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The need and development for a value-added toolkit—A case study with Montana specialty fruit growers

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Introduction: Cold-hardy small fruits and berries have the potential for specialty fruit growers in the Intermountain West, where the climate is not suited for conventional fruit crops. In the last seven years, approximately 50 varieties of cold-hardy, bush fruit types have been researched in western Montana.

Method: Hence with the increased small fruit and berry production, and interest of specialty fruit growers in value-added product development, this paper utilized participatory action research (PAR) to develop a value-added product development toolkit with specialty fruit growers and used an integrated logic model to discuss creating and implementing the toolkit. Firstly, we used an online survey to identify the needs and challenges of specialty fruit growers. Next, a value-added toolkit is drafted using the principles of design thinking and involving a student-grower partnership. Thirdly, the specialty fruit grower's interest in and feedback on the drafted toolkit is evaluated using focus group discussions and individuals interviews, and the results are used to revise the toolkit. Lastly, the short, medium and long-term outcomes for this toolkit are discussed using the logic model.

Results: From the survey, 61% of specialty fruit growers indicated an interest in value-added opportunities. Yet, focus group discussions and individual interviews found the biggest barriers to value-added product development are cost, resources, and environment. This indicated a co-created toolkit will be a beneficial solution. During focus group and individual interviews, the growers suggested including the toolkit as part of coursework in semester-long classes. This will address issues of continuity and funding.

Discussion: Overall, this study deployed PAR methods to propose with Montana specialty fruit growers a solution to their increasing needs in value-added pursuits, implying short-term economic benefits but also long-term socio-ecological benefits. The participatory model of creating value-added resources presented by this paper can benefit other small-scale specialty crop growers in underserved regions.

KEYWORDS

design thinking, specialty fruit, value-added production, participatory action research, Montana growers

1. Introduction

For every dollar US consumers spend on foods, growers receive only 16 cents [U.S. Department of Agriculture (USDA), 2022], the remainder mostly absorbed by the middlemen in the value chain. Hence, for growers to have a greater share of profit margins, value-added ventures provides a diversified income stream for growers to utilize surplus and unmarketable harvest to make products (Chen et al., 2021). This also gives more variety to consumers (Chen et al., 2021). The concept of value-added agriculture refers to the process of changing the physical state of an ingredient/raw commodity in order to produce a product that increases the value of the raw commodity (U. S. Department of Agriculture, 2022). Jam-making using fruits is an example of a value-added product (Fuller, 2019; U. S. Department of Agriculture, 2022). Value-added agriculture is particularly critical to small-scale specialty crop farms. This is because these farms are limited in resources to compete with larger entities, thus demand unique initiatives including value-added product development to capture newer markets (e.g., ecologically conscious consumers) (Selfa and Qazi, 2005).

Compared to typical crops (e.g., grains), specialty crops can generate sales revenue that are three to five times higher, and value-added efforts can increase this revenue even more. Winemaking, for example, can generate six times more revenue than selling the grapes otherwise (Miller, 2021). In Montana, however, only 1% of the 26,800 farms (U. S. Department of Agriculture, 2020) are engaged in value-added agriculture (Fuller, 2019). Particularly, small-scale growers in Montana have missed an opportunity to add value to their specialty crops. Adding value to promote specialty crops can help by diversifying agriculture landscape, decreasing the risk of crop failure and safeguarding community food security, unlike monocropping systems (Aguilar et al., 2015). Such efforts can ultimately enhance food system resiliency against global issues such as climate change and supply chain disruptions under pandemic (Ebel et al., 2022).

Among the specialty crops, the current study looked at the cold-hardy small fruits and berries such as haskaps, aronia, saskatoon, and dwarf sour cherries. These are considered "superfoods," owing to their richness in nutrients and physiologically active phytochemicals provided (Miller, 2016). Their market expansion has been attributed to this, with a growing number of consumers consuming berries, owing to the health benefits provided (Fortune Business Insights, 2020). It is estimated that the global berry market will increase by 5.7% annually by 2025, hitting $8.96 billion (More, 2022). The studied small fruit and berries contain phytochemicals such as flavonoids and phenolic acids that may prevent chronic diseases such as cancer, cardiovascular and neurodegenerative diseases (Rupasinghe, 2008; Rupasinghe et al., 2012). For example, haskaps were reported to have the highest antioxidant and total phenolic contents compared to strawberry, raspberry, blackberry, blueberry, partridgeberry, and grapes (Rupasinghe et al., 2012). Also, the total anthocyanins in saskatoons and wild blueberry were found to be 1.5 to 600 times as high as that in raspberry, chokecherry, strawberry, and sea buckthorn (Hosseinian and Beta, 2007).

Owing to the environmental conditions of Montana, the state has mostly neutral to alkaline soil (pH 6–8), not ideal for ericaceous fruit such as blueberries that require acidic soil, but rather suitable for growing cold-hardy small fruits and berries (Miller, 2016). Since cold-hardy small fruits and berries are perennial shrubs, they can reduce tillage and can increase water holding capacity and reduce soil erosion, allowing less disturbance in soil (Green America, 2018). The root systems of perennial plants also store more carbon, deeper in the root system, and this allows growth for healthier crops (Green America, 2018). In order to identify climate-adaptable and profitable bush fruit varieties, Montana State University-Western Agricultural Research Center (Bitterroot, MT) has evaluated 50 varieties of novel cold-hardy varieties.

A recent unpublished survey identified 61 growers who grow cold-hardy specialty fruits in Montana (Z. Miller, personal communication, October 19, 2021). Yet, only 15 out of the 600 Montana food establishments offer value-added cold-hardy specialty fruits, based on a comprehensive directory (Abundant Montana, 2022). This underlines the untapped territories of value-added ventures for most specialty fruit farms in Montana. However, published studies on value-added small fruits and berries are limited to common commercial varieties and lack information about cold-hardy specialty fruits.

