Proposal: Development of an Economic Modeling Tool to Evaluate Proposed Food Processing Facilities

(a) Introduction

The long-term goal of this project is to expand direct market sales opportunities for fruit and vegetable producers targeting local and regional markets. The project will also increase acreage of produce under production to meet new markets, establish new networks to raise public awareness about local agricultural producers, and provide means to retain and increase land in vegetable production where threatened by conversion to non-agricultural uses. This project will achieve these long-term goals by developing and applying an economic modeling tool to evaluate the financial performance of proposed food processing facilities.

Supporting objectives

1. Conduct a mixed-methodology qualitative research assessment of regional buyers and producers to quantify market and production potential to supply and purchase from a regional food processing facility
    a. Determine the regional market size and market growth potential for locally-grown processed produce
    b. Determine the existing and potential production capacity among regional producers to supply a food processing facility
    c. Determine potential for rental in addition to farmer cooperative food processing in the facility
2. Engage group learning contracts in the agriculture and community development program at The Evergreen State College (TESC) to learn about applied research by implementing a mixed-methodology approach evaluating four diverse buyer populations that would potentially purchase from a food processing facility
3. Engage a cohort of applied economics students at St. Martins University in development of an economic modeling tool to assess the financial performance of a food processing facility
4. Develop a transferrable economic model that can evaluate the feasibility of food processing facilities locally and nationwide
5. Develop and utilize an interactive web application to enable producers, buyers, investors and regional decisions makers to take and encourage informed action concerning food system infrastructure and equipment investment

Agricultural producers focused on direct sales in the U.S. have enjoyed rapid market growth, averaging 16 percent between 1992 and 2012 (USDA, 1992; USDA, 2012). This growth resulted in an increase from $400 million to $1.3 billion in direct sales to consumers between the 1992 and 2012 agriculture censuses. Between 2007 and 2012, this growth nationally attracted a 6 percent increase in farms utilizing this market channel (USDA, 2012a). While an increasing number of farms nationally utilize direct sales to consumers, small farms (generating less than $50 thousand in gross sales) more often predominantly rely on this market (Low and Vogel, 2011). In the south Puget Sound region of western Washington, similar trends are evident. Small farms account for 93 percent of production, dominate edible crop sales, and predominantly

market directly (USDA, 2012b). Eighty-eight percent of fruit and vegetable producers in south Puget Sound utilize direct sales to consumers (Patzek and Rocker, 2015), while in Thurston County (central to this region) this marketing channel accounted for 76 percent ($3.5 million) of total edible crops sales ($4.6 million) (USDA, 2012b).

Growth in direct sales has created opportunities for small and entry-level farmers to establish businesses locally and across the country, yet market and consumer preference shifts have created a need to augment this marketing model. Nationally, while direct sales increased by 8 percent between 2007 and 2012, this represents an overall reduction in the average annual rate of market growth to 1.6 percent as compared to a 16 percent background rate between 1992 and 2012. Additionally, while direct sales are utilized by 6.9 percent of US farmers, this market accounts for only 0.3 percent of total agricultural sales (USDA, 2012a). In Thurston County, farm numbers increased by 4 percent from 2007 to 2012, with gains made only on farms between one and nine acres (USDA, 2012b), which are those relying on direct sales. Between 2002 and 2012, the direct sale market in Thurston County expanded by only 8 percent, as compared to 357 percent between 1997 and 2002.

Factors limiting local food market development have been widely reported, as well as proposed actions to remove barriers such as development of value-based supply chains, mid-scale aggregation and distribution systems, local food processing facilities and other strategies to link local and conventional food systems (Day-Farnsworth, 2009; Feenstra and Hardesty, 2016; Nelligan et al., 2016). Farmers that utilize direct-to-consumer sales exclusively only account for 18 percent of overall direct sales in the US, while farmers utilizing institution and retailer direct markets in addition to consumer direct markets make up half of total direct sales (Low and Vogel, 2011). An increase in the number of consumers rating convenience as 'very important' in purchasing decisions from 35.7 to 53 percent from 2012 to 2014 may also be increasingly depressing consumer direct sales (Lempert, 2015). Many farmers are responding to these shifts. In south Puget Sound, 64 percent of producers maintain intermediated direct accounts in addition to direct consumer sales, while 40 percent anticipate expanding these (Patzek and Rocker, 2015).

