can easily vouch for the quality of the coffee to buyers.

3 Coffee Marketing

Equal Exchange roasts their coffee in Massachusetts daily with a team of quality control professionals. Each batch of coffee is "cupped" to make sure it meets the consistent and high-quality standards Equal Exchange set for their coffees. Equal Exchange offers both regular and decaffeinated coffee. To decaffeinate their coffee, Equal Exchange uses a natural water process. This process involves soaking the coffee beans in hot water to extract the caffeine, and then replacing the water with a natural solvent called ethyl acetate, which is extracted from fruits. This solvent binds to the caffeine molecules and is then removed along with the water. Finally, the beans are then dried to remove excess moisture and are ready for roasting. This process is all-natural, ensuring the coffee beans retain their flavor and aroma without the extra caffeine.

Coffee is one of the world's most valuable "soft" commodities and among the largest food value imports in many developed countries (Chaddad and Boland 2009). There are two different species of coffee. Arabica coffee beans are used for higher grade coffee and accounted for 60 percent of total world production. Robusta is a lower grade coffee with a neutral flavor and stronger caffeine content. Robusta coffee beans are grown at lower altitudes and are more resilient to disease and weather, while Arabica coffee beans are usually grown at higher elevations and mature more slowly. Arabica coffee bean production is concentrated in South America and Central America, while Robusta coffee bean production is concentrated in Asia and South America. Brazil is the only leading country to produce both Arabica and Robusta coffee beans.

Even though Robusta and Arabica coffees have different characteristics, their markets are highly interdependent because processors (or roasters) use both types of coffees in their blends. Robusta is normally used as "filler" in coffee blends—as it has a neutral flavor—with Arabica beans originated from different regions giving the coffee blend its distinctive attributes in terms of aroma, body, and flavor. Another distinguishing characteristic between Arabica and Robusta is that "defects" due to improper post-harvest handling of coffee beans in Robusta may be corrected by means of new processing technologies such as "steaming." In other words, whenever a Robusta bean is not properly harvested or handled, which creates a harsher or sour flavor, steaming is used to wash out undesired tastes. For Arabica beans, post-harvest handling operations at the farm and quality segregation and grading by the marketer (cooperative or trader) are substantially more important to preserve the desired coffee bean attributes valued by roasters. Figure B1 shows a description of the coffee supply chain.

Planting coffee trees	Harvesting coffee beans	Pulping and washing coffee beans	Drying coffee beans	Selling coffee beans to coffee co-ops or other companies	Roasting and grinding	Packaging, distributing, and retailing	Consumer
Coffee is grown on trees that thrive in tropical and subtropical climates.	Coffee beans are harvested from the trees once they are red and ripe.	Skins of coffee cherries are peeled by pulping machines. After pulping, the cherries are submerged in water pools for washing.	The beans are dried in the sun for several days. Once the coffee has dried, parchment beans are formed.	Farmers sell the parchment beans to the coffee co-operatives or other companies.	Coffee beans are roasted at different levels, from light to dark. After roasting, some of the coffee is ground according to the customers' needs.	Coffee is typically packaged in bags. Coffee co-ops and other companies sell their products online and deliver their products to retail grocers, cafes, schools, etc. for sale.	Consumers choose coffee based on their taste and preferred brewing method.

Figure B1: Overview of the Global Coffee Supply Chain

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Case Study

Renaissance Ag: Identifying the Who, How, and Where of Marketing a New Technology

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Abstract

This case study explores the marketing decisions facing an agricultural technology company in Utah. Renaissance Ag recently developed a technology that converts shipping containers to hydroponic feed production systems. One shipping container produces 1.5 tons of livestock feed per day and requires less water compared to conventional agriculture. This technology has promise in a world food system being constantly forced to produce more with less. However, promoting adoption of new technologies in agriculture is always challenging. Renaissance Ag's long-term viability is dependent upon efficiently channeling its limited marketing budget toward regions and agricultural sectors likely to receive the largest benefit from their technology. This case study challenges students to conceptualize and quantify the trade-offs associated with selling in different markets. It also has them consider impacts of different payment structures on equipment sales. The intended audience for this case is freshman and sophomore students in agribusiness and agricultural economic programs.

1 Introduction

Brady Blackett, the head of the sales team at Renaissance Ag, takes in the views of the Wasatch Mountains on his drive home from work. On the drive, he reflects on the day's meeting with the leadership team. Renaissance Ag has developed a hydroponic system that produces livestock feed using less land and water than conventional production. The problem is that the company needs to start making sales in a market that is in its infancy. It is up to Brady to identify the target market and the strategy that will lead Renaissance Ag to profitable sales as quickly as possible. This will be challenging, but if he can pull it off, Renaissance Ag will gain the resources they need to continue growing and maybe even revolutionize the livestock industry.

This technology is called the PastureBox, a system that offers several benefits. First, each shipping container-sized PastureBox can grow the feed equivalent of 15 acres of hay a year. It does so using 93 percent less water than conventional production. This attribute would be valuable for any livestock producer who is either land- or water-constrained. Second, experiment data from the engineering team looks promising. A pilot-scale PastureBox reliably produces fodder, and most engineering challenges are resolved.[1] Third, experiment data from the animal science team also looks encouraging. When compared to entirely alfalfa-based rations, 50-50 rations of a fodder-alfalfa mix produced similar weight gain in cattle and milk nutritional composition. This suggests that PastureBox fodder could be a close substitute for a portion of alfalfa rations in the cattle or dairy industries.

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[1] For the PastureBox to work, engineers needed to develop effective systems for lighting, timing, insulation, piping, and input use. All of these factors have been addressed. The only remaining engineering challenge includes making improvements to the water recycling system.

The PastureBox does have one major drawback, which is its cost relative to conventional agriculture. The PastureBox's cost of production can make it more expensive than the alfalfa equivalent in certain regions and times. Also, the box itself is expensive for Renaissance Ag to produce. Each unit costs Renaissance Ag over $100,000 to manufacture. Based on these considerations, Brady has three primary questions he needs to resolve before pitching his marketing strategy to management at the end of the week.

1. What industry should this technology be sold in? Brady feels that this technology should be geared toward either the dairy or the cattle industry since those are the two areas for which the technology has been tested. Each of these industries has potential benefits and costs associated with it, and it is not immediately clear which sector would be best.

2. What region should this technology be sold to? This technology will be most successful in areas that will benefit from it most (e.g., areas of scarce water, scarce land, high feed cost, etc.), but the degree to which each of these factors matters relative to the other must be carefully considered.

3. How should this technology be sold? A single PastureBox would be a large investment for a small- or mid-size business.

1.1 Learning Objectives of This Case Study

i. *What industry should this technology be sold in?* Students should gain an understanding of the trade-offs associated with technological adoption across various industries. These trade-offs will include costs, benefits, and changes in risk exposure associated with the technology in each industry.

ii. *What region should this technology be sold in?* Students should gain insight into the specific external factors (e.g., market, policy, natural resources, etc.) that influence the advantages and disadvantages of a given technology across different regions.

iii. *How should this technology be sold?* Students should learn how transactional structure (e.g., payment size, financing options, payment plans, etc.) influence the desirability of adopting a new agricultural production technology.

2 Background of Renaissance Ag and the PastureBox

Renaissance Ag is a young agribusiness company headquartered in Vineyard, Utah. Having a management team familiar with production agriculture in this region has acquainted them with the agricultural problems associated with limited land and water availability. This motivated them to invent the PastureBox. The PastureBox is made from a shipping container that is modified to grow grain fodder. This fodder is grown from seeds such as wheat, barley, or rye. Each day, new seed is placed in the box where it is watered. It then takes 6 days to reach maturity. The result is fodder, a grass-like feed that is a few inches high and can be used as a partial substitute for hay.

The PastureBox produces feed using less water and land than conventional production. One PastureBox can produce 3,000 pounds of fodder daily. The PastureBox also has the potential to cut down on hay storage costs. It creates a continuous stream of feed rather than being tied to the growing season. The controlled nature of this production also means that production cost of fodder produced in the PastureBox will be much more predictable than alfalfa or other hay sources that are subject to variations in rainfall, sun, pests, and any other factor that affects yield.

Figure 1: Picture of a PastureBox Unit (Renaissance Ag, 2024)[2]

Renaissance Ag is one of only a few companies that offer this kind of product. This status comes with both benefits and costs. On one hand, they face limited competition, which could give them a sizeable market share for hydroponically produced cattle/dairy feed. On the other hand, this market is in its infancy, and producers have yet to widely adopt hydroponic technology for livestock feed. Renaissance Ag first needs to build the market and associated supply chain for their product. With no existing road maps for hydroponically produced feed, they will need to develop all of their relevant strategies from scratch. They also have to win over producers who are unfamiliar with their product.

2.1 PastureBox Experimental Data

In the fall of 2022, Utah State University partnered with Renaissance Ag to bring a PastureBox to their south research farm. Researchers conducted a study where 20 beef cows with their calves were split into four groups of five. In this trial, two groups received alfalfa in their ration. The other two groups received a 50-50 (by weight) ration of alfalfa and fodder. On days 0, 10, 45, 55, and 90, researchers recorded observations such as the cow's weight, the protein and the fat in the cow's milk, and the calves' weight. For each metric, data was charted to compare the outcomes of alfalfa-fed rations to mixed rations. The results from this study were used to gauge the substitutability of fodder for alfalfa and calculate the cost per pound gained of both feed rations. In Figure 2, the blue line illustrates the average weight of the alfalfa-fed calves over 90 days. The orange line represents the fodder-alfalfa mix fed calves over 90 days. Alfalfa-fed calves started out a little heavier, but both groups ended at similar weights. Weight gain was slightly higher for the mixed ration. This study also collected data on beef cow milk attributes. This was done for two reasons. First, cow's milk plays a prominent role in a calf's growth. Checking the fat, lactose, and protein is the best way to see if there is a difference in milk quality. Second,

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[2] For a demonstration of this technology see, https://www.youtube.com/watch?v=E-fNbNplqLc
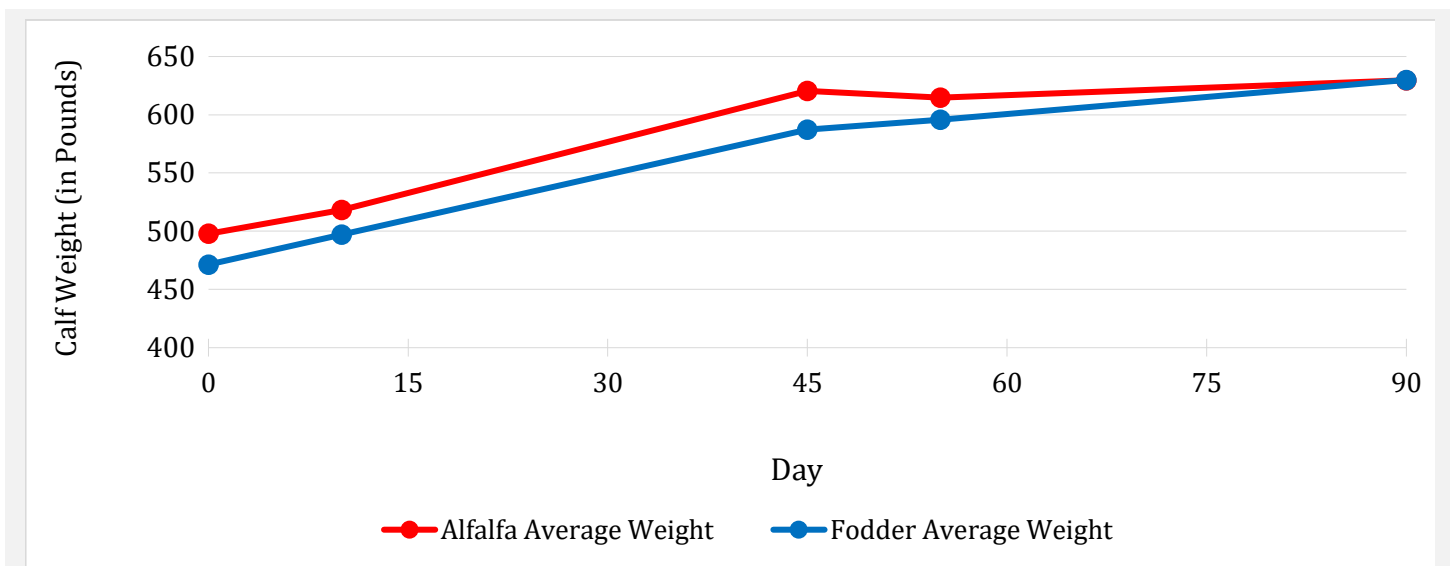
Figure 2: The Average Weights of Alfalfa-Fed Calves vs. Those Fed Fodder-Alfalfa Mix over 90 Days (Renaissance Ag 2023)[3]

Renaissance Ag is still deciding where their technology would be the most beneficial. The milk was tested to see if there was any difference in milk quality. If milk produced with the mixed feed had superior or similar qualities to milk produced with alfalfa-only feed, Renaissance Ag will also consider marketing their technology to dairies. The results of this study are displayed in Figure 3.