Although consumers are more familiar with the popular berries like blueberries and strawberries and their value-added products, many, including berry growers are unaware of the novel cold-hardy varieties and the possibility of producing value-added products from them (Miller, 2016). For example, saskatoon prove to be better used as value-added product than consumed raw since they have an earthy, musty, grassy, and mushy flavor, thus it makes them suitable for a value-added product, such as in jellies, juices, or pie fillings to improve the sensory acceptance (Kidd, 2006; Garg et al., 2023). By developing value-added products, these novel varieties could be introduced to the market with nutritional benefits and refined sensory profiles (Garg et al., 2023).

Participatory action research (PAR) was used in this study to address this market gap and promote value-added research for cold-hardy specialty fruit growers. In PAR, academics and non-academics collaborate to identify and solve community challenges (Méndez et al., 2017). It is the non-academics (such as smallholder farmers) who shed knowledge of the place, content, and practices, while the academics provide research and experimental design, collaboratively identifying practical solutions (Méndez et al., 2017). Qualitative stakeholder engagement methods combined with quantitative outcome-oriented approaches result in more scientifically sound and versatile results, which enable solutions to be strategized (Ivankova, 2017).

In literature focusing on agroecology, PAR is well-known for its effectiveness with small-scale growers (Méndez et al., 2017). A community-university partnership, for example, proposed a "learning framework" to understand how socio-ecological drivers influence urban farming in Minneapolis (Nicklay et al., 2020, p. 1). The teams investigated processes as enablers or barriers and the role of relationships in the collaboration. The results of qualitative online surveys and interviews identified that collaborative research in the urban agroecology will result in a shared learning outcome for both researchers and growers. Another PAR study investigated if small-scale coffee farmers in El Salvador can ideate strategies for biodiversity conversations and household livelihood (Méndez et al., 2017). During the process, (1) relationships were built and an understanding of the context was acquired, (2) actions

were supported, research was continued, and sharing of results was conducted, (3) directions were changed, and academic and action outcomes were obtained (Méndez et al., 2017). According to this study, PAR involves a shared interest in research by partners, belief in collective power, a commitment to participation, integrating humility between participants, establishing trust, and communicating effectively (Méndez et al., 2017).

PAR has proven successful in agroecology research, but there are few studies utilizing PAR for value-added projects. In order to address this gap, we integrated PAR and logic models. By doing so, we co-created a value-added toolkit for Montana specialty fruit growers. Specifically, this study aims to (i) apply PAR in co-creating a value-added toolkit with Montana specialty fruit growers, and (ii) develop a logic model to strategize and outline the anticipated benefits of co-creating the toolkit. Through the logic model, dynamic community engagement studies can be planned, implemented, evaluated and communicated more effectively (Taylor-Powell and Henert, 2018). The toolkit and model of this research may be applicable to other specialty crop growers in the future, encouraging them to pursue value-added agriculture.

2. Methods

This study used participatory action research (PAR) principles to co-develop a value-added toolkit with small-scale specialty fruit growers in Montana. Similar methodologies have been used in past studies to use action research and co-create products such as public health interventions and development of science shops (Leask et al., 2019; Senabre Hidalgo et al., 2021). PAR has six iterative stages: (1) identifying the problem, (2) collecting, analyzing, and interpreting the data, (3) developing a plan to intervene, (4) implementing the intervention, (5) evaluating the intervention, and (6) monitoring to inform revisions (Ivankova, 2017). This study presents outcomes from the first three stages, and uses a logic model to visualize the development (Stage 3) and proposed outcomes of stages 4–6 (Taylor-Powell and Henert, 2018).

We designed the study to maximize the growers' participation in all data collection and developing the value-added toolkit. This included surveying 42 specialty fruit growers for their needs and challenges especially in value-added areas. A preliminary value-added toolkit was drafted based on the survey feedback. Next, using focus group discussions and one-on-one interviews with 12 MT specialty fruit growers, we revised the drafted toolkit. Finally, for any conference presentation or publications, twelve MT specialty fruit growers were invited to review the material to ensure accuracy of the data and interpretation. Two of these growers shared feedback. Approval from the Institutional Review Board at Montana State University was received before carrying out the survey (W-YK090320), focus group discussion (SG022822-EX), and interviews (SG022822-EX).

2.1. Survey

An online survey was administered using Qualtrics^{XM} (Provo, UT) to identify the needs and challenges of specialty fruit growers particularly in value-added areas. The survey questions included a mix of quantitative and qualitative questions. Questions 1–5 provided fixed options that participants could select from Table 1. They could also elaborate on their selected choice, using the textbox provided. Question 6 was an open-ended question for the participants to share their opinion and thoughts.

Q1: What are the top three research and workshop topics on small fruits that you would be most interested in?

Q2: What are your top three choices for the product development of small fruits?

Q3: What are the top three aspects which you believe to be most important in the product development of small fruits?

Q4: What fruit crops have you planted or are planning to grow?

Q5: Please describe your current operation.

Q6: What are the most exciting or challenging aspects of your business? What growth or changes would you like to see in your business in the next 5 years?

The 42 growers were selected from the North American region by distributing the survey among channels where relevant audience can be acquired from—such as the Montana Berry Grower Association and Facebook groups where members who grew similar crops could participate. Individuals who self-identify as specialty fruit growers in the USA/Canada region and grew varieties such as aronia, currants, dwarf sour cherries, elderberry, haskaps, and saskatoons were selected for the survey. Emails to some growers were obtained by past partnership effort by members of the research teams. Forty-two specialty fruit growers participated in the survey, including growers operating farms in Montana (19), Utah (7), Canada (7), Minnesota (2), Missouri (2), New York (1), Ohio (1), Oregon (1), Illinois (1), and Wisconsin (1). Since the responses from the other regions are limited, the survey result analysis included only Montana and Utah to represent growers with geoclimatic proximity in the Intermountain West. Due to a greater number of responses from Montana growers in this survey, and their ease of access to the research site at Montana, only Montana growers were selected for the following focus groups and interviews. We had also previously collaborated with the specialty fruit growers in Montana, hence it made the partnership on the toolkit more realistic (Garg et al., 2023). Based on the outcomes of this partnership, collaboration with other states can be directed to evaluate the scalability of implementing the toolkit.