Motivation to augment direct sales market approaches stems from producer concerns over (1) plateau in high-value direct-to-consumer sales via farmers' markets and box subscription programs (Ujcic, S. Personal communication. 2016, 20 May), (2) increasing competition from organic and sustainably-raised product lines in mainstream food institution outlets, as well as non-farm-direct box-subscription programs, and (3) potential erosion of price premiums captured with consumer-direct purchases (Moskin, 2016). Results from a comprehensive 2017 south Puget Sound agricultural producer needs assessment indicated that needs related to market access received the second most producer comments (Bramwell et al., 2017). Farmers confirmed several needs identified in a 2014 Thurston County Farms to Market Assessment (Patzek and Rocker, 2015), including infrastructure for produce processing and storage, and collective marketing options. In particular, producers were interested in shared cold and dry storage, as well as shared infrastructure for food processing. A majority of farmers (64 percent) in the 2014 report indicated they would consider aggregating and/or jointly marketing their agricultural products with other farms to access markets, while lack of processing infrastructure was identified by 43 percent farmers as moderately to very limiting to their businesses.

In the study by Bramwell et al. (2017), farmers also expressed interest in collectively expanding access to institutional buyers willing to pay modest premiums for origin-identified, sustainably produced food. These views reflect farmer interest at the national level in adding food institution accounts to markets to stabilize cash flow (Vogel and Low, 2011).

This project directly responds to ongoing direct market trends and explicit producer needs. It will do so by designing an interactive, transferrable economic decision-making tool, and test it employing an inclusive community process utilizing supply, demand and facility operations data collected through qualitative and quantitative research in the south Puget Sound region. Design and application of this tool will enable evaluation by communities locally and nationwide of the potential of regional source-identified processed foods to profitably expand intermediated and direct sales, and provide the financial incentive and market stability to rapidly increase regional vegetable production.

The magnitude of the issues this project addresses are significant. In Thurston County, sixty-six percent of vegetable production acreage was lost between 1978 and 2012 (USDA). Concurrently, vegetable processing facilities moved to eastern Washington, where 14 of 15 remaining facilities are located (Globalwise, 2008). Compensating for loss of processing markets, forage as a percentage of total crop production increased from 37 to 68 percent during the same time period. Expansion of direct-marketing pathways has led to an increase in overall farm numbers in Thurston County, but has not offset an overall loss of farmland (four percent between 2007 and 2012 Census), a loss of large farms (decline in farmer numbers in all acreage categories great 1-9), and an overall decrease in average farm size (from 103 to 57 acres since 1978, and from 64 to 57 since 2002).

This project is also linked directly to ongoing state and national efforts. Regional analyses suggest that the fate of processing facilities and farm operations are linked. As early as 1986, the Washington State Department of Agriculture AG 2000 strategic plan identified a flagging food processing industry as a drag on state producers, and identified value-added food processing as among the top five recommended actions to enhance the future viability of agriculture (WSDA, 2009). Similarly, Priority 4 in the updated WSDA Future of Farming report (WSDA, 2009) identified strengthened support services, including product development, market information and analysis, marketing services, and support filling food processing infrastructure gaps as critical to Washington agriculture remaining viable and competitive. The report encourages creation of opportunities for farmers to diversify products through:

> *Value-added processing through improving the business climate and encouraging or recruiting selected processing activities. Processing can add value through a single technology, such as freezing or canning*

Despite early and consistent recommendations in strategic plans, in addition to consistent farmer requests, the Future of Farming report admits progress has been very limited in bringing these strategies to fruition. With respect to individual producers, serving large-volume markets with fresh or processed foods requiring costly expansion and infrastructure investment is difficult (Tropp, 2014). Additionally, new food processing safety regulations such as the Food Safety Modernization Act, while addressing gaps in federal food processing regulations, increase barriers to entry.

This work would contribute to ongoing Federal efforts launched in 2009 by the USDA, "Know Your Farmer, Know Your Food", which aims to support opportunities for regional food system development through origin-identified marketing, label-identifications, value-added food processing, and niche market development. Motivation among south Puget Sound region farmers to augment consumer direct markets with institution direct markets aligns directly with these state and federal initiatives.

The south Puget Sound region is a logical location for the development of the data collection design, application of econometric analyses, creation of a web application, and mobilization of student data collection cohorts. This is due to the presence of four academic institutions eager to partner; a history of expressed need by farmer stakeholders; ongoing regional issues with declining acreage of vegetable production in a region with prime agricultural soils, water rights, and high value consumer direct; and, presence of diverse buyer populations including consumer direct and institutional markets to evaluate a range of pricing structures for a food processing facility.