Figure 3 compares the resulting nutritional composition as a percentage of milk from cows fed the alfalfa ration (blue) and the fodder-alfalfa mixed ration (orange). Lactose, protein, and fat levels were similar across feeds for the duration of the study. The effect of feed composition was not found to be statistically significant for any of the milk nutrient levels over the duration of the study. This takeaway from the Utah State University study is corroborated by a second study Renaissance Ag completed with researchers at Cornell University. That study compared a control ration to one that
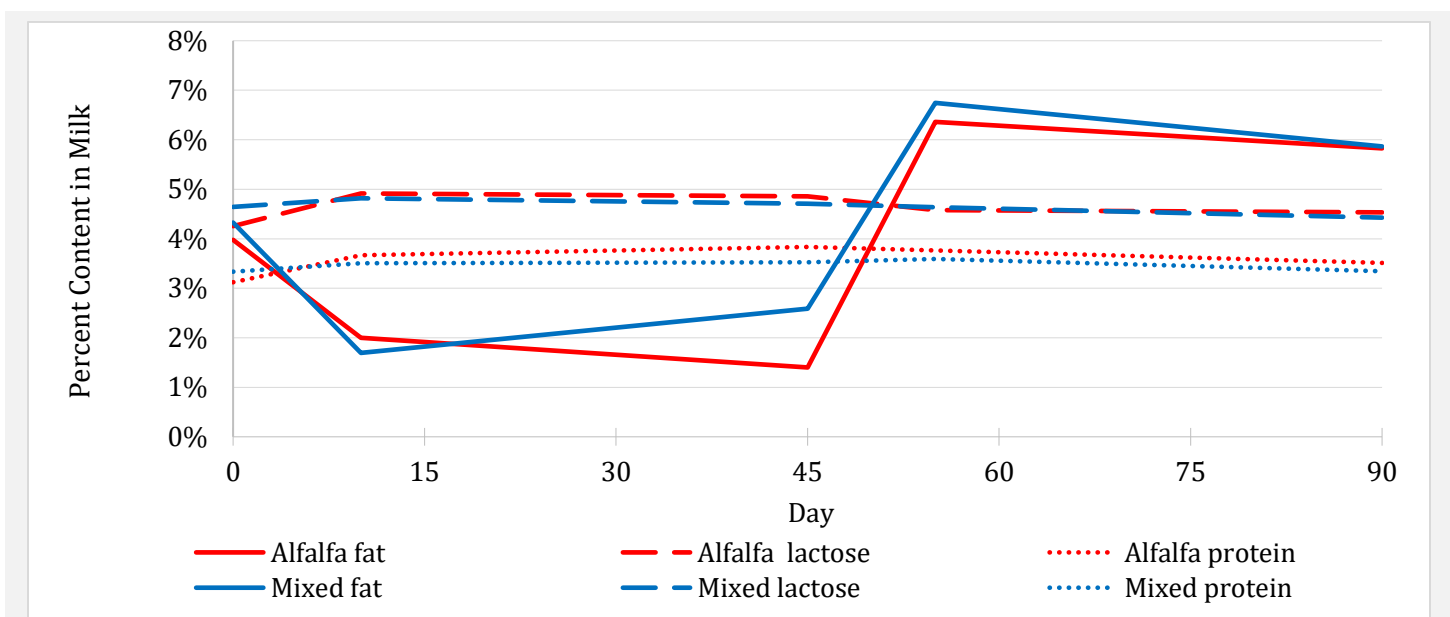
Figure 3: Measured Fat, Lactose, and Protein Percentages in Milk for Cows Fed Alfalfa vs. Fodder-Alfalfa Mix over 90 Days (Renaissance Ag 2023)[4]

included 10 percent wheat fodder and another that compared 10 percent barley fodder. Milk attributes were the same between both fodders and the control group. The barley fodder ration had a 7-percent higher feed efficiency compared to the control diet.

2.2 Economic Comparison of Different Feeds

While these feed sources may produce similar outcomes in terms of calf weight gain or milk composition, they may have different costs associated with them. Table 1 shows a budget for the costs required to produce fodder from a standard-size PastureBox and the associated per ton cost of producing fodder from the box.

Table 1: Estimated Cost of Producing Fodder from the PastureBox

| Item	Parameter	Units	Source
Daily output	1.5	Tons of fodder per day	(Renaissance Ag 2023)
Monthly output	45	Tons of fodder per month	(Renaissance Ag 2023)
Monthly water cost	$84.38	Total cost per month	(Logan Municipal Council
Monthly electricity cost	$33.60	Total cost per month	(Electricity Local 2023)
Monthly seed cost	$3,109.09	Total cost per month	(Renaissance Ag 2023)
Monthly rental cost	$2,500.00	Total cost per month	(Renaissance Ag 2023)
Total monthly cost	$5,727.07	Total cost per month	(Author Calculations)
Cost per ton of fodder produced	$127.27	Cost per ton	(Author Calculations)

Costs for the table were estimated using numbers provided by Renaissance Ag. Each PastureBox is supposed to produce 1.5 tons of fodder daily. Each pound of feed produced requires 0.625 gallons of water at an assumed price of $0.0015/gallon. The system requires an average of 14 kWh of electricity per day with an assumed electricity price of $0.08/kWh. The system requires 545.45 pounds of new fodder seed each day, which was assumed to sell at a price of $0.19/pound. Finally the cost of renting a PastureBox was assumed to be $2,500/month.

Researchers then combined results from the calf weight gain study and the PastureBox budget to calculate the average cost of weight gain across both diets. Average weight gain for each group was divided by total feed fed to each cow-calf pair over 90 days. Each pair in the previous study was allowed to consume as much feed as they wanted. Cow-calf pairs on the alfalfa ration consumed an average of 22.7 pounds of alfalfa daily. Cow-calf pairs on the mixed ration consumed an average of 15 pounds of alfalfa and 15 pounds of fodder daily. More pounds of feed were consumed in the mixed ration due to fodder having a higher water content per pound than alfalfa does. Table 2 displays the results and costs associated with the 90-day study.

The total feed consumed for a cow-calf pair over the duration of the study was multiplied by the price of the feed to calculate the total cost of feed. The fodder production cost was recovered from Table 1 ($127.27/ton), and the alfalfa price was assumed to be the Utah alfalfa price in 2023 ($303/ton; U.S. Department of Agriculture, National Agricultural Statistics Service 2023). Total feed cost for each ration

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[3] The mean feed treatment effect on cattle weight was not statistically significant, at a 5-percent level for any weigh day.

[4] The mean effect of feed treatment on milk fat, lactose, and protein percentages was not found to be statistically significant at the 5-percent level for any measurement day of the study with the exception of day 45 for lactose and protein.

Table 2: Feed Cost per Pound Gained Over 90 Days for Alfalfa-Fed Calves vs. Mix-Fed Calves

	Alfalfa ration	Mixed ration	Units
Cow-calf daily alfalfa consumption	22.7	17.5	pounds
Cow-calf 90-day alfalfa consumption	2,043	1,575	pounds
Cow-calf daily fodder consumption	0	17.5	pounds
Cow-calf 90-day fodder consumption	0	1,575	pounds
Total cost of feed over 90 days	$309.51	$338.84	total cost
Average calf weight gain	132	159	pounds
Cost per pound gained	$2.34	$2.13	$ per pound

Note: The feed rations in this experiment represent a realistic scenario but are by no means a one-size-fits-all strategy. Feed requirements will be affected by cattle breed, age, climate, and final market. Factors such as caloric needs, digestibility, and feed:grain ratios will vary across application. The implications of changing feed requirements are explored in the attached corresponding budget.

was divided by the average calf weight gain for each ration to recover the cost for each pound gained. Based upon these assumptions, the alfalfa fodder mix was estimated to be a cheaper alternative to alfalfa feed by $0.21 per pound gained. If the results for feed intake and weight gain from the nutrition study hold across larger samples and in years/regions where alfalfa prices are high, then the PastureBox would pass a cost-benefit analysis for farmers.

Researchers also recovered the break-even alfalfa price for the PastureBox under several assumptions. Under expected baseline assumptions (experiment results from Tables 1 and 2), the break-even alfalfa price for a producer adopting a PastureBox is $226/ton. Under a worst-case scenario assumption, where calf weight gain is equal across feeds but still requires 3.365 tons of fodder to replace 1 ton of alfalfa (feed substitution remains the same as Tables 1 and 2, but there is no difference in calf weight gain) the break-even alfalfa price becomes $428/ton. As a comparison, alfalfa prices in Utah were $303/ton in 2023 and averaged $228/ton between 2014 and 2023. Based upon these considerations, PastureBox is expected to be an economically attractive feed source for markets in which traditional feed cost is relatively high.

3 Decisions Under Consideration

Renaissance Ag will base their marketing strategy on Brady's recommendation. Brady believes there are three key questions to resolve to come up with the best marketing strategy. They include: what industry should this technology be targeted toward, what region should this technology be marketed toward, and what payment structure should Renaissance Ag adopt in selling this technology?

3.1 Target Industry

Fodder produced from the PastureBox could be used as a partial replacement feed in many different livestock industries. While it has been most rigorously tested for its substitutability for alfalfa, there are preliminary results suggesting it could also have some substitutability with dried grains. While dairy, beef, hogs, goats, or sheep could all be potential options, Brady thinks that either the dairy or beef industry would be the best fit due to the existing nutritional research being applied to dairy cows and beef cattle. The PastureBox could have uses for cow-calf operations, grazing operations, dairy operations, or feedlots. While every single farm/ranch is unique, each of these industries would have certain benefits and drawbacks associated with adopting the PastureBox.

3.1.1 Cow-Calf Operations

Cow-calf operations represent the first link in the beef supply chain. These cow-calf operations specialize in birthing calves and giving them a combination of cow's milk and feed for 6–9 months after

which they are weaned and moved or sold to grazing or finishing operations. These weaned calves are typically sold at weights between 400 to 700 pounds. Prescribed feed rations for the cows and calves in these cow-calf operations vary across farms, with some operations including inputs such as corn silage, sunflower meal, or distillers grains within a given ration (Tobin and Hoppe 2023). Having said that, most rations for cow-calf operations rely heavily on some mix of pasture forage, hay, straw, and/or stover. Cow-calf operations are further broken down into drylot and pasture/grazing enterprises. Drylot operations feed cow-calf pairs on a feedlot for most or all of the year (Tobin and Hoppe 2023). Pasture and grazing operations typically graze cow-calf pairs during the grazing season and move them to a drylot when forage is no longer available due to snow or drought (Myerscough et al. 2022). The important thing to remember for either scenario is that the cost of fodder is driven by the fixed cost of the PastureBox, and running a box for only half of the year could raise the average total cost of fodder considerably. For a drylot system, use of the PastureBox would be straightforward. Each day, fodder is produced and added to ingredients within the ration. It would be used the same way for the pasture/grazing system whenever the cows and calves are brought back to the feedlot. It could also be used during the grazing season to augment forage and allow grazing to occur over a smaller area; however, transporting each day to the grazing area would add cost to production and would be unrealistic for distant fields.

3.1.2 Grazing Operations
Once calves are weaned, they are sent to either grazing operations or feedlot operations. Grazing can be further segmented into practices in which the weaned cattle are kept with their mothers for a few additional months to graze (referred to as a cow-calf-yearling operation) or separated and sent to graze individually (stocking operations). In either grazing scenario, cattle are put on a range or pasture where they graze and add weight until they are sold to a feedlot for finishing once they reach somewhere around 800–900 pounds (Forero et al. 2017). While grazing operations focus on adding weight through forage, it is not uncommon to add a small amount of feed supplement such as alfalfa into production to either help weight gain, round out nutrition, feed cattle as they are received or shipped, or make up for forage shortfalls.

Due to alfalfa playing a more minor role in grazing operations, the only ranchers likely to be interested in a PastureBox would be those with large herds involved in unique situations. Fodder could be interesting for ranchers dealing with nutritional deficiencies in local forage or responding to local drought conditions. Forage availability, particularly in drier climates, is highly correlated with precipitation. Low precipitation decreases forage growth in the following months. If forage availability falls enough, ranchers can be forced to buy supplemental feed to make up for the shortfall. This problem gets exacerbated by drought conditions reducing water availability for water-intensive crops like alfalfa, spiking supplemental feed cost when ranchers need it the most. Having access to a PastureBox could substantially reduce this risk. With the recent droughts experienced by the western half of the United States, there could be interest from ranchers.

3.1.3 Finishing Operations
Finishing operations purchase weaned, yearling, or feeder cattle. These cattle are sent to a feedlot where they are fed a grain-heavy ration consisting of a mixture of corn silage, alfalfa, minerals, grains, and salts (Lee et al. 2023). Once these cattle reach a weight of 1,100–1,400 pounds, they are sent to slaughter plants. The constant feed demand associated with a feedlot would lend itself well to fodder.

The downside to targeting this industry is the lack of research testing the impact of partially substituting fodder for alfalfa in feedlot cattle. Without experiment data showing the impact of fodder on feedlot weight gain, feedlot owners may hesitate to adopt a technology that has been untested for their specific industry.

3.1.4 Dairy Operations

Dairies have different feeding options for cows. Feed for dairies can follow a total mixed ration, grazing, or any combination of the two (Haan 2023). Since dairies produce milk for human consumption, the nutrition of the cow's rations is generally more strict than rations fed to cows in cow-calf operations. Operations that have a constant demand for feed, could be particularly attractive to sell to as they would allow the PastureBox to run constantly and spread out fixed cost. Additionally, Renaissance Ag has the most experimental data for the impact of feed on milk attributes. Both the Utah State University and Cornell University studies found that milk nutritional content remains similar across feeds. On the other hand, dairies are generally more rigid with their feed choices than other sectors; thus, they may require more convincing to try something new.

3.2 Target Region

Land scarcity, water scarcity, local policy, transport cost, and alfalfa price are all likely to be important factors when considering the adoption of the PastureBox. However, the individual importance of these factors is unclear. Thus, it is necessary to identify cattle-producing or dairy-producing regions where these factors are present and then compare them holistically. In the following section, Brady considers the merits of two domestic and one international region with marketing potential for the PastureBox.

3.2.1 Utah

Utah is the second driest state in the United States (Burgueño Salas 2023). Aside from a few northern counties, the state is mostly dry and rocky. These climactic and land attributes make crop production difficult but also mean that a lot of land has remained in public hands and is available for grazing. The Bureau of Land Management in Utah manages 22 million acres of grazing land (U.S. Department of the Interior, Bureau of Land Management 2017). These attributes have pushed Utah's agricultural economy toward cattle and dairy production. Utah's largest industries by share of total agricultural commodity revenue are cattle and calves (25.1 percent), dairy products (20.5 percent), and hay (14.4 percent; U.S. Department of Agriculture, Economic Research Service 2023a). The total value of Utah's agricultural sector production in 2021 was $2.25 billion (Economic Research Service, 2023a).

This rangeland lets cows and cattle graze at a low cost. The key to success is precipitation. The recent decline in forage availability caused by drought has been a cause of concern. In years of poor forage availability, ranchers have to supplement their grazing operations by purchasing feed. Increases in demand for alfalfa increase local prices and squeeze grazing margins. This increase in alfalfa prices also gets passed on to cow-calf, feedlot, and dairy operations. All of these producers are forced to either pay a higher price for feed or sell their herd.