2.2. Value-added toolkit development

The toolkit was structured based on the Hasso-Plattner model which accounts for the five stages of design thinking. These include empathizing, defining, ideating, prototyping and testing. The process guide mentions that, *"To create meaningful innovations, you need to know your users and care about their lives"* (Plattner, 2021). The five stages were first modified to have the toolkit emphasize specialty fruit grower's needs, while still being in alignment with the five stages. The typical structure of design thinking model stems from user/consumer's needs (Plattner, 2021), however by integrating PAR, our model differs by engaging and empathizing both specialty fruit growers (who use the toolkit to develop the product) and consumers (who will be the end-users of the developed product). We replaced the terms empathize and

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TABLE 1 Quantitative results from the survey with specialty fruit growers in Montana and Utah.

Question and choices	Frequency	%[a]
1. Research/workshop topics of interest (choose up to 3)		
Farm Operation	22	85
Market and business planning	18	69
Value-added product development	16	62
Socioeconomic sustainability	13	50
Environmental sustainability	9	35
2. Choices of food product development (choose up to 3)		
Snacks and sweets (granola, candies, freeze-dried fruits)	19	73
Jams, jellies, and preserves	17	65
Hard beverages (wine, beer, hard cider, spirits, etc.)	13	50
Fermented beverages (cider, kombucha, kefir, etc.)	11	42
Condiment, sauce, dressing, seasonings, etc.	10	38
Flavored beverages (seltzer, juices, shakes, fruit tea, etc.)	8	31
3. Aspects of importance in product development (choose up to 3)		
Healthfulness	21	81
Taste	18	69
Branding	11	42
Environmental sustainability	10	38
Price	6	23
Promotion of agri-tourism	6	23
Clean label	5	19
Other	1	4
4. Operating size		
Currently in the planning stage	2	8
Less than 1 acre	8	31
Between 1-5 acres	12	46
More than 5 acres	4	15
5. Crops planted		
Raspberry	13	50
Haskaps	12	46
Currants	11	42
Dwarf Sour Cherries	8	31
Elderberry	7	27
Aronia	6	23
Saskatoon	4	15
Blueberries	1	4

[a]These percentages are based on the number of growers (out of the 26 growers surveyed) who choose this answer.

define in the design thinking model proposed by Hasso-Plattner and diverted to use of the term *"create partnership,"* instead. This allowed us to be less abstract and be more intuitive to help address the needs of the growers (as to be discussed in Section 3.1). Secondly, the revision of the toolkit had a final stage of scale-up and community engagement. This was also in alignment with the grower's concern from the survey of needing resources (scale-up), and support for market & business planning to get consumers more aware of these berries (community engagement). The toolkit was drafted (Figure 1) to serve as an intervention

(Plattner, 2021) that can assist the specialty fruit growers in value-added product development. The steps included (1) creating a student-grower partnership, (2) ideating a product, (3) prototyping product recipes, (4) testing the product with consumers, and (5) scaling-up and community engagement for product launch. The toolkit has iterative cycles between some steps to highlight the non-linear approach, as well as input and outputs from both students and growers to show the PAR process of engaging both researchers and non-researchers to establish a social change (Méndez et al., 2017). The value-added toolkit in this study followed a design thinking approach, as opposed to the traditional Stage-Gate® model (Stage-Gate International, 2022). The first reason to apply design thinking was that it is a human-centric model. Such model stresses empathizing with users to account for emotional connections and lived experiences, whereas Stage-Gate is driven more by rational thinking (Nakata, 2020).

2.3. Focus group and individual interviews

Twelve Montana specialty fruit growers reviewed and modified the toolkit *via* one focus group (8 growers) and 4 individual interviews (The moderator guide and questionnaire is attached as the Supplementary material). In the absence of a time that was convenient for all, eight participants participated in a 90-min in-person focus group (FG) and four participated in 25-min online interviews. The growers discussed the feasibility of value-added product development, specifically for small-scale growers, and how the drafted toolkit could be used to assist them in developing value-added products.

As part of the focus group protocol, the moderator began by asking general questions (e.g., knowledge and current practices of value-added product development) and then moved to more specific ones (e.g., feedback on presented toolkit). Growers were asked to share their understanding of the term "value-added product development," then to share their experiences with product development. Lastly, a handout of the draft toolkit was presented to the panel (Figure 1) to share a guided approach to value-added product development (with student-grower partnership), and they were asked to refine and modify the framework, as necessary. The same questions were asked during the four individual interviews, and there was a visual aid that listed questions and showed graphical illustrations to reduce fatigue for participants.

2.4. Ensuring validity and reliability of qualitative research

Qualitative research collection can often be questioned due to no means of assuring validity and/or reliability for such kind of studies (Noble and Smith, 2015).

In the present study, we assured validity in the manner of implementing semi-structured focus groups, avoiding biased perspective from moderator, and establishing a thick and rich verbatim. Semi-structured interviews and/or focus groups is when the moderator provides a list of predetermined questions to help initiate the conversation between participants and researchers (Gill et al., 2008). The list of predetermined questions are provided as part of the Supplementary material (refer to Moderator's Guide). This allowed us to minimize bias responses and provide an environment where participants can speak more freely, also if there is any emerging theme that becomes significant—the interview participant/researcher could diverge to pursue the idea in greater detail (Gill et al., 2008). Doing so, a thick and rich verbatim was established to clarify any abstract ideas and have a more accurate account of the participant's thoughts.

To achieve reliability in our findings, we recruited notetakers to sit in on the focus group/interviews, audio-taped the sessions and verified the material prepared. In qualitative studies, the equivalent term to reliability is "consistency" and "confirmability" (Noble and Smith, 2015). Consistency was achieved by keeping an accurate decision trail through the notes made by the two notetakers, and confirmability by having the notes verified by two separate researchers. These researchers could also utilize the audio-tapings to confirm the precision of the notes made. To further increase reliability of the study, this manuscript was shared among all the growers who took part in the focus group and interviews. The material was shared to all growers for first and second submission, and each time two of the twelve growers responded to confirm that all thoughts/ideas have been adequately denoted.