(b) Rational and Significance

This project will advance rural economic opportunity by providing farmers, entrepreneurs, investors and decision-makers with an economic tool to evaluate the potential of mid-scale, regional food processing facilities to expand local food markets. The economic opportunities this project will evaluate are grocery retailer, restaurant and institutional markets, as well as expanding existing consumer-direct (such as CSA) markets for processed produce for year-round customers.

Economic factors do affect the willingness of decision-makers to invest in food processing infrastructure, yet these economics are often poorly understood at the local level (Reid, M. Personal communication. 2017, 26 May). Without this information, efforts to invest in economic opportunities in rural communities are difficult to initiate and sustain. This project will support expansion of local and regional food systems by creating an interactive analytical tool for use by producers, buyers, decision-makers and potential investors. This project transforms the traditional enterprise budget of extension bulletins into an interactive web application, in which users adjust figures to conduct optimization, sensitivity and break-even analyses.

The need to conduct research on the food industry on a regional basis was addressed by Gempesaw et al. (1987) who state:

> *...regional differences in resource endowments, income opportunities and population distribution imply that the impact of changing economic environment will not be the same for all regions*

This study is an attempt to develop an economic modeling tool that takes into consideration such regional differences to evaluate viability of a food processing facility. We will use a combination of economic techniques to better position farmers in Thurston County, Washington, and the regional markets they serve, for success in a competitive agricultural industry.

Such a tool will create opportunities for key stakeholders to evaluate potential decisions. Additionally, the project will provide applied educational opportunities for student cohorts learning about food systems and agriculture while cultivating Science, Technology, Engineering

and Math (STEM) skills. The project will bring together students and faculty from three academic institutions in building a decision-making tool. The tool, as well as potential financial performance of a facility, will be tested utilizing region-specific financial data collected by local student cohorts and faculty advisors. An interactive web application will be developed by a faculty-student computer programming team.

This approach will assist efforts to scale up from direct to regional markets by providing easy access to interactive economic performance data. Applied to regional food processing, it enables scaling while creating opportunities to brand aggregated regional product.

This project's focus on cultivating support for mid-scale food processing facilities addresses many socio-economic factors that often impede these larger-scale rural economic development efforts. Several studies and needs assessments have indicated that, even where interest exists among retailers and institutional buyers in purchasing local produce, issues of volume, predictability, a need for "one-stop shopping", and limited buyer access to growers prevents it (Patzek and Rocker, 2015; Vogt and Kaiser, 2008; Visser, C. Personal communication. 2016, 15 August; WSU, 2015).

Food processing infrastructure and associated aggregated marketing could overcome these limitations. The interest is strong among both producers and buyers: a survey of intermediated buyers in Thurston, Lewis and Mason Counties of south Puget Sound indicates high and sustained interest for several years (4.35 priority ranking out of 5.0; Patzek and Rocker, 2015), while farmers identified processing infrastructure as a local food system gap (Bramwell et al., 2017); collective efforts to capitalize processing infrastructure would open markets that individual farmers have difficulty accessing; value-added processing could give farmer cooperatives more control over pricing, and higher prices, than even organic wholesale which is perceived to be stagnant (Ujcic, S.. Personal communication. 2016, 20 May); and, mid-scale processing would enable institutions limited by in-house raw-produce processing ability to purchase locally (Day-Farnsworth et al., 2016). Some local institutions have indicated they have difficulty utilizing budgets allocated for local purchases due to difficulty connecting with producers (Visser, C. Personal communication. 2016, 15 August).

(c) Approach

1. Objectives

1. Conduct a mixed-methodology qualitative research assessment of regional buyers and producers to quantify market and production potential to supply and purchase from a regional food processing facility
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2. METHODS

a. Stakeholder involvement. Direct producer identification of aggregated marketing and food processing infrastructure was identified in a 2016/17 needs assessment conducted in collaboration with a qualitative research specialist (Bramwell et al., 2017). Five listening sessions and seventeen one-on-one consultations were conducted, resulting in 235 needs comments contributed from ninety-two individuals consisting of eighty-three farmers representing seventy-two farms, and nine gardener-homesteaders. Needs associated with marketing ranked second of eight categories. Results of this assessment indicated that work initiated by the 2014 Farms to Market Assessment should continue. Specifically, assessment results suggested pursing food system development approaches that could strategically support aggregated market strategies, with consideration paid to cold/dry storage, aggregated distribution, and shared food processing infrastructure.