Utah and other western states are experiencing the region's worst ongoing drought in 1,200 years (O'Donoghue 2022). Years of drought have created friction between agricultural producers and a growing urban population. In Utah, about 75 percent of the water supply is used by agriculture. While this use was not problematic under historical precipitation levels, regional precipitation over the past two decades has declined. This has caused water levels in lakes and dams around the region to fall considerably. This is particularly problematic for the Great Salt Lake. Mining companies extract over $1 billion worth of minerals from the lake each year (Larsen 2022a). There are also concerns about arsenic beneath the lake that could be released into dust if the lake continues to dry out (Turner 2023). This dust could cause health problems for residents of Salt Lake City and the surrounding metro area. State policy makers are currently grappling with how to prevent the Great Salt Lake from completely drying out.

Water is not the only concern in Utah agriculture. Since 1997, Utah has lost 1.2 million acres of agricultural land to urban growth (Larsen 2022b). Reduction in arable land has hampered crop production inside the state. Producers who are unable to successfully feed their livestock on forage must either grow or buy feed. With less feed being grown in the state, they are forced to buy from out of state. This requires additional shipping costs, which raises final feed prices.

In addition to these environmental factors, Utah would be the easiest region to market the PastureBox logistically. Renaissance Ag is located in Vineyard, Utah, so selling locally would help minimize transportation costs. Renaissance Ag also plans on providing guaranteed maintenance and upkeep to their customers, which would be easiest to do if their customers were close to the main office.

3.2.2 California

California is the second domestic market with great potential for the PastureBox. Agricultural commodities produced in California were valued at $51.3 billion in 2021 (U.S. Department of Agriculture, Economic Research Service 2023b). Its year-round warm climate and rich soil are ideal for many different crops and livestock. California is the leading state in the dairy industry and accounts for 18.1 percent of all dairy revenue in the United States. Dairy is also the largest agricultural commodity produced within California (14.8 percent of all agricultural commodity revenue; U.S. Department of Agriculture, Economic Research Service 2023b). As of 2021, California had 1.72 million head of dairy cows (U.S. Department of Agriculture, National Agricultural Statistics Service 2021). California is also a major cattle producer. Cattle and calves accounted for $3.1 billion in revenue in 2021 (U.S. Department of Agriculture, Economic Research Service 2023b).

This seemingly ideal environment for agriculture is not without challenges. Water is a significant limitation of California agriculture. The state is also prone to multi-year droughts (Mall and Herman 2019). Hot California summers can exacerbate shortfalls in precipitation. This combination of heat and dryness reduces forage availability. High evaporation and lower water levels are testing the limits of California producers.

Sustained drought in California has also contributed to friction between agricultural producers and urban centers. Agricultural producers in California have been feeling the squeeze on water access from multiple fronts. The Sustainable Groundwater Management Act passed in 2014 requires that local agencies develop and implement groundwater sustainability plans that limit the amount of groundwater being pumped. Additionally, producers in many watersheds such as the Sacramento and San Joaquin have had their water rights curtailed by the state the past few years (James and Greene 2022). This decline in water availability has forced farmers across California to leave increasing amounts of land fallow. Between 2019 and 2022, an estimated 752,000 acres were pulled out of irrigation (James 2022). Droughts have a disproportionate effect on lower value crops such as alfalfa. When water becomes scarce, farmers re-route it to fruit and nut orchards, which provide higher returns per gallon of water and are more costly to replace if they dry out. This decimates local feed availability.

Cattle and dairy operations within California must also contend with a shrinking amount of agricultural land. After World War II, people moved to California and bought agricultural land to build homes on. This depletion of land pushed the government to establish the Williamson Act (California Department of Conservation 2022). This act aimed to make it harder for landowners to sell their land out from under farmers. It proposed that a rental agreement between a farmer and landowner must be at least 10 years in length. This act has been effective, with nearly one-half of the agricultural land enrolled in the program (California Department of Conservation 2022). The limited land and favorable growing conditions contribute to California's agricultural land having the highest value in the country. The average agricultural land value in California in 2022 was $15,410 per acre compared to the national average of $5,050 per acre (U.S. Department of Agriculture, National Agricultural Statistics Service 2022). With a high return on fruits, vegetables, nuts, and other crops, it is hard for the local farmers to justify hay production. This forces many dairies to pay a premium to truck hay in from areas outside the state.

The aforementioned factors highlight the potential benefits of selling the PastureBox in an area with high feed demand, high feed prices, scarce water, and scarce land. On the other hand, prioritizing sales to Californian producers would require a regional office in California where Renaissance Ag employees could locate to help promote sales and provide any future maintenance to the boxes.

Additionally, selling in the California market would require an increase in transportation costs to get the boxes from Utah to California.

3.2.3 Italy

"Wealthy, and with 100 million more people than the United States, the European Union (EU) has a prodigious demand for meat and other livestock products" (Hasha 2002, p. 2). The demand for meat is mainly met by its supply in the European Union. However much of the feed required to support those livestock is imported. This importation covers one-fourth of the livestock feed demand (Hasha 2002). Within the European Union, Italy is a key producer in the beef and dairy industries. They represent 11.3 percent of beef production (the third largest producer behind France and Germany) and 8.9 percent of milk production (the fourth largest producer behind Germany, France, and the Netherlands; Eurostat 2022). Italy is broken down into two agricultural regions: the northern mountainous region where livestock, dairy, and grains are the primary agricultural outputs, and the southern region, which specializes in fruits, vegetables, wine grapes, and olives.

What makes Italy an especially interesting region as a target market compared to other E.U. countries is that both the climate and land values within Italy lend themselves better to hydroponic technology adoption than would be the case with some of Italy's neighbors. The average value of agricultural land in Italy in 2020 was valued at just over $15,000/acre. The average value of agricultural land in France in the same year was just under $2,700/acre. These high land values can limit the availability of cheap grazing access and/or make it difficult to justify the production of feeds such as alfalfa. Reducing dependency on expensive feed imports could be advantageous in this region. Relatively high agricultural land prices in Italy can be attributed to declines in agricultural land over past decades. Between 1960 and 2020, agricultural land in Italy decreased from 206,830 square kilometers to 129,990 square kilometers (World Bank 2023).

Italy has also been experiencing its own problems with drought. Last year, the northern region saw its worst drought in 70 years. This reduction in precipitation was reported to have done over $1.1 billion in damage to Italy's entire agricultural economy that year (Amante 2022). Even worse, the drought has continued into this year with the Alps accumulating less snowpack than they typically do. This snowpack is crucial for feeding Italy's rivers, which provide both irrigation and electricity generation. Policy makers are concerned that later this summer, Italy may not have sufficient flow in the Po River to run its electric dams (D'Emilio 2023). It is unknown what policies will be implemented to respond to this drought, but it appears likely that agricultural producers will have less water access than usual to prevent grid blackouts.

There are several key benefits to marketing the PastureBox in Italy. High land values limit hay and pasture availability. Alfalfa and other types of hay are relatively bulky and low value, which makes importing expensive. Being able to produce a large amount of feed on a small geographic footprint could be a game changer for local producers. Additionally, the PastureBox seems consistent with the overall "Common Agricultural Policy" of the European Union, which emphasizes sustainability, environmental protection, and risk management. On the other hand, Italy is a long way away from Vineyard, Utah. Shipping costs would be considerable. Opening and operating an international branch would also be expensive and difficult. Specifically, it would require learning to navigate Italy's national and local laws, working across language and cultural barriers, coordinating across different time zones, and paying for the costs associated with opening and maintaining a second office. Finally, the beef and dairy industries in Italy are less consolidated and industrialized than those in the United States, meaning that careful attention would have to be paid to finding producers who are large enough to justify the purchase of a PastureBox.

3.2.4 Historic Feed Prices

One final key consideration is regional alfalfa prices. If the PastureBox cannot produce fodder at a competitive price relative to alfalfa, then producers will not be interested in the technology. Figure 4
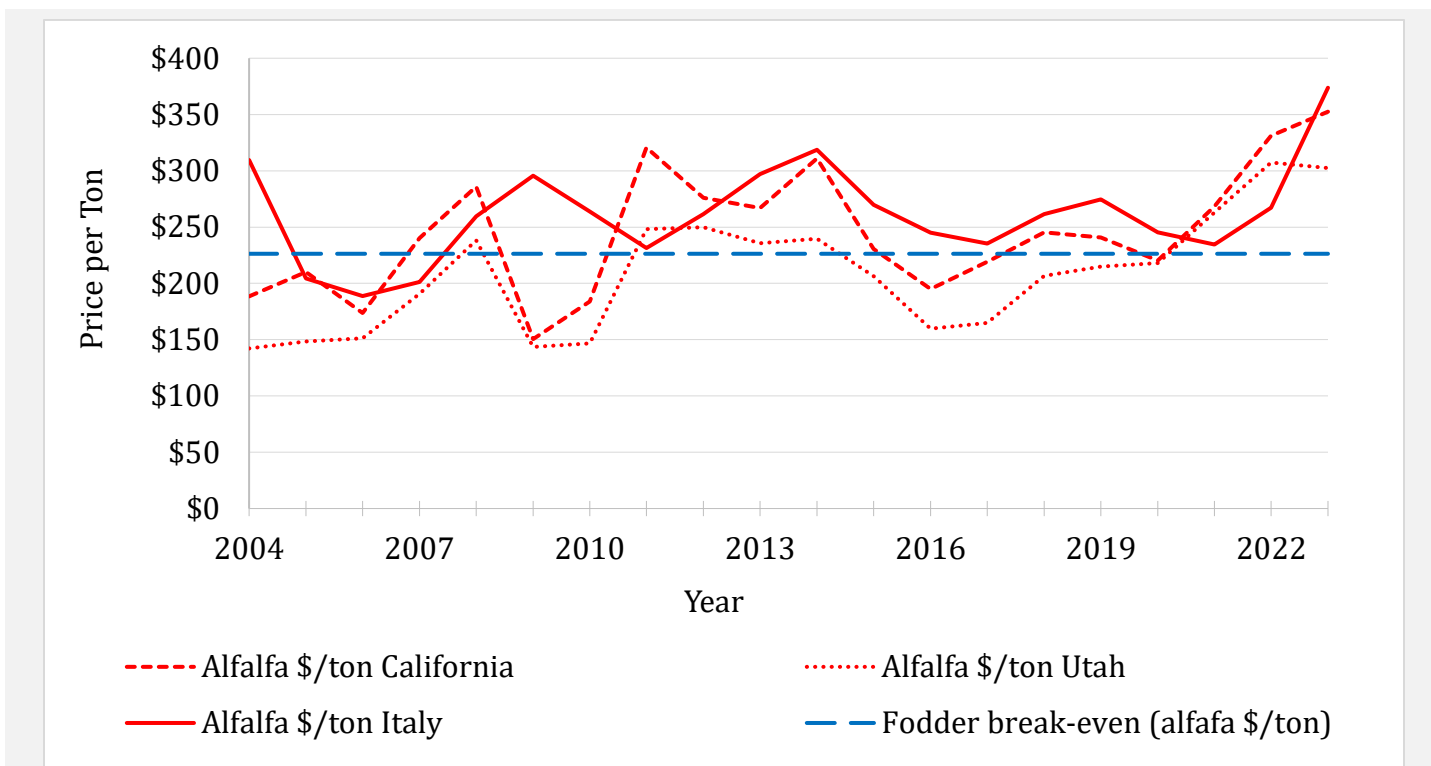
Figure 4: Historical Real Prices of Alfalfa (Inflation Adjusted for All Years with a 2023 Base

highlights the historical prices of alfalfa in Utah, California, and Italy. These are compared with the price of alfalfa that makes the cost per pound of calf weight gain equal across the previously discussed rations (under baseline assumptions). The figure shows that under baseline assumptions, fodder is more expensive than hay most years in Utah and cheaper for most years in Italy. California falls in the middle with alfalfa prices being lower than the fodder alternative about half the time.

There are several important caveats to consider. First, alfalfa prices have increased in real terms considerably over the past 20 years. The real rate of price growth has averaged almost 3 percent per year on average across these three markets. If alfalfa prices continue to grow at that pace, fodder could be even more competitive in the future. On the other hand, while Renaissance Ag would be an early entrant into this market, they do not have a monopoly on hydroponic technologies. If they are successful, there will likely be additional entrants to the market over time, which would introduce competition and put a cap on prices. As land and water in these regions continue to become increasingly scarce, there is good reason to assume alfalfa prices will continue to climb. Second, hydroponically produced fodder also has the ability to be used as a risk management tool. Farmers do not need to worry about purchase price or production volatility with a PastureBox, making returns more predictable over time. Fodder also does not need to be stored since it is produced every day. This should save labor hours usually required to put hay in and take hay out of storage.

While alfalfa is a key feed crop to compare fodder against, there are other popular feedstuffs to consider as well. While the experimental study used an alfalfa ration, there are many operations that use cheaper feed than alfalfa, such as forage or grass hay. That would lower the cost of a conventional ration. The average national price per ton of all types of non-alfalfa hay for 2023 was $90/ton below alfalfa-only hay prices (U.S. Department of Agriculture, National Agricultural Statistics 2023). Additionally, historical alfalfa price is based upon average alfalfa prices from a regional level (Milan Chamber of Commerce 2023; U.S. Department of Tagriculture, National Agricultural Statistics 2023). While average or even high-quality alfalfa is common for a dairy, a cow-calf operation may purchase lower quality alfalfa or non-alfalfa hay. Either of these would trade at a discount to the average alfalfa price and make fodder

adoption more difficult.

3.3 Transaction Structure Between Producers and Renaissance Ag

Any firm within the agricultural supply chain that sells big ticket items is familiar with the premise that how one sells something can be as important as the price tag. Farmers often do not buy tractors, combines, or irrigation equipment in cash because of the nature of agricultural production. Costs are incurred on the front end, and revenue does not happen until later. This incentivizes suppliers to work with banks to provide financing to their customers or provide other options to postpone payments. The possibilities for transaction structure are endless, but any potential transaction will have to satisfy several key considerations.

First, it costs Renaissance Ag more than $100,000 to manufacture each PastureBox, so they need to charge enough to be profitable. Second, most farmers are going to prefer a structured payment plan over a large cash investment in a new technology. Third, while Renaissance Ag does have a few million dollars' worth of liquidity to help their potential customers get started, they need to start producing a revenue flow in a relatively short period of time to continue growing.