3. Results and discussion

3.1. Survey

From the survey, 46% of the Montana and Utah growers had a farm size between 1 and 5 acres. While 8% were still in the planning stage, 31% and 15% growers had farm size <1 acre and more than 5 acres, respectively (Table 1, Q4). The average Montana farm size across all crops types in 2019 was 1,272 acres (United State Department of Agriculture, 2020). To contrast, the total farmland of the 156 berry farms in Montana in 2017 was just 52 acres (United State Department of Agriculture, 2017). Hence, our survey agrees with the above comparison, that the majority of these specialty fruit growers operate on very small-scale, and the average farm size is far below the state average.

The top crops planted include raspberry (50%), haskap (46%), and currants (42%) (Table 1, Q5). This identifies which varieties are the most popular among small scale specialty fruit growers. From a study in Nielsen, it was reported that while strawberries and blueberries had the greatest category share of berry sales in the US—44.2 and 28.8%, respectively, raspberries had the third greatest share of sales at 14.6% (Shahbandeh, 2021). The fact that 50% of growers from our survey are growing at least one of these top varieties suggests there is a consumer market which they can tap into, whilst also sharing varieties that are not as common to consumers (haskaps and currants).

Five research/workshop topics were provided to the growers to indicate their area of interest (Table 1, Q1). From the 17 Montana and 9 Utah growers, the top three topics chosen were farm operations, market and business planning, and value-added product development (selected by 85%, 69%, and 62% of the growers, respectively). At least one of these topics was selected by all 26 participants. When asked to write down the most challenging

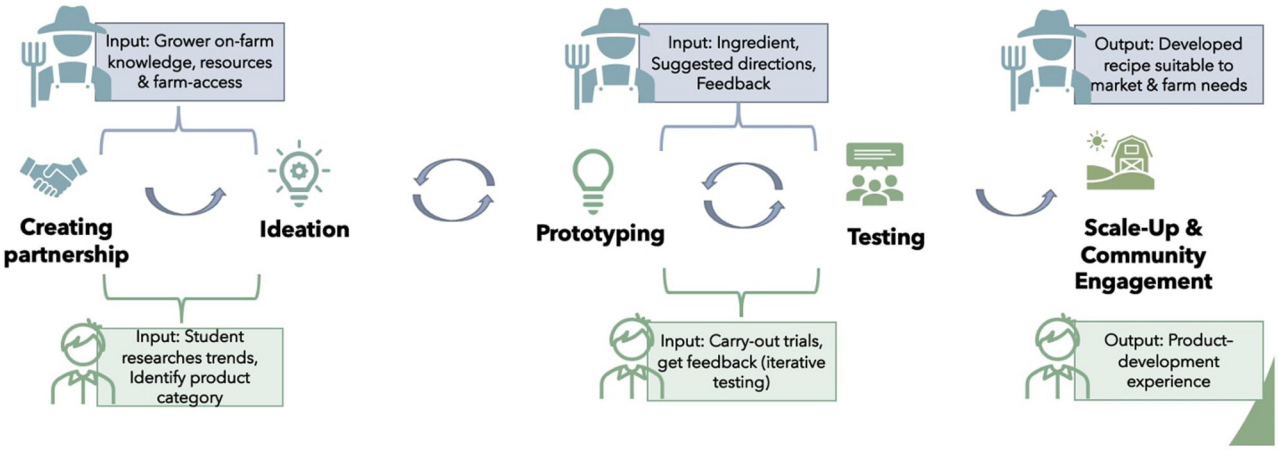

FIGURE 1
Proposed draft toolkit for engaging Montana specialty fruit growers in value-added product development adapted from Stanford School of Design, as proposed by Plattner (2021).

aspects, several growers expressed that marketing berries within Montana is challenging due to the lack of fruit recognition by consumers and the relatively small market size. A Montana grower stated, "*The most challenging has been the lack of knowledge, by consumers, of what the berries are. Marketing will play a huge role in the future of the industry,*" The growers further explained the struggles of differentiating their products and competing with larger entities, an issue of small specialty crop farms discussed in previous literature (Selfa and Qazi, 2005). For example, one grower commented *"Our business emphasizes products that are made from fruit that grows in Montana. Some Montana wineries and jam and jelly processors and other retailers sell out-of-state fruit or wine promoted as Montana products, when these products are simply bottled or packaged in Montana. There is a hunger for genuine, local-grown and produced products."*

A Fisher's exact test was performed to evaluate whether the interest between the top three research/workshop topics (farm operations, market and business planning and value-added product development) was significantly different among growers with differing farm sizes. Growers who were currently in the planning stage or had a farm-size less than one acre were compared with growers with a farm size larger than one acre. Our results concluded that regardless of the farm size, all growers showed a consistent interest in the three research/workshop topics.

Followingly this survey, we conducted a separate study to evaluate the market potential of some Montana specialty fruits (haskaps, saskatoons, and dwarf sour cherries), and found that consumers were interested in supporting local produce and paying slightly more to support small-scale producers, but would like them to be storage stable and year-round accessible (Garg et al., 2023). This consumer study and the survey of the present study jointly indicated that value-added initiatives could connect these growers with local consumers by developing products that extend the sale season and improve the palatability for these specialty fruits that are not as well-known in the fresh market.