A planning committee was convened in March 2017 to consider developing a research initiative aimed at evaluating the potential economic viability of a food aggregation facility in south Puget Sound. Representatives attended from the agricultural community, the Port of Olympia, the City of Olympia, Olympia Farmers Market Association, Thurston Economic Development Council, and the culinary arts community. Following recommendations from this meeting, in April 2017 an agricultural producer steering committee was formed to guide a project to evaluate the feasibility of a food aggregation/processing facility in the south Puget Sound region. Farmers electing to participate in the steering committee represented both well-established and new farm operations. The majority have been in business for greater than ten years. All members earn greater than 75 percent of their income from farming. Four of the members are among the top ten vegetable producers in the region. Initial meetings of both the planning committee and the steering committee resulted in identification of three models for a marketing support facility: food storage (dry, cold, freezing; food processing; and food processing plus aggregation/distribution of fresh and processed produce). Discussion and ranking by the farmer steering committee identified a food processing as being of potentially the greatest usefulness to the region's producers.

b. Proposed project activities. Project activities are organized to complete all five project objectives: qualitative research design; engagement of a TESC student cohort for data collection supported by WSU Extension and Thurston EDC; engagement of a St. Martin's University student cohort to develop an economic model that will serve as a financial decision-making tool; development of a web application to make the model user friendly for community use; and,

outreach events with farmers, buyers, decision-makers and community members to utilize the model to make informed decisions about development of a food processing facility in the region.

Objective 1 activities

a) **Assessment of producers**. Grower capacity will be assessed through two methods: a mixed-mode survey and in-depth interviews. The mixed-mode survey will consist of a mail survey for initial contact and follow-up phone survey to increase response and reduce non-response bias. The survey will be sent to at least 100 growers in a five-county region using contact lists provided by County Extension and selected partners. The goal of this survey is to gather information on production capacity, current markets utilized, acreage in production, range of price points, and perspectives on processed vegetable production, and other areas as appropriate to inform the project overall. If needed to increase response, growers who do not respond to the initial mail survey will receive a follow-up phone call inviting them to complete the survey over the phone. Survey phone calls will follow standard academic procedures, including up to 5 follow-up contacts in attempt to complete the survey. Select growers (up to 20) will receive a request for follow-up in-person interviews to discuss grower perspectives and concerns more in-depth. To ensure diversity of perspectives in follow-up interviews, growers will be selected by varying production capacities, and readiness to scale up.
b) **Assessment of buyers.** Assessment of buyers will use mixed-methodology approaches to examine four diverse buyer groups: Consumer Support Agriculture (CSA) members, grocery store shoppers, grocery retailers, and institutional buyers. The mixed-method approach will consist of two online surveys: a survey of CSA customers of 8 Thurston County vegetable farms (at least 2,000 total individuals), a separate survey of grocery store shoppers in 18 grocery stores in the region, and interviews with regional managers of grocery outlets, restaurants and institutions. This information will be used to determine marketability and demand for increased production of value-added processed products. More details on each method are outlined below.

   Consumer Support Agriculture (CSA) Members. An online survey will be developed for this specific buyer type, designed to garner more information on frequency of purchase, interest in processed vegetable products, including frozen, dehydrated and canned products, and other information as determined by the Advisory Group. All CSA members will receive an invitation to participate in the online survey from their respective individual farms. Survey implementation will utilize three contact methodology to help increase response rates, and will include follow up contacts to non-responders, as needed to ensure against non-response bias.

   Grocery Shopper Survey. A mixed-mode survey of grocery shoppers in the south Puget Sound region will be conducted in order to understand the demand of divergent consumer bases. The survey will be implemented at 18 grocery stores in a five-county region, including traditional grocery stores and farmer's markets. Students at The Evergreen State College trained in survey interview procedures will use convenience sampling and will conduct interviews at each type of facility on select days and times designed to correlate to higher availability of shoppers with the goal of 200 completed surveys.

Students will be equipped with tablets to the online survey so that the survey can be entered immediately. In the case of poor internet access, hard-copy surveys will be completed and students will enter the data at a later time.