3.3.1 Transfer Ownership to Farmer Through Sale

Renaissance Ag could try to sell their PastureBox as a one-time purchase. They would either sell the box to large operations for cash or work with mid- and small-size operations to obtain funding from banks. If this strategy works, it would provide Renaissance Ag the quickest path to positive cash flow and grow their liquidity. The downside to this strategy is that it would be the hardest one to convince customers on. The technology is new, so producers may not be willing to put down a six-figure investment on a technology they are unfamiliar with. Additionally, banks often frown on making loans for newer technologies. Even if a bank were willing to make a loan, high interest rates will raise the final cost of a PastureBox. A $200,000 loan with a 7-percent interest rate paid back over 10 years means the farmer would actually pay almost $285,000 over the life of the loan.

3.3.2 Rental or Leasing Agreement

Renaissance Ag could instead rent out or lease their technology to interested parties. Renaissance Ag would charge either a monthly or yearly fee to their customer in order to rent a PastureBox and produce feed in it. The producer would pay for it as long as they use it, and ownership would revert back to Renaissance Ag if the farmer ever wanted to terminate their rental agreement. The advantage of this strategy is that it neutralizes the two greatest hurdles to farmer technology adoption: the perceived risk of a new product and liquidity constraints. If producers do not have to worry about paying for this technology all at once and only risk a rental fee testing this new product, they will be much more likely to try it out. However, Renaissance Ag would be forced to cover a higher share of upfront costs, capital that could take years to recoup. Additionally, it puts them in the unenviable position of having to police subscription payments. They also would have to deal with the possibilities of higher transportation costs if farmers adopt PastureBoxes when feed prices are high and send them back to headquarters when prices are low. Finally, there could be the potential for moral hazard in this arrangement if the renters do not maintain the PastureBox and return it with damage to Renaissance Ag, claiming it was just regular wear and tear.

3.3.3 Installment Plans

Installment payment plans would strike a balance between the first and second options. The farmer would acquire the technology and pay it back over a predetermined number of years in installments. Farmers would be exposed to a larger upfront cost than a rental but not as large as buying the machinery all at once. Renaissance Ag would still provide a fair amount of liquidity upfront but could dictate how much by the period of time the repayment plan covered.

3.3.4 Lease to Buy

In a lease-to-buy plan, the farmer would be given the technology and make monthly payments in the same way that they would under the rental agreement. However, they would also pay an upfront fee that would allow their rental payments to go toward purchasing the equipment outright at an agreed upon date in the future. It would provide the farmer with a fair amount of liquidity while keeping risk exposure low and reducing the level of potential moral hazard in maintaining the technology. It would however still expose the farmer to more upfront cost and risk than renting would.

3.3.5 Combinations of Plans or Multiple Plans

Payment plans are infinitely modifiable, and the above plans act as a jumping-off point rather than a comprehensive list. It would be possible to offer each of them separately to allow potential consumers to self-select into what works best for them or to make some type of a hybrid payment plan (e.g., 20 percent down payment with yearly installments after that). The important thing is that the plan is attractive to the farmer and that Renaissance Ag can be profitable with it.

4 Reflection

Developing and testing a new technology is only half the battle. Forming a successful marketing strategy to support this product will present its own challenges. Deciding who to sell to, where to sell, and how to sell are all difficult questions in well-established markets. They are considerably harder in nascent industries where information is incomplete and the situation in terms of prices, policy, and competition evolves daily. Developing a solid marketing strategy will allow Renaissance Ag to build upon their previous success and continue growing. Answering these questions will not be easy, but Brady feels that he is up to the task. After all, if he wanted things easy, he would not have gotten involved in agriculture in the first place.

5 Discussion Questions

1. List the two largest advantages and two largest drawbacks associated with each type of market the PastureBox could be sold in (cow-calf, grazing, feedlot dairy).

2. Based upon your answers to question 1, which industry would you market the PastureBox to and why?

3. Conduct a brief PESTEL[5] analysis for each of the considered target regions (Utah, California, and Italy). Think in terms of how the external factors associated with operating a PastureBox in these regions would affect its viability for feeding beef cattle or dairy cows.

4. Based upon your answers to question 3, explain which of the three regions you feel would be the best to market to and why?

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[5] For background information and the definition on PESTEL analysis see,
https://blog.oxfordcollegeofmarketing.com/2016/06/30/pestel-analysis/

5. Your answer to question 4 depended upon a narrowly defined set of regions. Utah, California, and Italy are hardly the only regions that are interesting within the entire world. For instance, Saudi Arabia is more water-constrained than any listed region, and Bangladesh is more land-constrained. Australia and Mexico both have limited water and relatively high production costs. Come up with one additional region you feel would be economically interesting to sell the PastureBox to and give at least four reasons defending why it would be a good region. Be sure to back up your solution with data and at least two citations.

6. Based upon your answer to question 5, would your answer to question 4 change? Explain why or why not?

7. What two payment factors do you think would be most important to a farmer for being willing to purchase a PastureBox and why?

8. What two payment factors do you think would be most important to Renaissance Ag for being able to successfully sell a PastureBox and why?

9. Based upon your answer to questions 5 and 6, develop a payment plan that you feel would be successful in incentivizing farmers to adopt a PastureBox while keeping Renaissance Ag profitable and solvent. Be specific on what the details of this plan would be (payment levels, timing, etc.).

10. As mentioned, depending upon the payment plan, a PastureBox can be a large upfront cost for a farmer or rancher to incur. This money would not be able to be invested into other parts of the operation. What would the opportunity cost be for a farmer or rancher adopting the PastureBox be, and how would that cost change under different financing options?

11. If Renaissance Ag can successfully roll out their technology in a profitable market, what can they do to maintain market share over time as additional hydroponic feed companies attempt to enter the same market?

12. How would changes in the interest rate effect either the farmer's decision to adopt the PastureBox or Renaissance Ag's marketing strategy to the farmer?

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Case Study

Financial Ratios of the U.S. Grocery Sector in a Changing Industry Landscape

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Abstract

The U.S. grocery sector is one of the few sectors that benefited economically from the coronavirus pandemic. This was due to a combination of supply and demand shocks, including increasing food-at-home related purchases when restaurants were in lockdown to curb the spread of the coronavirus, supply disruptions across diverse food supply chains, and customer panic-buying behavior and hoarding products. As a result, more innovations have occurred recently compared to changes in the past. This case study discusses the changing landscape in the grocery sector, including mergers, new kinds of competitors, and how firms react to those changes. This discussion allows for conducting a systematic analysis of the U.S. grocery sector. Motivated by the potential acquisition of Albertsons by Kroger, announced on October 14, 2022, the case study focuses on these companies. The article models a financial analysis of Kroger. Students using this case study are expected to replicate the financial analysis for Albertsons. The case study's learning objectives are to (1) calculate and interpret financial ratios by category for a traditional grocer, (2) compare and contrast the financial ratios of two companies in the same industry, and (3) perform an industry analysis of U.S. grocery firms using Porter's Five Forces.

1 Introduction

The U.S. grocery sector, encompassing traditional and non-traditional grocery stores and multiple segments, is one of the few sectors that benefited economically from the coronavirus pandemic (CFRA 2022; U.S. Census Bureau 2023).[1] This was due to a combination of supply and demand shocks, including increasing food-at-home related purchases when restaurants were in lockdown to curb the spread of the coronavirus, supply disruptions across diverse food supply chains, and customer panic-buying behavior and hoarding products, all of which contributed to price increases (Hobbs 2021).

The U.S. grocery sector has traditionally been characterized as a low-growth, low-margin, and mature group of firms where grocery stores compete primarily with price discounts. The pandemic changed this a little, causing this sector to grow faster in recent years. As a result, more innovations have occurred recently compared to changes in the past. For example, the entrance of Amazon into groceries, with the acquisition of Whole Foods Market Inc. (Whole Foods) in 2017, significantly increased the visibility and convenience of online grocery and food sales. The pandemic lockdowns accelerated online sales growth across many grocery firms. Specifically, e-grocery represented 3.4 percent of all grocery sales in 2019, and this share increased to 11.1 percent in 2022 (Acosta 2021). In addition, Amazon has opened Amazon Fresh stores, where shoppers scan their items to their Amazon accounts and do not deal with checkout lines. Another example of how food retailing is changing is the acquisition of Fresh Market

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[1] Revenue from U.S. retail food and beverage stores grew on average 2.9 percent per year during the five years before the pandemic and 9.7 percent in 2020, 3.5 percent in 2021, and 7.6 percent in 2022 (U.S. Census Bureau 2023). In addition, U.S. publicly traded grocery and food retailers' equity value increased significantly more than the entire U.S. market (CFRA 2022).

Inc.—a close competitor to Whole Foods—in July 2022 by Cencosud S.A., a prominent South American retail and supermarket conglomerate.

Technology and changing consumer habits have led to industry disruptions that will likely continue. Conventional supermarkets have responded by acquiring smaller regional chains to remain competitive, leading to a more significant industry concentration. Most prominently, on October 14, 2022, The Kroger Company (Kroger) announced plans to purchase Albertsons Companies Inc. (Albertsons). According to a Wall Street Journal article, the announcement received much attention from the business community because it would be one of the biggest deals, with a $24.6 billion value, in the history of the U.S. grocery industry (Kang 2022). For context, the highly publicized acquisition of Twitter in 2022 was valued at $44 billion.

This case study discusses the changing landscape in the grocery sector, including mergers and new kinds of competitors, and how firms react to those changes. This discussion allows for conducting a systematic analysis of the U.S. grocery sector. Motivated by the potential acquisition of Albertsons by Kroger, the case study focuses on these companies. After describing the grocery sector in the next section and presenting the two firms in section three, the authors model a financial analysis of Kroger in section four. Students using this case study are expected to replicate the financial analysis for Albertsons. The case study's learning objectives are to (1) calculate and interpret financial ratios by category for a traditional grocer (Albertsons), (2) compare and contrast the financial ratios of two companies in the same industry (Kroger and Albertsons), and (3) perform an industry analysis of U.S. grocery firms using Porter's Five Forces.

Our proposed framework to conduct the financial analysis is curated to provide insightful schemes for analysis. Specifically, we select a manageable yet informative set of financial ratios to study based on prior research. In addition, we define a categorization of financial ratios that is comprehensive because it covers accrual accounting (income statement and balance sheet), cash accounting (statement of cash flow), and market data (stock prices). Furthermore, we propose a template with instructions evaluating trends and comparisons, which is particularly important for teaching purposes.

2 The U.S. Grocery Sector

2.1 Grocery Business Segments and Firms

In the early 1900s, urban Americans still primarily bought food from peddlers, public markets, and local grocers (Deutsch 2012). It was during the Great Depression when supermarkets became popular and the "norm" in U.S. food retailing because cost efficiencies and large scale allowed these businesses to offer lower grocery prices when people most needed them. Business historians attribute the origins and popularity of supermarkets to their efficiency and low prices (Savitt 1989; Howard 2011).

Grocery retailing has changed since the first self-service grocery store, Piggly Wiggly, opened in Memphis, Tennessee, in 1916.[2] Some grocery stores have significantly departed from the original concept, making classifying and analyzing grocery stores into sub-groups—industries and segments— challenging. In addition, grocery stores compete in different store formats, with groceries sold in department stores Walmart and Target and in dollar stores. However, identifying business segments within a broad sector is relevant for an economic analysis of industries.

According to the Food Marketing Institute (FMI), grocery retailing can be broadly categorized into traditional and non-traditional grocery stores (Food Processing 2016). This document refers to these sub-sectors as industries of the grocery sector. Furthermore, the traditional grocery industry includes the following segments: (1) conventional supermarkets, (2) natural or fresh grocers, (3) limited

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[2] https://tnmuseum.org/junior-curators/posts/the-story-of-piggly-wiggly-the-first-supermarket?locale=en#:~:text=Then%2C%20on%20September%2011%2C%201916,would%20pick%20their%20own%20items.

assortment grocers, (4) super warehouses, and (5) others. Non-traditional grocery stores include (1) wholesale clubs, (2) supercenters, (3) mass merchandisers, (4) dollar stores, (5) drug stores, and (6) others. This case study focuses on conventional supermarkets, one segment of traditional grocers. However, competition among grocery firms occurs among all participants in the grocery sector. Therefore, an understanding of the entire sector contributes to the analysis of firms in a particular segment. Table 1 lists selected grocery stores in the United States classified by industries and business segments.

Table 1: Selected Grocery Stores in the U.S. Grocery Sector

Firm	Industry	Segment
Kroger	Traditional grocery	Conventional supermarkets
Publix	Traditional grocery	Conventional supermarkets
Safeway	Traditional grocery	Conventional supermarkets
Albertsons	Traditional grocery	Conventional supermarkets
HE Butt Grocery Co.	Traditional grocery	Conventional supermarkets
Wegmans Food Markets Inc.	Traditional grocery	Conventional supermarkets
WinCo Foods Inc. (Waremart)	Traditional grocery	Conventional supermarkets
Whole Foods	Traditional grocery	Natural grocer[1]
Sprouts Farmers Market	Traditional grocery	Natural grocer[1]
The Fresh Market	Traditional grocery	Natural grocer[1]
Trader Joe's	Traditional grocery	Limited assortment grocery stores[2]
Aldi	Traditional grocery	Limited assortment grocery stores[2]
Save-a-Lot Food Stores	Traditional grocery	Limited assortment grocery stores[2]
Smart & Final Stores Inc.	Traditional grocery	Super warehouse
Food4Less	Traditional grocery	Super warehouse
Walmart Supercenter	Non-traditional grocery	Supercenter
Target Supercenter	Non-traditional grocery	Supercenter
Meijer Inc.	Non-traditional grocery	Supercenter
Costco	Non-traditional grocery	Wholesale club
Sam's Club	Non-traditional grocery	Wholesale club
BJ's Wholesale Club Inc.	Non-traditional grocery	Wholesale club
Dollar General	Non-traditional grocery	Dollar stores
Dollar Tree	Non-traditional grocery	Dollar stores
Walmart	Non-traditional grocery	Mass merchandiser
Target	Non-traditional grocery	Mass merchandiser
Walgreens	Non-traditional grocery	Drug stores
CVS	Non-traditional grocery	Drug stores

Source: Prepared by authors based on classifications from different sources, including Food Processing (2016), Blankenship and Schill (2017), Danzinger (2020), and Sundaram (2022).
[1] Also known as fresh format stores.
[2] Also known as discount grocery stores.