When asked to choose the top three interested categories of food product development (Table 1, Q2), the majority chose snacks and sweets (73%), jams, jellies and preserves (65%), and hard beverages (50%). The global consumption of snacking has increased by 5% after the pandemic, and 64% of consumers have reported replacing one meal with a snack (Mondelēz International, 2021). In a following study on the market potential of Montana specialty fruits, the participants indicated interest to access these fruits as either jams/jellies/preserves or snacks and treats (Garg et al., 2023). The agreement between growers and consumers regarding which product categories are of most interest is promising for being successful in our value-added endeavors. When asked to share the three major aspects of importance in product development, healthfulness (81%), taste (69%), and branding (42%) were the leading factors (Table 1, Q3). The 2021 Food & Health Survey had found that among consumers the leading drivers are taste, followed by price and then healthfulness (International Food Information Council, 2021). The proximity between the growers' and the consumers' interest in healthy and tasty snack foods implied that the growers were well in tune with the leading market trend, demonstrating their motivation in value-added ventures. On the other hand, the growers' choices for products commonly seen in the current marketplace such as jams and wines may be partly due to limited innovation infrastructure, which can be expanded by university-grower partnerships.

3.2. Focus group and individual interviews

A comprehensive analysis of the focus group and individual interview findings can be found in Tables 2, 3. Due to the difference in data collection methods adopted, we separated the tables to remove any biases from participating in a group-setting (FG) or individually (individual interviews). The dominant themes discussed remained unchanged between the FG and individual interviews (Tables 2, 3). These included

benefits of developing value-added product, barriers to product development and expectations for the presented toolkit. However, different aspects triggered interest for value-added product development among the focus group participants and the individual interviewees. Focus group participants appreciated that value-added product development can help with preservation, transport to greater distances and can keep food healthy (Table 1). In addition, individual interviewees shared that branding and marketing provide benefits toward value-added product development (Table 2).

The barriers toward product development shared similarity between the focus group and the individual interviews. These were primarily *cost*, *resources and environment* (Tables 2, 3). Since small-scale growers lack capital, time and knowledge to carry out value-added activities on their own, finding an alternate solution can make this venture more profitable. The individual interviewees further shared that unforeseen *environmental* concerns (such as crop failure due to insects) can also be limiting factors for them (Table 2). A similar study in Indiana identified the barriers and motivators for starting value-added businesses from the viewpoint of growers and farmer market managers (Chen et al., 2021). The study agreed with our findings that a lack of resources, such as time, labor, cost, and infrastructure hinders the founding of value-added enterprises (Chen et al., 2021). The same study also reported the difficulty with marketing as another hurdle for the growers. While farmer's markets were a good starting point to pilot-test the sales, growers seemed to experience challenges with expanding their sale to broader markets such as wholesale or retail outlets (Chen et al., 2021). Likewise, this hurdle was captured in the present study, when the growers mentioned marketing being the prerequisite for profiting from value-added efforts.

Next, when presented with the drafted toolkit, the growers indicated funding as an expected challenge. This challenge concerned access to capital funds for trialing different recipes, sourcing equipment and supplies. Table 2 (quotes D and E) and Table 3 (quotes C and D) provide examples of direct quotations from growers, which highlights the costing and resource concerns raised. However, the growers agreed that integrating this toolkit with coursework can benefit both them and students. Such as, implementing this student-grower partnership in food product development courses offered at the university to have tuition fees support the testing supplies. The partnership endeavor was viewed as an area of great technical support for growers, and product development experience for students *via* service and learning. Some example dialogues from growers to support the partnership endeavor are shared in Table 2 (quote G) and Table 3 (quote G). Such expression implied the grower's strong initiatives in being a player in partnerships with the university, instead of being a research subject, which stresses the critical role of PAR in value-added research with growers. Collective decision-making and active engagement from all stakeholders (researchers and non-researchers) is integral to the success of PAR (Senabre Hidalgo et al., 2021).

When growers were asked about the duration of the partnership, there was debate on the timeline of this toolkit because each grower had different business needs and aims. For example, while one grower in the focus group had an established value-added business, the remainder were still in the trialing phase to discover their value-added market. Nevertheless, for having quick and action-orientated results, semester-long (16 weeks) undergraduate courses were preferred by the majority. Embedding this student-grower partnership in coursework also allows for a level of continuity, because the coursework will be closely monitored and adjusted by faculty each year, as opposed to a 2-year graduate thesis which may be hard to follow up, after the student graduated. This thought was expressed by one grower in the focus group, who believed coursework studies would provide a better level of continuity than implementing the project as part of a thesis (Table 2, quote I). The partnership could be initiated by faculty in fall to identify the growers which had sufficient produce from summer and would like to participate. Then, in the spring semester the students can take this produce and complete the steps of ideation through to testing. This is because a grower mentioned the availability of farmers is best during the months of January-February (Table 3, quote H). This was confirmed by knowing the harvest season of these fruits range from June to September (Miller, 2019). Therefore, growers could be more actively involved in the co-creation of the value-added product, during the spring term when they are best available.

One individual interview participant also brought up the idea of maintaining intellectual property (IP), as growers may be sensitive to sharing trade secrets/ideas (Table 3). For example, a grower shared, *"I guess I have mixed feelings about it because I think the testing and developing will be...I mean something that's more personal to the grower."* Hence, establishing agreement was added to the revised toolkit to reassure the growers' IP right. A paper by Smith and Bragdon (2016), also discussed the important relationship between intellectual property rights and small-scale farmer innovation. The paper highlighted how many small-scale farmers do not use IP tool, and with the presence of such practices it can encourage small-scale farmer innovation, or at least provide the space for it to occur without any hindrance. With this IP concern in mind, forming the student-grower partnership *via* undergraduate courses also helps growers to retain more intellectual property. This is because graduate students are typically expected to publish theses, but undergraduate students can be offered the options to partner with growers for the benefit of experiential learning, and in exchange, sign on non-discloser agreements to keep the product recipes confidential for the growers.

3.3. Revised value-added toolkit

As discussed in Section 2.2, this study integrated PAR with design thinking principles, thus the toolkit serves to empathize with both the growers and consumers to create products meeting the needs of both. Therefore, following the design thinking framework to construct the value-added toolkit was preferred over Stage-Gate for this study, so the students can be more empathetic of the growers' needs and form partnerships based on emotional connections with them. Design thinking framework also allows decision making to be directed by the design teams, while Stage-Gate relies upon hierarchical judgment by senior managers

TABLE 2 Dominant themes from the focus group discussion with specialty fruit growers in Montana.