Interviews with Grocery Retailers, Restaurant Managers and Institutional Buyers. Marketability, demand, and feasibility will be assessed through interviews with managers of grocery retailers, restaurant managers and institutional buyers. DGSS will work with the Advisory Group to develop an interview protocol designed to better understand topics such as purchase volumes, frequency, food safety, insurance requirements, purchase prices, flexibility, and barriers and strategies to inform demand, profitability, and feasibility. Interview protocol will utilize purposive sampling to acquire perceptions and opinions of diverse grocery retailers and institutional buyers (such as School Districts, hospitals, etc.), and will be conducted and transcribed by TESC students. A total of 13 grocery retailer managers, restaurant managers, and institutional buyers will receive an invitation to participate in the interview, with a goal of at least seven individuals from each buyer category completing an interview.

c) **Assessment of independent processors:** an opportunity sampling survey will be developed to gather data from potential food processing entrepreneurs in the region. Actions to generate participation will include posting to media advertising, flyering, networked groups and associations, and social media. A target of 250 survey responses will be obtained across the five-county region.

Objective 2 activities:

Engage a cohort of Evergreen students to implement a mixed-methodology approach evaluating four diverse buyer populations. Survey and interview tools developed by DGSS (Objective 1) will be implemented by students engaging in group and individual learning contracts for Upper Division work in qualitative research methods and agricultural economic development. Students will survey three of the four diverse buyer populations: grocery shoppers, grocery retailers, and restaurant managers. For the grocery surveys, three teams of paired students will utilize convenience sampling and will conduct interviews at each type of facility on select days and times designed to correlate to higher availability of shoppers with the goal of 200 completed surveys. Tablets and hard copy survey forms will be utilized as described above. For grocery retailer and restaurant manager surveys, student teams will utilize purposive sampling to acquire perceptions and opinions of diverse grocery retailers and institutional buyers. Sample quantities are outlined above. This work will provide substantive exposure to STEM skills by providing experience in conducting field surveys and market research, in addition to preliminary data transcription and analysis. This work will be supported by WSU Extension and Thurston EDC for aspects of survey and interview implementation.

Objective 3 activities

Engage cohort of St. Martin's students to develop an economic model. A combined approach of linear programming, econometrics and enterprise budgeting will be utilized to evaluate the profit potential of a food processing facility. Responding to interest of farmers on the Advisory

Group, the profitability of the facility will be evaluated in response to variation in processing type, facility usage, product selection, and seasonality. Regional primary data collection and economic sciences will be utilized to evaluate predictions, such as: availability of a high-value market for selected agricultural crops will spur increased production of them, and: the availability of a regional processing facility will create significant increases in supply of and demand for crops to be processed.

a) **Estimate supply and demand elasticity.** Compile up-to-date supply and demand elasticity estimates for top high value vegetable crops in south Puget Sound. This will include short and long-run own-price elasticities of supply and own price, cross-price and income elasticities of demand.

   Collect primary data. Estimate regional supply and demand elasticities based on primary survey data (Objective 1). A survey of farmers will be conducted as described to provide input on identifying top crops crops for food processing, and production potential at a range of prices for operations in a five-county region.

   Compile existing secondary data. Agricultural extension data, USDA Census Data, and Washington State Department of Agriculture data will be utilized, for the crops identified above, to supplement the primary data.

   Develop econometric models. These will be utilized to assess supply and demand and respective elasticities. Additionally, they will be utilized to attempt to understand price points for processed crops for the region using econometric tools, enabling producers to better position themselves to meet market opportunities. Different functional forms will be evaluated by Saint Martin's University (SMU) students enrolled in the ECN 371 econometrics course to assess best fit. The EViews 7.0 econometric software program will be utilized. Likely exogenous variables to be included on the demand side are per capita consumption, commodity own-price, recognized possible substitute commodity prices, consumer price index, regional per capita incomes, and consumer preference and willingness-to-pay data from primary research. On the supply side current acreage, potential acreage, yield, and marketable production functions will be assessed.

b) **Identify optimal processing options.** Thurston County farmers have indicated a desire to explore the economic viability of a farmer-cooperative food processing enterprise, with rental space as an option to augment cash flow. The processes identified include frozen, canning, and dehydration and rental space aside from the primary processing cooperative could include farmer usage, and independent processor rental. Thus the study will assess the economic feasibility of each approach, based on assumptions of best practices and most efficient technology, and then utilize linear programming to assess and rank optimal mixes based on constraints and prices that are collected via secondary and primary data sources with the primary objective function being to maximize returns above operating costs. Six processing crops will be evaluated.