2.1.1 The Traditional Grocery Industry

The business market research firm IBISWorld refers to traditional grocers as "supermarkets and grocery stores." This case study mainly uses the term "traditional grocers" following the FMI's classification. (Bold type is used in this and the following section to indicate the name of segments in the grocery sector.) **Conventional supermarkets** are traditional grocers that closely keep the format of the original supermarkets created at the beginning of the twentieth century but are updated to modern needs. Like other grocers, these stores sell food products, including bakery goods and prepared food, beverages,

dairy and egg products, fresh and frozen meat, frozen foods, fruit and vegetables, other foods, and other nonfood products (IBISWorld 2023). What distinguishes **conventional supermarkets** from other segments, according to the FMI, is that they generate up to 15 percent of their revenue from general merchandise, health, and beauty care products. Some conventional supermarkets also offer pharmacy and gas station services.

Kroger, Albertsons, Publix Supermarkets Inc. (Publix), H-E-B Grocery Co. LP (H-E-B), and Koninklijke Ahold Delhaize N.V. (Delhaize) are the largest conventional supermarket firms in the United States. In March 2023, IBISWorld estimated the market share of these firms in the traditional grocery industry to be 14.4 percent for Kroger, 8.3 percent for Albertsons, 6.4 percent for Publix, 3.9 percent for H-E-B, and 3.0 percent for Delhaize. Whole Foods, a **natural or fresh grocer** owned by Amazon.com Inc., ranked sixth, with a 2.2 percent market share, in the traditional grocery industry (IBISWorld 2023).

As shown in Table 1, in addition to **conventional supermarkets**, traditional retail grocery stores include **natural or fresh grocers** such as Whole Foods, Sprouts Farmers Market, and The Fresh Market; **limited assortment grocers** such as Trader Joe's, Aldi, and Save-a-Lot; and **super warehouses** such as Smart and Final Stores Inc. **Natural or fresh grocers** specialize in perishable, with an emphasis in natural, organic, or ethnic foods. **Limited assortment grocers** are also known as discount stores because they base their business strategy on offering low prices for a limited assortment of groceries. Finally, **super warehouses** are a hybrid between **conventional supermarkets** and **wholesale clubs**.

2.1.2 The Non-Traditional Grocery Industry

Traditional grocers compete with non-traditional grocers, such as **mass merchandisers** and **supercenters**, typically represented by Walmart and Target stores. **Mass merchandisers** sell appliances, clothing, electronics, sporting goods, and groceries. In addition, mass merchandisers have larger store formats known as **supercenters** (e.g., Walmart Supercenter and Super Target), considered a hybrid between conventional supermarkets and mass merchandiser stores. **Supercenters** typically have at most 40 percent of their space dedicated to grocery products (Minnesota Growers Association 2023).

Walmart entered relatively late in the grocery business by opening its first supercenter in Washington, Missouri, in 1988, combining a supermarket with general merchandise to provide one-stop shopping convenience.[3] As a result, Walmart became the country's largest grocer within a decade (White 2020). The company is still the largest grocery firm in the whole grocery sector, capturing about a quarter of the U.S. grocery sector. (Table 2 provides estimated market shares in this sector, including traditional and non-traditional grocery industries.) Walmart's annual revenue from groceries, at $247.3 billion, represented 59 percent of the company's total revenue during the 2023 fiscal year ending January 31, 2023 (Walmart Inc. 2023).

Other non-traditional grocers are **discount wholesale** or **warehouse clubs** like Sam's Club[4] and Costco Wholesale Corporation (Costco). These club formats, created in the United States during the 1970s and 1980s, offer discounts through a paid membership in a warehouse-type environment. Typically, between 30 and 40 percent of products in these stores are groceries provided in large sizes and bulk sales, and the rest are general merchandise and health and beauty care products (Minnesota Growers Association 2023).

Dollar stores and **drug stores** are other non-traditional grocers. **Dollar stores**, including firms Dollar General and Dollar Tree, are small store formats that previously offered knickknacks and staples, and currently offer food and consumable products at price discounts. **Drug stores**, such as Walgreens and CVS, also offer groceries.

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[3] https://corporate.walmart.com/about/history.
[4] As of 2022, Sam's Club was a division of Walmart Inc.

Table 2: Estimated Market Shares in the U.S. Grocery Sector (Average of 2021 and 2022)

Company name	Business segment	Market Share (%)
Walmart Inc.	Supercenter	25.7
Kroger Co.	Conventional supermarkets	7.0
Costco Wholesale Corp.	Wholesale club	6.5
Target Corp.	Supercenter	5.4
Albertsons Inc.	Conventional supermarkets	4.1
Koninklijke Ahold Delhaize NV	Conventional supermarkets	3.2
Publix Super Markets Inc.	Conventional supermarkets	3.2
HE Butt Grocery Co.	Conventional supermarkets	2.1
Seven & I Holdings Co. Ltd.	Limited assortment grocery	1.4
Aldi Group	Limited assortment grocery	1.4
Meijer Inc	Supercenter	1.3
Wakefern Food Corp.	Conventional supermarkets	1.1
Trader Joe's Co.	Limited assortment grocery	1.1
Amazon.com Inc.	Natural grocers	1.0
Hy-Vee Inc.	Conventional supermarkets	0.8
BJ's Wholesale Club Inc.	Wholesale club	0.7
Wegmans Food Markets Inc.	Conventional supermarkets	0.7
WinCo Foods Inc (Waremart)	Conventional supermarkets	0.6
Giant Eagle Inc.	Conventional supermarkets	0.6
Southeastern Grocers LLC	Conventional supermarkets	0.6
Alimentation Couche-Tard Inc.	Limited assortment grocery	0.6
Northeast Grocery Inc.	Conventional supermarkets	0.5
Other		30.8

Source: Market shares estimates by Euromonitor International (2023). Grocers with less than 0.5 market shares were added to "Other." The business segment classification was based on information in Table 1 and according to Capital IQ's description of firms (S&P Net Advantage 2023).

2.2 Revenue, Growth, Competition, Trends, and Profitability

Despite many changes in the grocery sector, almost a century after the first supermarket was created, conventional supermarkets remained the primary destination of grocery shoppers in the United States (Blankenship and Schill 2017; Winsight Grocery Business 2019; FMI 2023). However, competition from other traditional and non-traditional store formats has recently been and is expected to continue to be fierce, focused mainly on price discounts. This intense price competition has traditionally defined grocery as a low-margin sector. However, recent research shows that this sector is highly profitable in terms of returns on assets, equity, and investment (Trejo-Pech 2023), which suggests that the traditional low-margin stylized fact to describe this sector might be misleading. Indeed, as shown in section four, Kroger's return on investment is relatively high.

Traditional grocery[5] revenues have grown an average of 2.6 percent annually during 2018–2022. Except for 2020 and 2022, retail food and beverage sales growth has been low and steady during the last three decades (U.S. Census Bureau 2023). Traditional grocery store sales were estimated at $811 billion in 2022 (Diment 2023). Of this revenue, $677.6 billion (83.5 percent) corresponded to food and

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[5] As noted above, IBISWorld uses the term "supermarkets and grocery stores," and the FMI uses "traditional grocery stores" when classifying industries in the grocery sector.

beverages. This included 2020 revenue growth of about 9.0 percent, an industry-atypical high increase driven by more people staying and cooking at home, restaurant closures, less travel, and more caution during the pandemic. Other factors that increased revenues included greater disposable income—federal economic stimulus—greater popularity of more expensive organic food options, and continuation of pandemic habits: less dining out and more work-from-home.[6] All this benefited traditional grocery stores, primarily conventional supermarkets and supercenters like Walmart and Target, because those companies have the most significant market shares.

However, the picture is not entirely rosy for conventional supermarkets and supercenters. As the effects of the pandemic faded and inflation rates—particularly for food items—increased in 2022, some consumers also have turned to less expensive warehouse stores and simpler store formats. Simpler format stores carry fewer products and fewer branded products, emphasizing their own store or private brands. Examples are Aldi, Lidl, and Trader Joe's, whose private brands are often organic and non-GMO. Private-label brands tend to have higher profit margins than national brands of the same item. While offering store brands is an extended business practice among different segments in the grocery sector, discount stores Aldi and Trader Joe's had the highest share of store brands in their portfolio in 2022 (Progressive Grocer 2022).

Large retail grocery firms have become even more prominent through mergers and acquisitions and have offered discounts to loyalty rewards members to face the competition of those and other grocery segments. These trends increased revenues but not necessarily profits in the traditional grocery industry during 2018–2022. IBISWorld expects future profits to be stable and revenues to grow more slowly. Specifically, industry growth through 2027 will likely be under 1 percent per year, with total industry revenues reaching $846 billion by 2027, including non-food-related revenues.

Considering the entire grocery sector, sales in some alternative retail grocery stores grew more quickly than in conventional supermarkets like Kroger and Albertson during 2018–2022. For instance, organic sales in discount grocers (Aldi, Lidl, and Trader Joe's), warehouse clubs (BJ's, Costco, and Sam's Club), and groceries sold in department stores (Walmart and Target) grew faster than in conventional supermarkets. Conventional supermarkets have responded by acquiring smaller regional chains, leading to a greater concentration in that industry's segment. However, the traditional grocery business is not yet highly concentrated despite merger and acquisition activity. The top four traditional grocery chains—Kroger, Albertsons, Publix, and H-E-B in order of market shares (IBISWorld 2023)—account for about 33 percent of the total revenue of the traditional grocery industry (refer to section 2.1). In contrast, concentration in the non-traditional grocery industry is very high, with the top four companies, led by Walmart and Costco, having more than 90 percent of this industry (Petridis 2022).

Digital revenues from grocery sales are also substantial. Traditional groceries have recently faced more competition from online grocery retailers like Amazon. Until recently, few grocery purchases were made online. However, Amazon's acquisition of Whole Foods in 2017 significantly increased the visibility and convenience of online sales, with the firm moving from paper goods and cleaning supplies to boxed staples (cereal, crackers, etc.) to fresh perishables. In addition, COVID-19 pandemic lockdowns accelerated online sales growth across many grocery firms. For instance, Acosta (2021) estimated that U.S. pre-pandemic e-grocery represented 3.4 percent of all grocery sales in 2019, and this share

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[6] Household disposable income is considered the most important driver of retail grocery sales. Disposable income rose during the pandemic and is expected to decline slightly in the future. Regarding organic and more natural food in general, millennials (born 1981–1996), the largest demographic group, tend to be more health-conscious. Whole Foods, for example, reacted by stocking more premium private label items, more organic choices, and a food bar where busy shoppers can pick up a healthy meal. Some grocers also have in-store dining areas, all trends that traditional grocery chains could copy.

increased to 8.1 percent in 2020, then 11.1 percent of revenues in 2022. Post-pandemic, online grocery sales are expected to increase to around 20 percent in 2026 (Acosta 2021) as more people become more comfortable with online grocery shopping and grocery firms consolidate their investments in this technology. In addition, the use of online delivery services such as Instacart increased during the pandemic and is likely to continue growing.

Technology and innovation disruptions may play a role in the future of the grocery sector. Amazon, for instance, has opened Amazon Fresh stores, where shoppers scan their items to their Amazon accounts and do not deal with checkout lines. While technology in grocery stores has been increasing, historically, the sector has had a meager innovation rate. Historically, labor has been more critical in stocking shelves and helping customers. On the other hand, innovation has been crucial in the delivery process, with newcomers like DoorDash, Instacart, Uber Eats, and HelloFresh delivering directly to consumers.

For various reasons, including supply chain issues and pandemic stimulus money, inflation for many food products increased during the pandemic. Since it is challenging to differentiate food items (e.g., a box of Cheerios is the same at every grocery store), consumers tend to be very price-conscious and price-sensitive and buy at the store with the lowest prices. This causes price competition in the grocery industry to be significant and margins to be low but highly stable. Precisely, net profit in the traditional grocery industry was estimated at 1.9 percent during the last five years—reaching a peak of 2.2 percent in 2020—and 1.8 percent in 2022 (Diment 2023). In contrast, non-traditional groceries, particularly wholesale clubs and supercenters, had a higher net profit, estimated at 3.9 percent during the last five years, with the same 3.9 percent net profit in 2022 (Petridis 2022). Profitability in the wholesale clubs and supercenters segments was driven mainly by Walmart. One 2023 study calculated financial ratios across U.S. industries, finding that retail food and grocery was the fourteenth least attractive industry in terms of margins among 94 industries, with 2 percent net profit margin. The median net profit margin for all 94 industries was 7.3 percent (Damodaran 2023).

As of early 2023, the grocery sector faced moderate entry barriers, mainly due to high initial investment costs. Not only would newcomers need capital for buildings and inventory, but the technology was also becoming a more increased investment. For example, many stores have "point of sale" systems, a technology that allows stores to track inventory, determine trends, and gather marketing data. However, once the initial capital expenditures are made, grocery firms have relatively low additional capital expenditures, with about nine cents spent on capital expenses for every dollar spent on wages.

3 The Kroger Company and Albertsons Companies Inc.

Kroger, whose beginnings can be traced back around a hundred years (Kang 2023), is a publicly traded firm trading on the New York Stock Exchange (NYSE). In addition to Kroger grocery stores, Kroger owns other brands, including Harris Teeter, Smith's, Food4Less, Dillon's, Roundy's supermarkets, Ruler Foods, and others. The firm is headquartered in Ohio and employs about 420,000 people.

Kroger is classified as a conventional supermarket, according to the FMI, and is the largest traditional grocery store in the United States. The firm captured a 14.4 percent market share, according to estimations by IBISWorld as of March 2023. This scale gives Kroger the potential to achieve savings from economies of scale. Its stores are full-service operations, generally including a bakery, pharmacy, gas, and household products. The firm has about 2,700 stores in 35 states in the United States, without a presence in other countries. In addition, Kroger ranks second in the entire U.S. grocery sector, with about 7 percent market share (considering both traditional and non-traditional grocers), with this sector led by

Walmart, with around 25 percent market share (Table 2). Appendix 1 gives Kroger's financial statements from 2019 to 2022. (The financial analysis is conducted for the 2020–2022 period, and 2019 data are provided to calculate 2020 year-to-year growth rates.)

Albertsons started as a single store in Idaho in 1939 (Kang 2023). It is currently a publicly traded firm trading its stocks on the NYSE. The firm's initial public offering (IPO) occurred recently, during the COVID-19 pandemic, on June 26, 2020. By the end of 2022, the company operated about 2,300 supermarkets in 34 states and the District of Columbia (Kang 2022; Graja 2023). In addition to Albertsons stores, the firm owned Safeway, Vons chains, Shaw's, Jewel-Osco, and Acme markets. Appendix 1 provides financial statements for Albertsons from 2019 to 2022.