Dominant theme	Explanation	Example from focus group	Number of references
Benefits for value-added product development	Preservation—panel expressed interest for product development to preserve products and extend shelf-life.	(A) *"That's what brought me to freeze drying, it was just another way of being able to preserve them."*	Preservation—5
	Transport—with extension of shelf-life can make the product widely available	(B) *"[With product development] can get the product to consumers at greater distances."*	Transport—4
	Health—realizing with some processing methods can help to keep nutritional benefits	(C) *"I'm kind of interested in freeze-drying for its' health properties."*	Health—4
Barriers to product development	Cost—Numerous concerns were raised with how cost-prohibitive product development can be for small-scale growers.	(D) *"And there's cost to using the kitchen. . . it kind of keeps building until, you're almost cost-prohibitive to sell your product."*	Cost—7
	Resources—Panel shared they lacked knowledge surrounding appropriate licensing or did not have time and resources to execute the activities of product development, independently.	(E) *"I got good ideas I just, I just don't have the time or the resources to [execute it]."*	Resources—8
Expectations from presented toolkit	Funding –Panel shared that funding can be an issue for executing the toolkit. Initially, shared that a grant may be required prior to partnership, but later agreed that testing out the success of a partnership will help in writing the grant.	(F) *"And it wouldn't be as much of a monetary investment (as growers), until we can get something established and then, then it would be much easier to write a grant for it, to say, this is what we have and this is our value-added product.*	Funding—10
	Partnership—Growers were willing to offer knowledge and ideas (of what they have experienced). But they lacked time for experimenting—hence found the partnership between student and grower can be of great values. Also, shared the interest to extend the toolkit and be connected with markets.	(G) *"I've got ideas that I don't know how to proceed with them, so yea, I think that would be great if we had somebody that was able to do that."*	Partnership—9
		(H) *"I would just take it one step further with the scaling up and the marketing like where to go from there as far as making the connections to get it to market."*	
	Timeline—there was slight debate if toolkit should have a shorter timeline (coursework class) or longer timeline (thesis research), but most later agreed that a shorter duration would be a good place to start for them.	(I) *"If it's part of classwork, it could have some continuity, or, pretty easily, might have different students over a period of time. If it's part of their thesis, I think that will be very difficult."*	Timeline—10

(Nakata, 2020). Again, design thinking was highly preferred in this case, so the decision flows have an equal hold among the research team of students/university and growers.

The value-added toolkit draft (Figure 1) was revised to incorporate growers' feedback from the focus group and individual interviews (Figure 2). First, in the *creating partnership* stage, to address the growers' expectations for funding, timeline, and IP right, we have embedded faculty tasks to secure funding and establish timeline and IP agreements with the growers prior to the student-grower collaboration. Second, to address the growers' perceived barriers including cost and resources, we propose to implement the student-grower partnership in two courses at Montana State University, SFBS491—Special Topics: Farm to Market (Montana State University, 2022b) and NUTR496—Practicum Food Product Development (Montana State University, 2022a).

Building on the partnership developed by faculty with the growers, SFBS 491 in spring semester will focus on the first four stages of the toolkit (Figure 2). This includes students *creating partnership* with the growers to empathize with the needs of growers and consumers, defining the problems, followed by *ideation, prototyping* and *testing* to create and validate the product concepts and preliminary prototype recipes. For the *prototyping* and *testing* stages, the toolkit was revised to add grower's input on product ideas, as some of the growers interviewed had carried product development efforts in their own capabilities and were aware of what can be a good product for their enterprise. The prototyping activities in this spring course are to gain a proof of concept at the front end of innovation, instead of optimizing the prototype quality, thus can use the leftover produce from past season without having to use the fresh summer harvest.

Subsequently, NUTR496 in fall semester will have students perform *prototyping* to *scale up and community engagement* stages. Having empathized in SFBS491 with the grower's needs and requirements, NUTR496 will be more student-led, where students can refine the prototype recipes by consulting with growers on their business goals, ensuring technical benchmarks such as food safety, nutrition, sensory, and shelf life are met. The students will then perform scale-up trials and community outreach with product evaluations to identify the appropriate commercialization and marketing platforms. For the *testing* stage, to consider for growers' concern with funding and resource access, the toolkit was revised to emphasize the university and faculty providing equipment, facility and technical advice to students. For the *scale-up and community engagement* stage, the toolkit has expanded to suggest to growers which avenues the developed product can be marketed toward. This was after a grower at the focus group mentioned the idea of adding another step to the toolkit on helping growers with marketing and building connections (Table 2, quote H). Finally, as the growers generally agreed that the toolkit for student-grower partnership can benefit their businesses, the toolkit has included one output of the university fulfilling their land-grant missions.

TABLE 3 Dominant themes from the individual interviews with specialty fruit growers in Montana.