Assess facility operating and overhead costs. This would be done for a select number of processing combinations, utilizing crops identified earlier as having significant potential for regional farmers and processing. This will include the cost of building and operating a multiline processing plant (where viable) based on the different criteria outlined above. Further, to assess if economies of size exist, three top viable size plants (based on output capacity of pounds per hour) will be analyzed for the different scenarios, based on input for experts and demand estimates. The economic engineering technique will be utilized to estimate construction and operating costs of the processing plants. For each plant size and scenario, the optimum numbers and sizes of machinery will be determined at each stage of processing based on the machines required for an operation and the performance rates and prices provided by manufacturers and dealers. The initial machinery investment will be calculated by determining the compliment of machinery required, obtaining appropriate prices from manufacturers and dealers, and summing the values. Operating and overhead expense figures will be estimated utilizing interviews as well as publicly available industry data. Interviews will be arranged with operators of comparable processing facilities both in the region and nationwide. A total of 20 food processing facility operators will receive a request to interviewed with a goal of at least ten completing. Publicly available industry data will be sourced from equipment distributors, product distributors, Washington State Employment Security Department, and industry associations (such as for wholesale pricing), among others. Modest stipends will be offered to industry professionals to consult on costs of operation. Overhead and operating cost estimations will be utilized to assemble enterprise budgets consisting of six crops processed for either frozen, dehydrated or canned market outlets.

Sales price and production potential obtained through grower assessment described earlier are assumed to account for all necessary crop production expenses. Sales price and available volume will be utilized to develop facility revenue estimates.

Determine optimal product mixes. Complied information from above will then be integrated using linear programming techniques to determine and rank the optimal processing combinations for the prior identified crops. Software to be utilized will be Matlab with the Optimization Toolbox add-on and Solver in MS Excel.

c) **Develop enterprise budgets.** This would be done for each processing facility enterprise to better understand optimal enterprise mix at the facility. Specific steps would include:

Compile available food processing enterprise budgets. These would serve as the baselines for this component.

Update and customize budgets based on study results. Budgets would then be developed using MS Excel software that would accurately reflect any scenarios unique to regional production and optimal processing options.

Incorporate sensitivity capability. Budgets would enable inputs to be modified to enable farmers, buyers and decision-makers to better understand how changes in inputs impact economic viability of the enterprise suite as a whole.

Objective 4 activities

Develop smartphone application. In order to better assist farmers, information generated from the steps above will be incorporated into a smartphone app (in both iOS and Android platforms). The capability to update and customize the variables and inputs (by both the farmer and researchers, as new information become available) would be invaluable to smaller farm operations unique to Thurston County in order to enable more timely decisions for planning and 'what-if' scenarios assessments.

a) ***Development of an interactive web application to create a user-friendly interface to utilize the economic model.*** The web application will be a web server scripted application written in C#, ASP.Net, JavaScript and jQuery. Underlying data will be accessed from Excel worksheets, and an MS SQL Server Database file will be developed for them. The web application will be interactive, using several user controls to dynamically change properties and run supply, demand, seasonality, enterprise and pricing scenarios to explore profit and loss of a processing facility. The application will utilize drop down text boxes to explain different aspects of what each section means to the user. The user interface will meet the Disabilities Act of 1973, Section 508 compliance, and be visually appealing and easy to use.
b) **Enable decision-making.** Users will be able to conduct evaluations of supply and demand elasticities, and determine facility profit-loss based on product, price, seasonality, and volume selections. The web application will draw input data from primary data collection results and secondary data where appropriate. The supply database will quantify potential production, seasonality, and price points for six crops. The demand database will quantify potential consumption, consumption seasonality, and price points for six processed products. The revenue database will aggregate production and price data into revenue potential ranges. Facility profit potential will be estimated through development of enterprise budgets integrating expense data described above, utilizing algorithms to elevate and decrease operating costs on the basis of production. The web application will integrate operating and overhead costs with revenue, supply and demand data to estimate facility profit potential under user-selected scenarios.