Kroger and Albertsons have a relevant presence in the online grocery market. 2022 shares of total grocery e-commerce sales of leading online grocery stores were estimated as follows: Walmart 27.6 percent, Amazon 21 percent, Kroger 9.9 percent, Target 5.1 percent, and Albertsons 3.6 percent (Insider Intelligence 2022). The Kroger and Albertsons brands are also well-recognized by customers, particularly Kroger. The grocery stores ranked by brand awareness in 2022 were, in order of higher rank: Walmart, Target, Sam's Club, Costco, Kroger, Aldi, Whole Foods Market, Trader Joe's, Safeway, Publix, Albertsons, BJ's, Food Lion, Fred Meyer, Hy-Vee, and Lidl (Statista 2022). Due to its strong brand name recognition, Kroger ranked #21 in the 2022 Fortune 500 list.

4 Financial Analysis of Kroger

Ratio analysis has a wide variety of uses in business. For example, based on recent historical financial data and ratios, lenders want to know if a company is sound enough to repay their loan. Shareholders want to know the firm's future cash flows and financial health to decide whether to invest in that firm. A firm acquiring another company wants to know whether the target firm will fit the acquirer well. In general, financial ratio analysis is often the starting point for cases involving financing and investment decisions. In this case study, the motivation for the analysis is the potential acquisition of Albertsons by Kroger.

One significant challenge when conducting financial ratio analysis is selecting a manageable yet informative and helpful set of financial ratios to study. This is because many financial ratios are used in practice; no consensus exists regarding the most important ones, and financial ratios contain overlapping information. The ratios used in this case were selected based on prior research on this topic. (Trejo-Pech (2023) discusses this issue and summarizes findings in this literature. Trejo-Pech, Noguera, and White (2016) investigated the financial ratios preferred by equity analysts.)

In addition, defining a systematic approach to follow is helpful. For this analysis, we define a framework that categorizes financial ratios into four groups: (1) income statement-based ratios, (2) ratios combining balance sheet and income statement data, (3) statement of cash flow ratios, and (4) stock price-related ratios. This framework is more comprehensive than others, such as the DuPont model—which focuses on drivers of firm profitability—or group of ratios that typically cover income statement and balance sheet-related ratios only. This framework also allows students to recognize what type of relevant information each of the three financial statements brings to the analysis.

Finally, providing a template with instructions on calculating and evaluating the financial ratios is particularly important for teaching purposes. The authors have already filled in the template for Kroger to model a financial analysis (Table 3)—discussed next. Students are expected to replicate this analysis for Albertsons using this template (Appendix 2).

4.1 Income Statement-Based Ratios

Margins (i.e., any income statement item divided by revenue) are relevant for financial analysis. Operating or EBIT (earnings before interest and taxes) margin is relevant for analysis because it captures revenue, cost of sales, and operating expenses, that are under management control, unlike financial expenses and taxes that escape management control. The net margin relates net income, the bottom line, to revenue. In addition, given the prominence of revenue in generating profits and cash, the year-to-year revenue growth is closely scrutinized by investors. Investors are also concerned about the amount of profits generated by the firm on a per share basis (earnings per share, EPS).

Table 3 shows that (1) Kroger operates with very low margins (below 2 cents of net profit, on average, for every dollar sold), (2) EBIT margin is increasing every year, and (3) the other metrics (net margin, revenue growth, and EPS) are volatile but with an upward curve in the three year period, meaning that in 2022, the most recent year, these metrics increased. Overall, Kroger's income statement appears healthy, particularly in 2020 and 2022.

Table 3: Financial Ratios for Kroger

	2020 KR	2021 KR	2022 KR	KR Avg.	Trend
Margins:					
EBIT margin	2.4%	2.7%	3.1%	2.7%	Increasing (+)
Net margin	2.0%	1.2%	1.5%	1.6%	Volatile (upward)
Other income statement:					
YtoY revenue growth	8.4%	4.1%	7.5%	6.6%	Vol. upward
EPS	$3.3	$2.2	$3.1	$2.9	Vol. upward
Asset mgt efficiency:					
Assets turnover	2.7x	2.8x	3.0x	2.8x	Increasing (+)
Profitability					
ROI	8.1%	10.1%	11.5%	9.9%	Increasing (+)
Lev. & Debt Mgt:					
Debt to assets	42%	42%	41%	42%	Stable (=)
Debt to EBITDA	3.5x	3.1x	2.7x	3.1x	Decreasing (+)
EBIT to interest	5.8x	6.5x	8.5x	6.9x	Increasing (+)
Liquidity:					
Current ratio	0.8x	0.7x	0.7x	0.8x	Stable (=)
Cash flow:					
CFO to CAPEX	2.4x	2.4x	1.5x	2.1x	Vol. downward (-)
CAPEX to D&A	1.0x	0.9x	1.0x	1.0x	Stable
Market value-related:					
Price to Earnings (PE)	10.3x	19.6x	14.3x	14.7x	Vol. downward

Note: The **intra-firm trends** were determined according to these rules:
Increasing: If financial ratios grow every year.
Decreasing: If financial ratios decline every year.
Stable: If financial ratios move <u>within</u> a range of +/– 0.5%, 0.5x, $0.5, or 5.0 percentual points (the latter for leverage).
Volatile: If financial ratios move <u>out</u> of a range of +/– 0.5%, 0.5x, $0.5, or 5.0 percentual points (the latter is for leverage). For a volatile curve, the curve is identified as <u>upward</u> or <u>downward</u>.
The positive (+), negative (–), or equal (=) signs after the trend indicate whether the trend benefits, hurts, or is neutral for the financial health of the firm.
Formulas to calculate the financial ratios are in Appendix 3.

4.2 Ratios Combining Income Statement and Balance Sheet Data

This group of ratios includes four subcategories, with ratios proxying (a) asset efficiency, (b) profitability, (c) leverage and debt management, and (d) liquidity.

Table 3 shows that according to the asset turnover ratio, Kroger is selling more relative to resources or assets used, becoming more efficient yearly. On average, Kroger sells $2.8 for each dollar invested in total assets. The firm is also growing its profitability, measured by the return on investment.[7] During the three years, Kroger's operating income after taxes (but before interest expenses) represents, on average, 9.9 cents for every dollar of financing capital (i.e., debt plus equity) it uses to operate.

Table 3 also gives leverage and debt management ratios. Here, three ratios are provided because they convey different information related to firm leverage and payment capacity. Debt to assets measures leverage level, which at 42 percent has been stable during the three years. While stability is in general desirable in financial analysis, this level of debt seems relatively high. A recent benchmarking analysis shows, for instance, that the median value debt to assets for the aggregate U.S. market during the last twenty years is 17 percent, with this ratio varying between 9 to 36 percent across 16 economic sectors (Trejo-Pech 2023). Furthermore, debt to assets for Walmart, the leading firm in the whole grocery sector, was 25 percent on average during 2020–2022.

Debt to Earnings Before Interest, Taxes, Depreciation, and Amortization (EBITDA) measures total debt relative to EBITDA, a proxy of firm cash flow. Table 3 shows that this ratio is consistently decreasing yearly, which is positive for Kroger given that even though debt is stable relative to total assets, debt is decreasing relative to the amount of cash the firm generates. In addition, EBIT to interest payments is increasing, meaning Kroger generates more operating income (which potentially converts into cash) relative to short-term debt-related obligations. Overall, while Kroger's level of debt may be concerning, the company is improving its payment capacity. Finally, for the second group of financial ratios in our categorization, Table 3 provides the liquidity ratio, which is stable for Kroger, with about 80 percent of current assets relative to current liabilities.

4.3 Statement of Cash Flow Ratios

The cash flow from operations (CFO) and capital expenditures (CAPEX) are critical cash flow items when evaluating the statement of cash flows (Hertenstein and Bruns 1998). Mature, healthy firms are expected to generate CFO (i.e., buying, manufacturing, managing, and selling) at least as high to cover CAPEX or long-term investments. The CFO to CAPEX measures this behavior, with a 2.1 average ratio in 2020–2022, indicating that Kroger's CFO covers twice the amount invested in CAPEX. A minor concern in this regard is the downward trend of this ratio (Table 3). In addition, the CAPEX to depreciation (D&A) ratio measures how much a firm invests (e.g., CAPEX) relative to worn-out or depreciated assets (e.g., D&A). Financially healthy firms are expected to invest at least the assets used to avoid obsolescence. Table 3 shows that Kroger has a CAPEX to D&A stable ratio of 1.0, indicating that this firm re-invests the same amount of assets used or depreciated.

4.4 Stock Price-Related Ratios

Stock prices are, in theory, supposed to reflect accruals and cash flow-based historical performance. Furthermore, stock prices should reflect the firm's expected performance according to investors' perceptions. The price to earnings (PE) and firm value to EBITDA are two commonly used ratios (called market multiples) relating stock prices with financial statement data. Table 3 shows that, on average, Kroger's PE is 14.7x in the last three years, indicating that it would take about 15 years for an investor to recover the price of a purchased Kroger share fully, assuming a similar level of profits in the future. The

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[7] The return on assets (ROA) and the return on equity (ROE) are other profitability measures commonly used in practice. However, ROA, ROE, and ROI are highly correlated. Trejo-Pech (2023) documents that the correlation coefficients between these ratios are between 0.65 and 0.81 for the U.S. market categorized into sixteen economic sectors.

downward trend of this ratio shows that a Kroger share was more attractive (i.e., cheaper) to investors in 2020 and 2022, the years this firm reported higher net income margins. Whether this PE multiple is cheap or expensive for investors can be assessed in relation to benchmarks.

As conducted above, trend analysis of financial ratios helps understand where a firm may be heading and detect intra-firm financial strengths and weaknesses. Comparing financial ratios to leading competitors or industry standards gives additional insights into the analysis. In this case study, students are asked to replicate the analysis for Albertsons and compare Albertsons's performance to Kroger's. Appendix 2 can be used to conduct this comparison. Students need to identify why Albertsons was economically attractive for Kroger. Students also needed to evaluate whether Kroger was financially strong enough, according to its recent history, to successfully implement the merger if authorized by antitrust regulators.

5 Discussion Questions

Below, we suggest questions to achieve the case study learning objectives.

1. Perform Porter's Five Forces analysis for the U.S. grocery sector.

2. Conduct a financial analysis of Albertsons based on financial ratios. In particular, answer the questions below. Use the template provided in Appendix 2 to answer 2.1 and 2.2. For 2.3, prepare a brief report.

(2.1) Calculate the financial ratios for Albertsons from 2020 to 2022 and the 2020/2022 averages using data from Appendix 1.
(2.2) Evaluate the trend for each financial ratio by filling in the appropriate column in the template.
(2.3) Evaluate Albertsons's financial performance to Kroger's (benchmark). You can compare the firms' financial ratios averages during 2020–2022 or their trends over time. For this evaluation, provide a brief conclusion for each ratio category discussed in this article and an overall conclusion of the Kroger vs. Albertsons financial comparison. Your conclusion may emphasize strengths and weaknesses that potentially facilitate or make the proposed merger more difficult for the potentially combined Kroger company. You can strengthen your analysis using information from this case study.

Appendix 1: Financial Data as of the End of Fiscal Years for Kroger and Albertsons ($ Millions, Unless Otherwise Specified)

Table A1: Financial Data as of the End of Fiscal Years for Kroger and Albertsons ($ Millions, Unless Otherwise Specified)

	Kroger				Albertsons			
	2019	**2020**	**2021**	**2022**	**2019**	**2020**	**2021**	**2022**
Cash and ST Investments	399.0	1,687.0	1,821.0	1,015.0	484.2	1,728.9	2,916.4	455.8
Accounts receivable	1,706.0	1,781.0	1,828.0	2,234.0	502.8	526.3	540.1	687.6
Inventories	7,084.0	7,063.0	6,783.0	7,560.0	4,352.5	4,301.3	4,500.8	4,782.0
Other current assets	1,701.0	1,972.0	1,742.0	1,861.0	391.8	431.5	409.1	345.0
Net PP&E	28,685.0	29,182.0	30,484.0	31,388.0	15,079.3	15,428.3	15,258.0	15,237.8
Financial investments	1,078.0	2,247.0	1,578.0	995.0	296.3	445.0	481.2	0.0
Other non-current assets	4,603.0	4,730.0	4,850.0	4,570.0	3,628.2	3,736.7	4,017.4	4,660.0
Total assets	45,256.0	48,662.0	49,086.0	49,623.0	24,735.1	26,598.0	28,123.0	26,168.2
Accounts payable	6,349.0	6,679.0	7,117.0	7,119.0	2,891.1	3,487.3	4,236.8	4,173.1
Notes payable (short-term debt)	2,562.0	1,578.0	1,205.0	2,037.0	850.9	857.7	1,479.8	1,740.5
Other current liabilities	5,332.0	7,109.0	8,001.0	8,082.0	2,162.3	2,487.2	2,631.9	2,515.2
Long-term debt	18,635.0	19,009.0	19,235.0	18,440.0	13,896.1	13,649.2	12,556.2	13,220.6
Other long-term liabilities	3,805.0	4,737.0	4,099.0	3,931.0	2,656.6	3,193.2	2,915.2	2,862.4
Total liabilities	36,683.0	39,112.0	39,657.0	39,609.0	22,457.0	23,674.6	23,819.9	24,511.8
Preferred stock convertible					0.0	1,599.1	1,278.5	45.7
Common stock	5,255.0	5,379.0	5,575.0	5,723.0	1,830.1	1,904.8	2,038.1	2,078.6
Retained earnings	20,978.0	23,018.0	24,066.0	25,601.0	592.3	1,263.0	2,564.9	-185.0
Other equity items	-17,660.0	-18,847.0	-20,212.0	-21,310.0	-144.3	-1,843.5	-1,578.4	-282.9
Total equity	8,573.0	9,550.0	9,429.0	10,014.0	2,278.1	2,923.4	4,303.1	1,656.4
Shares data:								
Number of shares outstanding	799.0	773.0	744.0	718.0	579.40	500.30	469.60	529.00
Price per share ($)	26.86	34.50	43.59	44.63	NA	16.2	29.2	19.9

Table A1 continued.