Dominant theme	Explanation	Example from focus group	Number of references
Benefits of value-added product development	Branding—many interviewees shared interest for local made products can be a good pursuit to drive economic gain in Montana.	(A) *"I came up with the totally Montanan moniker. Which in our Montana grape and wine association was a very popular idea, and I think it will grow as more of our wineries produce wines that qualify."*	Branding—4
	Marketing—with appropriate use of marketing messaging, it was idolized that some growers could reap better profits by use of value-added product development.	(B) *"…the increase in value per pound of grapes is five or six times higher in terms of the sale than we would get if we just sold the grapes"*	Marketing—3
Barriers to product development	Cost—Primary cost concerns with the interviewees surrounded with finding a product that returns sufficient profit margin, for the time and energy that growers may be placing in turning their produce from raw commodities into value-added goods.	(C) *"…our biggest struggle right now is just trying to figure out with the least amount of effort what's gonna be our biggest profit margin…"*	Cost—9
	Resources—Many interviews stated how troublesome it can be to turn a simple idea/recipe into a product ready for market-sale.	(D) *"...they (grower's) don't know the reality of getting form here's my berries in a bucket to into a jar that has a FDA approved label, like not just figure out the recipe, but they're gonna need help with all of the in-between."*	Resources—5
	Environmental—Though these fruit varieties prove to be resilient to Montana's harsh climate, the uncertainty with environmental conditions is a common barrier for growers.	(E) *"Our primary grower in Livingston had a complete crop failure last year, he was a steady supplier for us for 3 or 4 years and got attacked by an insect…wiped out his whole crop."*	Environmental—6
Expectations from presented toolkit	Funding—Panel shared that toolkit needs to consider funding sources, especially with small-scale growers lacking capital support to get them involved.	(F) *"Um well one thing that isn't indicated anywhere here that I think is absolutely important and that we do all the time is to look at the financial implications of any possible project."*	Funding—5
	Partnership—Growers shared great interest in the partnership between students and realized this as a tool which can assist them in their learning, whilst getting some assistance.	(G) *"I would do it more as a helping them to develop their skills while maybe getting something out of it rather than relying on them to develop a product for me."*	Partnership—20
	Timeline—whilst there was debate upon an appropriate length of duration for the toolkit (due to each project being slightly different), it was agreed that a spring semester start would be easier to start the collaboration (while agreeing to keep leftover produce from prior season).	(H) *"…if you guys could do it spring semester that would be the best, because farmers are most available in January-February"*	Timeline—5
	Maintaining intellectual property (IP)—few growers expressed that sharing their trace secret (recipes) for testing can be problematic, and there may be need to develop some agreement for that.	(I) *"I guess I have mixed feelings about it because I think the testing and developing will be...I mean something that's more personal to the grower."*	Maintaining IP—3

3.4. Logic model

This study presents outcomes from the first three PAR stages To illustrate the short, medium, and long-term outcomes of the value-added toolkit created in this study, we developed a comprehensive logic model following the approach of Taylor-Powell and Henert (2018) (Figure 3). This allowed us to address the remaining three stages of PAR.

In this logic model, we define "short-term" to be outcomes that resulted in changes in learning and knowledge with the proposal and revision of the toolkit draft (6 months−1 year). "Medium-term" outcomes are those that result in behavioral changes after a student-grower partnership has been established and product development and testing activities carried out (1–3 years). Finally, we consider "long-term" outcomes to be changes in conditions that have resulted after the toolkit has been implement for several years (3 years+).

In the short term, our proposed toolkit served as an immediate benefit for the specialty fruit growers in Montana, and a catalyst toward the future development of the specialty fruit value-added industry. By participating in the focus group and individual interviews of this study, the Montana specialty fruit growers had increased knowledge and awareness of (1) the potential assistance and resources available for their value-added interest, (2) the stages involved in a food product development cycle, and (3) how the successful use of PAR in value-added agriculture can be economically beneficial for their on-farm businesses. This also served a secondary benefit of revising the toolkit based on grower feedback and finding growers who will be interested in trialing the toolkit.

Our understanding of the growers' network in Montana makes us confident that we will find growers willing to partner to trial this toolkit. With this, we will see "medium-term" changes such as (1) participation of growers to utilize the toolkit for developing

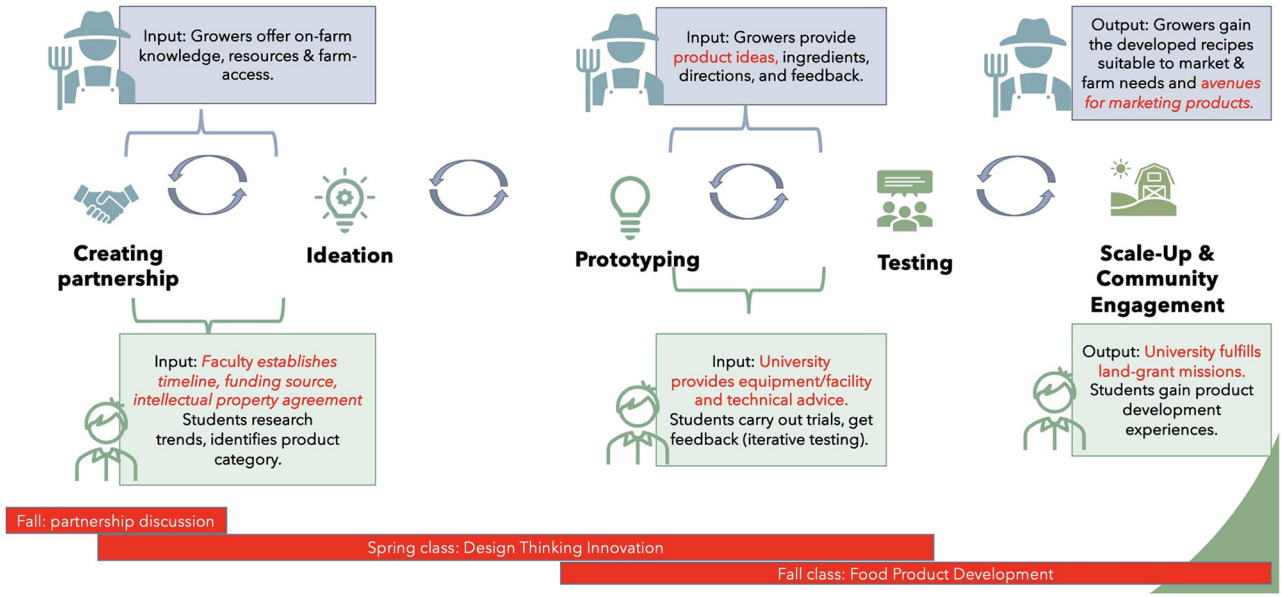

FIGURE 2
Revised toolkit for engaging Montana specialty fruit growers in value-added product development. Changes from previous draft are highlighted in red.