Objective 5 activities:

Engage the community in taking informed action. The approach employed by the research team is based on adult-education theory suggesting that a good role for Extension is facilitating community decision-making rather than providing discrete skills or explicit guidance (Franz, 2007). As Franz notes, a facilitation role for extension enables a community through democratized learning, and supports the community in addressing complex problems, such as how to address critical infrastructure gaps. Therefore, the project proposes development and facilitated community use of a decision-making tool to evaluate profit potential of a food processing facility.

a) **Five farmer-buyer-community workshops using decision-making tool.** Five workshops will be facilitated for growers, buyers decision-makers and community members to use the decision-making tool. Attendees will be broken into groups with tablet per table. A set of questions will the group through making decisions on products, facility enterprises, processing type, product volume and pricing. Groups will develop and evaluate alternate scenarios, and assess profitability outcomes. Group decisions will be shared with the group for discussion. All group results will be archived as preference selections for summary across the region.

b) **Regional food processing summit.** Growers, buyers, agriculture support organizations and decision-makers will be assemble across the region and state to review study results, present results of relevant work such as the Washington State Department of Agriculture's Washington State Food Hub networking efforts, facility inventory, and surveys. State and region-wide facility operators, buyers and suppliers will be invited. Summit activities will aim to develop action-implementation plans, including evaluating location and scale considerations to establish a facility serving region and state-wide needs.

c. Techniques employed

This project employees techniques from all three functions of the knowledge system, including research, education and extension. Standard techniques for developing qualitative and quantitative research tools will be utilized by team partners at WSU DGSS to evaluate grower and buyer populations, avoid non-response bias and ensure minimum sample populations. Data collection targets to reach at least 100 growers are feasible with budgeted resources for survey development and follow-up. Contact lists to reach buyer populations are available through WSU Extension and partner organizations, while explicit farmer interest in addressing processing infrastructure gaps provides a strong rationale for pursuing this data collection. (WSU, 2015; Patzek and Rocker, 2015; Bramwell et al., 2017).

Survey and interview population target numbers are realistic due budgeted resources for research technician at WSU, data collection services from Thurston EDC, and engagement with student cohorts providing applied research experience and data collection services. This project supports experiential learning and theory-to-practice educational techniques that are central to TESC teaching pedagogy and enthusiastically supported by St. Martins economics faculty partners on this proposal. Purposive sampling and convenience sampling will be utilized, with preparatory instruction for data collection teams (student and technicians) provided by research faculty at WSU DGSS. Data collection integrity will be ensured through explicit survey functions on Tablets, and back-up paper forms as described in the Data Management Plan.

Reaching target CSA customers (at least 2,000) is feasible due to large populations of CSA customers committed to the region's farmers, where as few as two farms would be sufficient to access 2,000 customers through existing mailing lists. At least eight farmers are committed through participation on the Advisory Group, and suggest that as many as 75 percent of customers would be interested in off-season frozen vegetables (Wilson, J. Personal Communication. 2016, 16 July). Conducting surveys with 200 shoppers, and obtaining interviews with at least seven grocery retail, restaurant and institutional kitchen managers is

feasible due to at least three, 2-person student teams conducting shopper and institutional buyer surveys/interviews over three quarters, and restaurant and retailer interview conducted by Thurston EDC, both with support from WSU Extension faculty and staff. At an estimated ten hour transcription rate per hour of survey (Sutton, 2015), work load will be feasibly managed by maintaining 30-45 minute interviews and dividing retailer, restaurant and institutional buyer transcription tasks across students, Thurston EDC and WSU Extension. This will limit any one research partner to no more than 60 hours of estimated transcription time. Research team leads listening to and verifying audio files against transcripts will ensure verbatim transcription accuracy. Opportunity sampling survey will be developed to gather data from potential food processing entrepreneurs.

Linear programming, econometrics and enterprise budgeting will be utilized to evaluate the profitability of a food processing facility. Linear programming is widely used in agricultural sciences to optimize outcomes, such as profitability, in response to limited production inputs and independent variables. Supply and demand elasticity estimations are standard calculations; secondary USDA data sources are readily available for comparison with estimations based on primary data collection. The economics research partner at St. Martin's is well-positioned through teaching experience to apply these techniques in a teaching environment, providing applied learning experiences to students. Students will develop best-fit models to compare regional with national data, and identify variables impacting supply and demand elasticity other than price.

Standard enterprise budgeting techniques and formats, and for integrating sensitivity capability will be used, linking data from survey and interview results, and facility expense data research by WSU and Thurston EDC technicians. The rationale for this work is that decision-makers are keenly interested in food processing infrastructure but lack financial data to make informed decisions (Reid, M. Personal communication. 2017, 26 May).