	Kroger				Albertsons			
	2019	**2020**	**2021**	**2022**	**2019**	**2020**	**2021**	**2022**
Revenue	122,286.0	132,498.0	137,888.0	148,258.0	62,455.1	69,690.4	71,887.0	77,649.7
Cost of sales (except D&A)	94,440.0	100,709.0	106,555.0	115,450.0	44,455.9	48,906.0	50,762.4	55,894.1
Operating expenses (except D&A)	22,525.0	25,863.0	24,800.0	25,297.0	15,431.0	17,569.3	16,986.5	17,705.3
EBITDA	5,321.0	5,926.0	6,533.0	7,511.0	2,568.2	3,215.1	4,138.1	4,050.3
Depreciation and amortization	2,649.0	2,747.0	2,824.0	2,965.0	1,519.8	1,364.3	1,516.6	1,644.4
EBIT or operating income	2,672.0	3,179.0	3,709.0	4,546.0	1,048.4	1,850.8	2,621.5	2,405.9
Interest expense (financial gain)	603.0	544.0	571.0	535.0	725.3	558.3	475.3	404.6
Other expenses (income)	-59.0	-732.0	1,098.0	1,114.0	-276.1	163.8	46.7	65.8
Earnings before taxes	2,128.0	3,367.0	2,040.0	2,897.0	599.2	1,128.7	2,099.5	1,935.5
Income taxes	469.0	782.0	385.0	653.0	132.8	278.5	479.9	422.0
Net income	1,659.0	2,585.0	1,655.0	2,244.0	466.4	850.2	1,619.6	1,513.5
Statement of cash flow data								
Cash flow from operations	4,664.0	6,815.0	6,190.0	4,498.0	1,903.9	3,902.5	3,513.4	2,853.9
Cash flow from investing	-2,611.0	-2,814.0	-2,611.0	-3,015.0	-378.5	-1,572.0	-1,538.9	-1,977.3
Capital expenditures	-3,128.0	-2,865.0	-2,614.0	-3,078.0	-1,475.1	-1,630.2	-1,606.5	-2,153.9
Other investing	517.0	51.0	3.0	63.0	1,096.6	58.2	67.6	176.6
Cash flow from financing	-2,083.0	-2,713.0	-3,445.0	-2,289.0	-2,014.2	-1,041.8	-789.5	-3,365.4
Debt issued	1,163.0	1,049.0	56.0	-	3,874.0	4,094.0	-	2,150.0
Debt repaid	-2,304.0	-1,897.0	-1,442.0	-552.0	-5,785.9	-4,526.6	-408.9	-1,222.4
Common stock	-410.0	-1,197.0	-1,475.0	-859.0	-18.8	-215.3	-29.4	-44.0
Dividends paid	-486.0	-534.0	-589.0	-682.0	0.0	-159.7	-322.0	-4,237.3
Other financing	-46.0	-134.0	5.0	-196.0	-83.5	-234.2	-29.2	-11.7
Foreign exchange rate and other adj.					23.8	-44.0	2.5	28.2
Net change in cash	-30.0	1,288.0	134.0	-806.0	-465.0	1,244.7	1,187.5	-2,460.6

Source: Assembled and adjusted by authors from financial statements in S&P's Net Advantage (2023).
Notes: Shares outstanding in millions. Price per share as of the end of the fourth quarter in each fiscal year, obtained from CRSP (Wharton Research Data Services 2023). 2018 data: Revenue (Kroger: $121,852 million and Albertsons: $60,534.5 million) and net profit (Kroger: $3,111 million and Albertsons: $131.1 million).

Appendix 2: Template for the Analysis of Albertsons

Table A2: Template for Analysis of Albertsons (ALB).								
	20 ALB	**21 ALB**	**22 ALB**	**Avg. ALB**	**Trend ALB**	**Avg. KR**	**Trend KR**	**ALB vs. KR?**
Margins:								
EBIT margin						2.7%	Inc. (+)	
Net margin						1.6%	Vol. (up)	
Other IS:								
YtoY revenue growth						6.6%	Vol. (up)	
EPS						$2.9	Vol. (up)	
Asset mgt efficiency:								
Assets turnover						2.8x	Inc. (+)	
Profitability								
ROI						9.9%	Inc. (+)	
Lev. & Debt Mgt:								
Debt to assets						42%	Stable (=)	
Debt to EBITDA						3.1x	Dec. (+)	
EBIT to interest						6.9x	Inc. (+)	
Liquidity:								
Current ratio						0.8x	Stable (=)	
Cash flow:								
CFO to CAPEX						2.1x	Vol. (down)	
CAPEX to D&A						1.0x	Stable	
Market value-related: Price to Earnings (PE)						14.7x	Vol. (down)	

Notes: KR stands for Kroger.
1. Determine the **intra-firm trends** (in column "Trend ALB") according to these rules:
Increasing: If financial ratios grow every year. **Decreasing:** If financial ratios decline every year. **Stable:** If financial ratios move within a range of +/– 0.5%, 0.5x, $0.5, or 5.0 percentual points (the latter for leverage). **Volatile**: If financial ratios move out of a range of +/– 0.5%, 0.5x, $0.5, or 5.0 percentual points (this latter is for leverage). For a volatile curve, identify the curve as upward or downward. In addition, indicate with a positive (+), negative (–), or equal (=) sign after the trend whether the trend benefits, hurts, or is neutral for the financial health of the firm.
2. To compare Albertsons's average performance to the **benchmark (Kroger),** mark, in the last column, as "Similar" if the difference between financial ratios is within +/– 0.5%, 0.5x, $0.5, or 5.0 percentual points (the latter for leverage). Otherwise, define it as superior or inferior.

Appendix 3: Formulas of Selected Financial Ratios

(I) Income statement related ratios

Margins

Operating or EBIT margin (%)

$$\frac{EBIT}{Revenue} \times 100$$

Net margin (%)

$$\frac{Net\ income}{Revenue} \times 100$$

Other income statement-related ratios

Year-to-year sales growth (%)

$$\left(\left(\frac{Revenue\ year\ t}{Revenue\ year\ t-1}\right) - 1\right) \times 100$$

Earnings per share (EPS) ($)

$$\frac{Net\ income}{\#\ of\ shares\ outstanding}$$

(II) Financial ratios combining income statement and the balance sheet data

Assets management or efficiency

Assets turnover   (x)

$$\frac{Revenue}{Assets}$$

Profitability

Return on Investment (ROI) (%)

$$\frac{NOPAT}{Capital} \times 100 = \frac{EBIT(1-Tax\ rate)}{Debt+equity} \times 100$$

NOPAT stands for Net Operating Profits After Taxes.

Leverage and debt management

Debt to assets (%)

$$\frac{Debt}{Assets} \times 100$$

Debt to EBITDA (x)

$$\frac{Debt}{EBITDA}$$

EBIT to interest expenses (x)

$$\frac{EBIT}{Net\ interest\ exp.}$$

Liquidity

Current   ratio (x)

$$\frac{Current\ assets}{Current\ liabilities}$$

(III) Cash flow statement-related financial ratios

CFO to CAPEX (x)

$$\frac{Cash\ flow\ from\ operations}{Capital\ expenditures}$$

CAPEX to D&A (x)

$$\frac{Capital\ expenditures}{D\&A\ expenses}$$

(IV) Stock prices or market value-related

Price to Earnings (PE) (x)

$$\frac{Stock\ price}{Earnings\ per\ share} = \frac{Market\ capitalization}{Net\ income}$$

Market capitalization = Equity in market value (no book/balance sheet value) = stock price × # of shares

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Teaching and Educational Commentary

A Commentary on Extension Programming: An Overview of the Costs and Benefits of Patch-Burn Grazing Extension Program Development Through the Use of a Logic Model

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Abstract

The Extension program discussed in this commentary was developed using a logic model to provide the missing economic analysis of patch-burn grazing in comparison to traditional rangeland management practices. It was submitted to the Graduate Student Extension Competition through the Agricultural and Applied Economics Association (AAEA) to take advantage of the opportunity to present patch-burn grazing as a potential cost-reducing and beneficial management practice to Oklahoma cow-calf producers. Delivery plans and communication methods for the program include fact sheets and budget tools, research articles, conference presentations, and workshops. The development of this Extension program centered around the economics of patch-burn grazing is supplemental to ongoing research by the Prairie Project. The Prairie Project utilizes outputs such as fact sheets, workshops, and social media to convey the benefits of patch-burn grazing, which has been shown to be effective. The opportunity to build an Extension program around research using a logic model allows young professionals to learn how to build a successful program.

1 Introduction

The Costs and Benefits of Patch-Burn Grazing Extension program was developed to aid cattle producers in management decisions and to provide an example of program development using a logic model. The use of a logic model ensures that the program will address a problem, identify who is affected, have clear objectives, create activities to relay information and solutions, and measure outcomes of the program. The program discussed in this commentary was centered on the economic research of patch-burn grazing that developed due to recognizing missing information in existing programs.

The overall purpose of this article is to show the benefits of using a logic model as a young professional to develop a successful Extension program around applied research. The objectives are to (1) briefly convey economic research about patch-burn grazing, (2) walk through the development process of building an Extension program using a logic model, and (3) highlighting the logic model as an effective tool for young professionals developing a career in Extension.

2 Summary of Patch-Burn Grazing Economic Research

Due to rapid invasion of Eastern red cedar trees, fire suppression (not burning at all) should not be a rangeland management option for cattle producers. Any form of prescribed burning is encouraged to control woody plant encroachment (WPE). By maintaining rangelands through patch-burn grazing, cow-calf producers can potentially reduce drought impacts and supplemental feed costs due to higher quality and quantity forage while also reducing WPE.

2.1 The Problem: Woody Plant Encroachment

WPE is taking over rangelands and reducing forage production for cattle to graze, which increases supplemental costs for producers. The rapid invasion of Eastern Red Cedar and other invasive species is a result of years of fire suppression since European settlement in the late nineteenth and early twentieth centuries (Twidwell et al. 2021). Mechanical removal of the trees is an option, but becomes expensive (Smith 2011). The most cost-effective way to control invasive species is to re-adopt the practice of prescribed fire. However, to maximize the benefits of prescribed fire, an impactful grazing management system must be initiated.

2.2 What Is Being Done: The Prairie Project

To encourage cattle producers to use prescribed fire to limit WPE, collaboration between three universities, University of Nebraska-Lincoln, Texas A&M University, and Oklahoma State University (OSU), was established to create what is known as *The Prairie Project*.[1] This project consists of research, Extension, and teaching faculty that promote the rangeland management strategy of incorporating an interaction between fire and grazing on livestock operations known as pyric-herbivory. Pyric-herbivory, more commonly known as patch-burn grazing, is implemented by dividing a pasture into sections with one to two sections being burned annually rather than the traditional approach of burning the entire pasture every three years. This heterogenous pattern improves rangeland productivity by creating a natural rotational grazing environment for cattle to have improved forage quality in burned areas and stockpiled quantity in unburned areas to mitigate drought impacts.

2.3 The Missing Link: Economic Research

Although research emphasizes the benefits of patch-burn grazing, cattle producers are still skeptical of adopting the practice (Adhikari et al. 2023). There is also little economic information to support cost-effectiveness of the practice. One method of providing additional support is to provide a cost-benefit analysis of implementing and utilizing patch-burn grazing. Building a cost-benefit analysis for patch-burning involved estimating the costs of burning for both patch-burning and traditional burning (burn entire pasture every three years) using 2021 survey response data from the Natural Resource Ecology and Management Department at OSU. The main costs associated with both burn strategies include firebreak construction, fuel, and labor. After calculating these costs based on the survey responses, results convey that it costs approximately $2.77 more per acre to implement patch-burning ($4.58 per acre) in the first year compared to traditional burning ($1.81 per acre). However, it is anticipated that labor and fuel costs will decrease in years two and three by roughly 28.5 percent once firebreaks are initially constructed. Costs will vary across operations, but results provide a baseline estimate. After three years (full burn rotation), the cost to use patch-burning decreases to an average of $2.40 more per acre per year compared to traditional burning (Table 1).

Table 1: Comparison of Three-Year Total Investment Costs for Burning 150 Acres Using Patch-Burning and Traditional Burning

Category	Investment Cost
Patch-Burning	$677.67
Traditional Burning	$317.14
Difference in Investment Cost	$360.53
Average Per Acre Cost Difference	$2.40

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[1] See https://www.theprairieproject.org/.

Quantifying the benefits of patch-burning, high quality forages, and drought impact mitigation, was the second objective of the research. Feed costs were estimated utilizing results that saw a 40 percent reduction in supplemental feed requirements for cows on patch-burned pastures compared to cows on traditionally burned pastures (Limb et al. 2011). Combining these results with 2021 feed cost estimates,[2] patch-burn grazing has the potential to save cattle producers $20 per head in supplemental feed costs each year, dependent on the area not experiencing a drought. In the event of a drought (represented in year four for this research), stockpiled forages in unburned areas become the main benefit. It is estimated that if patch-burn grazing is utilized before and after a drought while not burning a patch during a drought, total supplemental feed and burn costs are lower after six years (two full-burn rotations for both practices; Figure 1). The long-term economic benefits potentially justify the higher implementation costs, especially in drought years.[3]

This economic research for patch-burn grazing is focused on serving cattle producers in Oklahoma since the data used to conduct the research was collected and analyzed at OSU. However, the results and development of the Extension program can be used to develop similar estimations and programs across the Great Plains region.

3 Extension Program Development

An Extension program was developed using a logic model to present the results of the economic patch-burn grazing research in the AAEA Graduate Student Extension Competition. The use of the logic model is beneficial in learning how to follow a step-by-step process of creating a successful outlet for applied research. The logic model in Figure 2 served as an outline of how to effectively convey the economic research of patch-burn grazing (Israel 2021).