Input	Outputs		Outcomes		
	Activities	*Participation*	*Short (LearningΔ)*	*Medium (Behavior Δ)*	*Long (Condition Δ)*
• Proposed toolkit draft • Montana Berry Growers and Association • Montana State University (MSU) - Students/MSU extension, faculty, equipment • Product development supplies • Funding support from Montana Specialty Crop Block Grant • Consumers, Community	Refine and co-create proposed toolkit draft – suggest changes/ modifications to better serve purpose	Growers'[1] focus group and interview, students (graduate and undergraduate), MSU faculty/extension	Increase knowledge on product development and the importance of it by growers. Growers[1] are familiar with the different stages involved in food product development	Participation of growers[1] and student to use toolkit for developing products	Increased value-added products made from specialty fruit varieties ready for market consumption in community
	Establish student-grower partnership. Students to carry out product development trials – based on grower & market needs	Research team, growers[1], students, MSU Extension/faculty	Increased awareness by growers[1] of how the successful use of PAR in value-added agriculture can be economically beneficial for grower's on-farm businesses	Development and scale-up of products aligned to market demand and resources available	Increased consumer awareness and acceptance of novel local crops
				Establish evaluation methods and results for product quality, safety, and marketability	Diversified income streams for small-scale growers'[1] to reap higher income
	Students to test the success of product among desirable target market	Students, consumers (target market), MSU Faculty	Revising toolkit from collected feedback and finding growers[1] for partnership	Recommended steps to commercialize product for consumer market	Contribution to crop biodiversity with more growers cultivating these varieties
				Use of safe food-handling practices for processing yield into value-added products	Students attain thorough product development skills

Assumptions
The research findings from the toolkit developed with Montana specialty fruit growers will be applicable across other regions. The acceptability of the proposed toolkit draft will be heavily influenced by the growers

External factors
Statewide food policies, consumer acceptance, yield, amount of engagement, environmental changes will influence the outcomes

FIGURE 3
Logic model to visualize the input, output, and outcomes for the creation and implementation of the value-added product development tool. Logic model is based on the approach demonstrated by Taylor-Powell and Henert (2018). [1]In this model, any place where it is mentioned growwers, it signifies Montana specialty fruit growers.

value-added products, (2) development of value-added products addressing market demand and resources available, (3) use of safe food-handling practices for processing yield into value-added products, (4) established methods to evaluate product quality and safety, and (5) recommend steps for commercializing product for the consumer market. With the assumption that there are several student-grower partnerships created, we anticipate noticing long-term conditional changes. These include (1) increased value-added products made utilizing these novel berries and fruit varieties ready for market consumption, (2) increased consumer awareness and acceptance of these novel crops, (3) economic benefits for small-scale growers to diversify income streams and reap higher income, and (4) contribution to crop biodiversity with more growers cultivating these novel crops (5) students attain thorough product development skills. In summary, we expect that this project could be a contributing factor to assist small-scale fruit and berry growers with value-added product development and assist the Montana small fruit and berry industry with related agri-businesses. Though this model is constructed to address the needs of Montana growers, it shows promise for long-term applicability among similar farms in different locations.

3.5. Limitations

First, based on the six PAR stages, we propose a logic model of developing and implementing the value-added toolkit to assist specialty fruit growers. However, this study focuses on the outcomes from only the first three PAR stages (identifying the problem, collecting and analyzing data, and developing the intervention). Since we did not implement the value-added toolkit, we used the logic model to visualize the proposed outcomes of the remaining three stages (implementing, evaluating, and monitoring for revising the interventions) (Taylor-Powell and Henert, 2018). Therefore, this paper requires a follow-up study on a larger representative sample size to testify the logic model by implementing and evaluating the outcomes of the value-added toolkit, which is an ongoing research direction of our team.

Second, this study was based on survey results only from the specialty fruit growers in the Intermountain West, and the focus groups and interviews with Montana growers only. Therefore, the toolkit developed and the logic model proposed in this study may have place-based features and may not be directly generalized for applying in other regions. However, testing the implementation of this toolkit spanning to other regions with small farm productions may share knowledge to revise the partnership model tailoring to the specific needs of growers.

4. Conclusion

To support Montana specialty fruit growers in diversifying their income streams, this study implemented PAR to engage the growers in value-added initiatives. Through surveys, focus groups and individual interviews with the growers, a value-added toolkit involving student-grower partnership was co-created with the growers, and discussed with a logic model for its short to long term benefits.

Value-added efforts with these specialty fruits can help growers extend the sale season and improve the palatability of these varieties. Past studies have presented the successful role of participatory research in urban agroecology by combining knowledge from science and practice. However, PAR frameworks for value-added agriculture are still evolving. Thus, developing and promoting more collaborative frameworks in value-add agriculture can serve as a model for future research.

This study concludes that value-added product development is an interesting learning topic for many specialty fruit growers in Montana. Yet, with the barrier of cost, resources, and environment, the growers struggle to carry out these activities by their own means. However, implementing student-grower partnership through a co-created, value-added toolkit promises to address the needs of both the growers and consumers in encouraging value-added endeavors of small farms.

Responding to the growing market of berry consumption and establishing crop biodiversity in places such as the Intermountain West, future research is called for to test, evaluate and monitor the implementation of this toolkit, as suggested by the remaining three principles of PAR. Doing so will also allow us to raise the awareness of these novel cultivars [including haskap, aronia, elderberry, currants, saskatoon, and dwarf sour cherries (DSC)], by means of value-added product development. The current literature suggests that though these berry varieties offer resounding health benefits, there is a lack of consumer awareness, and the acceptability of these fruits has not been formally evaluated. Hence, future studies can focus on addressing some of these concerns.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary material, further inquiries can be directed to the corresponding author.

Ethics statement

The studies involving human participants were reviewed and approved by Institutional Review Board at Montana State University. The patients/participants provided their written informed consent to participate in this study. Written informed consent was obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article.

Author contributions

SG analyzed and interpreted all results and wrote the manuscript. GJ shared expertise on the logic model and edited the manuscript. S-HK assisted in data analysis generated from focus group discussions and edited the manuscript. ZM provided horticultural background expertise and edited the

manuscript. W-YK advised the entire study and edited the manuscript. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fsufs.2023.1084750/full#supplementary-material

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