6-Year Costs
TB & PBG: No Burn During Drought

TB	(bar extending to ~$8,190.00)
PBG	(bar extending to ~$8,025.00)

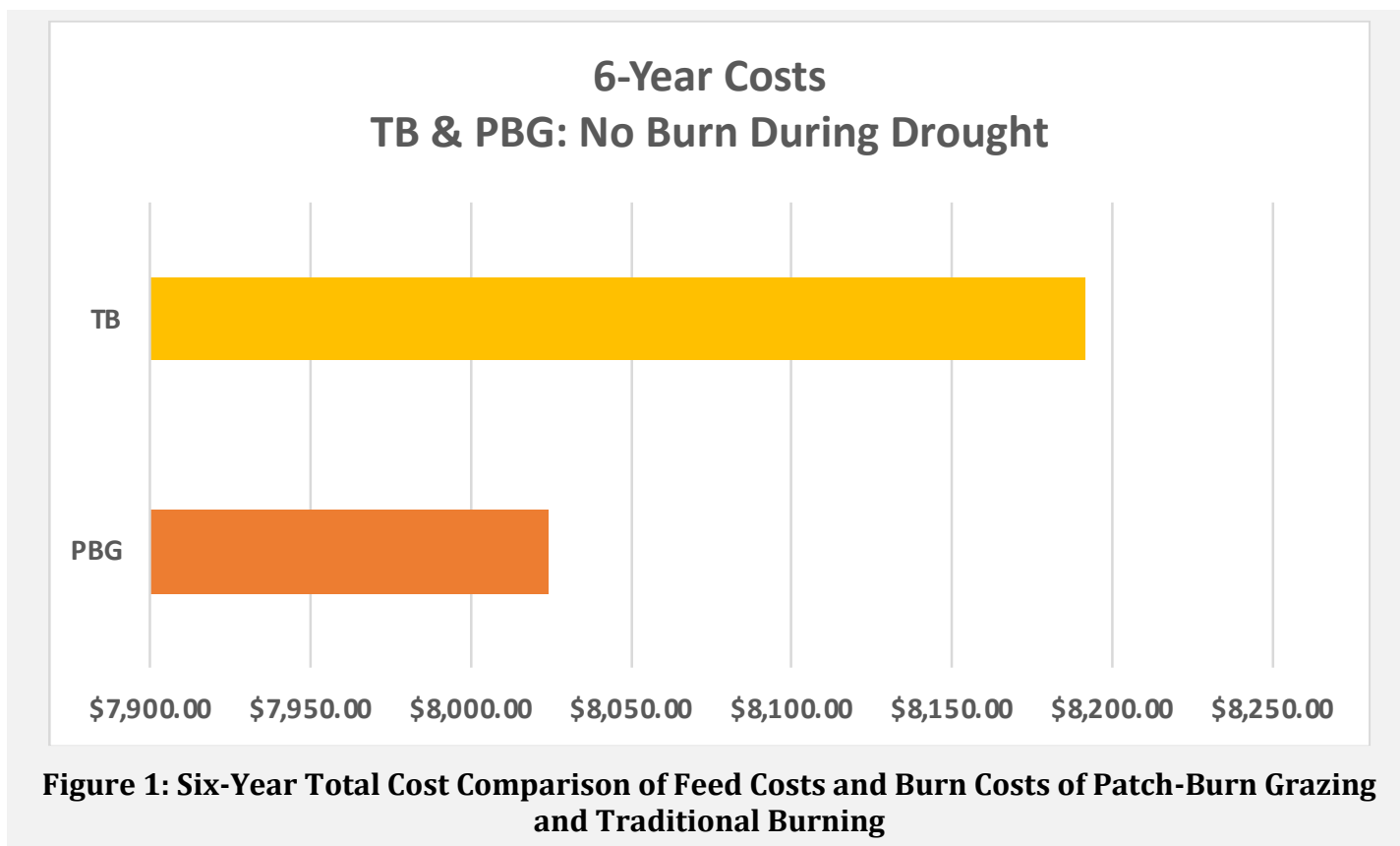$7,900.00 $7,950.00 $8,000.00 $8,050.00 $8,100.00 $8,150.00 $8,200.00 $8,250.00

Figure 1: Six-Year Total Cost Comparison of Feed Costs and Burn Costs of Patch-Burn Grazing and Traditional Burning

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[2] See https://extension.okstate.edu/fact-sheets/supplementing-beef-cows.html.
[3] See https://extension.okstate.edu/fact-sheets/implementation-costs-and-benefits-of-patch-burning.html.

Program: Cost and Benefits of Patch-Burn Grazing

Situation: Patch-burn grazing offers many environmental benefits and has been studied for decades. Yet, there is little economic research supporting the implementation of the practice on cattle operations. This program will use the results from conducted economic research of patch-burn grazing to convey the long-term economic benefits to emphasize the environmental ones.

Inputs	**Outputs**	
	Activities	*Participation*
Time, knowledge, and collaborative efforts from OSU faculty and The Prairie Project	Fact sheets Workshops Budget Estimations Webinars Journal articles Conferences	Cattle producers The Prairie Project Team/Academia Extension Agents

Outcomes -- Impact		
Short (KASA)	*Medium (Behavior Change)*	*Long (SEE)*
Knowledge: about economic benefits of PBG **Attitudes:** Willingness to evaluate PBG for their operation **Skills:** increase confidence in estimating/ teaching how to estimate costs of PBG **Aspirations:** economic information will improve awareness and adoption of PBG	Cattle producers will evaluate the costs and savings of PBG on their operation within one year of learning about the economics of PBG	**Social:** Cattle production will be better prepared for weather events and market fluctuations, resulting in a more stable supply of cattle/beef **Economical:** Profitability on individual ranches will increase due to reduced costs. **Environmental:** WPE will decrease, improving ecosystems and wildlife habitats.

Assumptions: This program will improve confidence and encourage Extension agents and The Prairie Project to incorporate economics into their existing programs about PBG. Cattle producers will reduce costs through the gained knowledge about the economic management strategy presented through the activities of this program. Cattle production will become more efficient and beef production will improve as a result.

External Factors: Producers who want to keep tradition no matter what or who think they do not have the time or money to implement a different management strategy will not see the benefit of this program. For others, the data and program presentations may not be convincing enough to make major changes to their operation.
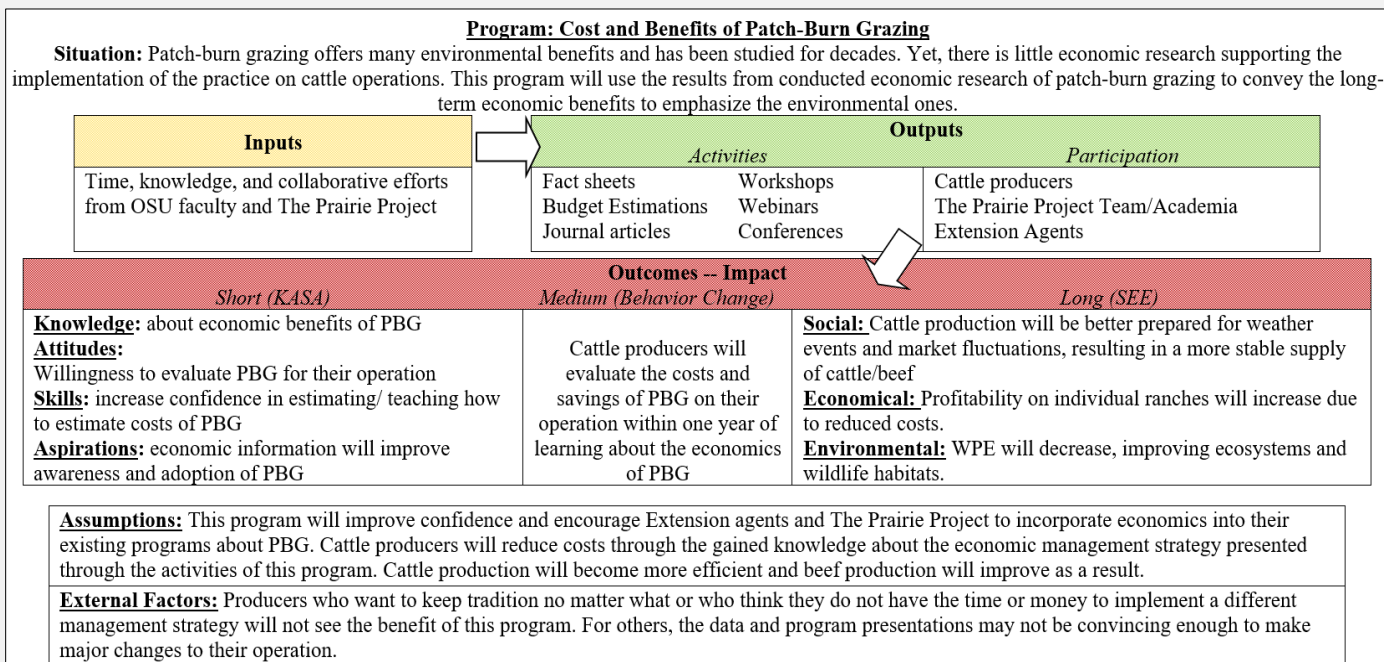
Figure 2: Logic Model of the Cost and Benefits of Patch-Burn Grazing Extension Program (Modified Wisconsin Model)

3.1 Situation: The Challenge and Opportunity

The first step in building a program is recognizing the need for the program and how to go about meeting that need. For the Extension program discussed in this commentary, the situation is that there is little economic research supporting the implementation of patch-burn grazing. This challenge presents an opportunity to estimate implementation costs for cattle producers, while also emphasizing and quantifying the environmental benefits of patch-burn grazing.

3.2 Inputs and Outputs: Activities and Participation

Step two is identifying the inputs needed for the program to be successful. This involves any effort, time, and money spent on development. The inputs of this program included time to develop activities and resources such as online webinars, conference presentations, and literary materials. Online webinars and presentations highlight only the economic information, while the economic literary materials such as fact sheets with budget estimations, research articles,[4] and newsletters[5] can be added to existing workshops and field days as handouts. Funding from a USDA-NIFA AFRI grant and collaborative efforts between researchers and Extension faculty at OSU and The Prairie Project were also inputs of this program.

Step three goes hand in hand with developing activities because the outlets developed are based on how your target audience best receives information. This Extension program is designed to reach a wide range of audience members that includes cattle producers, Extension agents, The Prairie Project team, and fellow professionals in academia. Therefore, a wide range of resources and activities were developed.

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[4] See https://bit.ly/patchburn-potentialcostsaver.
[5] See https://bit.ly/patchburn-mastercattleman.

3.3 Outcomes: Short-Term Impacts

Step four involved measuring the effectiveness of the program through short-, medium-, and long-term impacts (Israel 2001). Short-term impacts involve seeing change in the areas of knowledge, attitudes, skills, and aspirations. The short-term goal is to get the audience thinking about how they can apply what they learned. The short-term goals of this program are to increase awareness of patch-burn grazing by increasing knowledge about the economic benefits, improving confidence about how to estimate the costs, and willingness to evaluate the use of patch-burn grazing for specific cattle operations.

3.4. Outcomes: Medium-Term Impacts

Medium-term impacts involve the target audience reacting and adopting change. This goal should be measurable by time and realistically achievable. The medium-term impact for this program is to see cattle producers evaluate the costs and economic benefits of patch-burn grazing for their operation and decide on whether adoption is economical within one year of learning about the economics of patch-burn grazing.

3.5 Outcomes: Long-Term Impacts

Last, long-term goals are categorized by social, economical, and environmental categories. The long-term outcomes for the program discussed in this commentary include a social impact of improved cattle and beef supply, an economic impact of increased profitability on cattle operations, and an environmental impact of maintaining ecosystems and wildlife habitats. Each long-term impact would be a result of producers utilizing patch-burn grazing as a long-term investment practice on rangelands.

3.6 Assumptions and External Factors

This part of the logic model is important for considering the terms of the program and recognizing circumstances that could affect the success of the program. The assumptions in this logic model are that providing economical information will enhance existing programs and increase knowledge of patch-burn grazing. Cattle producers will strive to be profit maximizing, cattle production will become more efficient, and rangelands will be restored. The external factors that could limit program outcomes include producers who prefer their traditional style of management and producers who may not be convinced by the data to make any changes.

4 Extension Program Structure, Outreach, and Evaluation

Building an Extension program around applied research enhances the knowledge of the target audience. Providing economic information about the advantages of patch-burn grazing creates the opportunity for various resources to be utilized in various ways. Measurable outcomes are necessary for the program to improve and grow in the future.

4.1 Structure and Outreach: Stand-Alone or In Addition To

This Extension program was developed after recognizing that economic information needed to be added to existing programs to support implementation from an economical viewpoint. An additional goal of the research was to emphasize the environmental results by quantifying them. Therefore, the economic materials and information developed can be used in existing programs as well as in a program of its own because the environmental and economic benefits go together.

Structuring the program to be utilized as a "stand-alone" program and as an "in addition to" program creates the opportunity to reach a larger audience. Some participants may only need economic information through online webinars and literary materials that assign monetary value to what they already know. Others who are new to patch-burn grazing need a more hands-on experience by attending

workshops and field days hosted by The Prairie Project, where they will see the environmental results in the field while also being presented with economic information through the form of a presentation or handout.

4.2 Evaluation: Measuring the Success and Effectiveness of the Program

Feedback from the target audience is vital to measuring the outcomes stated in the logic model. The audience is encouraged to provide feedback through pre- and post-surveys at in-person events and online webinars. For an audience of Extension agents, The Prairie Project Team, and academia professionals, questions will include the following, using a ten-point ranking scale with "1" being the least and "10" the greatest:

1) Before/After this event, how beneficial do you think knowing the economics of patch-burning grazing is for cattle producers?
2) Before/After this event, how confident are you in talking with producers about estimating the costs and economic benefits of patch-burn grazing?
3) Before/After this event, how likely are you to incorporate economics into your existing programs?

Questions for a producer audience would include the following, on the same ranking scale:

1) Before/After this event, rank yourself on how much you know about the costs and economic benefits of patch-burn grazing.
2) Before/After this event, how confident are you in estimating the costs of patch-burning on your operation?
3) Before/After this event, how likely are you to use patch-burn grazing on your operation?

Number of downloads, views, and engagements on social media and websites (The Prairie Project, OSU Extension, etc.) is also accounted for to measure the impact of literary materials.

5 Conclusion

In this article, we review the development of the Costs and Benefits of Patch-Burn Grazing Extension program that was derived from the opportunity to build a successful program using a logic model to present an economic analysis of patch-burn grazing. The logic model was a valuable tool in recognizing the challenge and opportunity among a target audience, intentionally creating activities, and setting measurable outcome goals to ensure the effectiveness of teaching the costs and economic benefits of patch-burn grazing. The flexible structure of the program allows for literary and online resources to be used in various ways to reach the entire target audience.

Target audiences of Extension programs need resources to make informed decisions. Research projects are designed to provide solutions to aid in this decision-making process. Using a logic model as a tool to bridge the gap between the target audience's need and the research project's design ensures the success of an Extension program.

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