Adult educational techniques that minimize lecture/presentations and emphasize interaction will be utilized since this approach has been suggested as more effective than lecturing to farmer (and likely buyer) audiences (Johnson et al., 2008). The research team will enlist farmers and buyers on the Advisory Group to facilitate the five buyer-grower-community workshops, utilizing a peer-to-peer teaching approach. Small groups will follow instructional prompts, and utilize the interactive web application to develop supply, demand, and pricing scenarios to evaluate processing facility feasibility. This technique is intended to put onus on group process as opposed to central direction to co-create community knowledge, in this case about facility profitability (Franz, 2008). A regional summit will be convened to aggregate this data, and again address results through group problem-solving techniques.

d. Expected results

We expect this research project will not only identify directional trends that would likely result from a food processing facility, but also with the application of econometric modeling quantify the potential volume of those responses. For example, potential increase in regional crop production required to satisfy unmet demand; value of additional crop production; and, the capacity of regional producers to increase production.

We hypothesize that economic projections resulting from this work will:

- Demonstrate that both buyers and producers would change purchasing and production behavior in response to availability of a food processing facility
- Identify a mismatch between willingness to pay and cost of production for processed food, with significant differences in this discrepancy across buyer type
- Indicate substantial unmet demand for processed produce in the region that may exceed several million dollars in value
- Indicate substantial potential production of and interest in allocating acreage to processed produce, that may exceed several hundred acres at least in Thurston County
- Demonstrate similar supply elasticity in response to price based primary regional data compared to estimated values
- Demonstrate that, above a certain price, available markets are at least as significant as price in determining supply
- Demonstrate relative demand inelasticity for regional processed food, but with significant variation based on buyer type
- Demonstrate greater demand inelasticity for regional organic processed produce as compared to national figures for conventional processed produce, but with significant variation based on buyer type
- Indicate a narrow profit margin, even among the most lucrative crops, for processed vegetables based on substantial overhead and operating costs
- Demonstrate increases in knowledge among producers, buyers and decision-makers regarding potential of a food processing facility
- Demonstrate enthusiasm and confidence in the County Extension and the research team to facilitate community responses to complex public problems
- Provide research-based information for the community to develop an informed action plan concerning a food processing facility in the region
- Lead to utilization of this decision-making tool by other communities around the county.

e. How extension and education activities, if applicable, will be evaluated

This project will employ an evaluation approach described by Powell et al. (1996), which provides a framework to systematically identify evaluation objectives, users, questions, and indicators. This approach utilizes the Bennett hierarchy to identify evaluation questions and indicators at multiple program levels, including resources invested, activities, participation, reactions, learning, actions taken, and, impacts. This approach was used to develop specific evaluation indices, below, and will be used to more fully develop these indices. These will be used to gauge the success of project implementation as well as project results, including information gained by participants, utilization of that information and potential for economic, social and environmental change. Examples of evaluation indices from lower to higher on the Bennett hierarchy include progress towards project milestones, quarterly financial reports on project finances, number of activities (field days, informational resources developed), participation measures (workshop, summit, downloaded materials), evaluations of extension events, and application of information (implementation project recommendations).

Progress towards milestones will be evaluated based on the project timetable, and will be documented through quarterly research team reports and action plans. The table below provides an overview of the evaluation design, with evaluation questions, data collection methods and indicators to evaluate progress towards proposed project outcomes.

Bennett hierarchy	**Evaluation question**	**Data collection**
Resources & activities	Are project timetable milestones being met? Are project resources being utilized as planned Is the research team & Advisory Group (AG) functioning well to implement research design?	Quarterly 1-pg evaluation review by research team Quarterly research team and AG internal survey
Indicators	Timing of task completion, budget expenditures, group self eval checklist	
Participation	Are survey particpation targets being met? Is the AG engaged? Are buyers, farmers and the community engaged in the issue?	Quarterly 1-pg evaluation review by research team Survey results Workshop sign-ins Summit sign-ins Web-site and social media usage Blog and newsletter reach
Indicators	Survey participation, no. of individuals at decision-tool workshops across counties, no. individuals at regional summit, AG attendance, website access, social media "reach", readership of outreach materials	
Reactions and learning Awareness Knowledge Attitudes Skills	Did buyer and grower populations become more aware of potential of food processing facility? Did growers and buyers increase understanding of potential facility profitability Was supply and demand quantified? Were through-put volume requirements quantified Do decision-makers better understand opps and barriers? Are buyer and grower attitudes understood? Is community ready for next steps? Are farmers optimistic that research collaboration addreses complex problems?	Evaluation question embedded in surveys Final summary and evaluation St Martins cohorts of economic modeling Final summary and evaluation TESC cohort of survey results OFM* and EDC** survey summaries Evaluation at workshops and summit of decision-makers Quarterly 1-pg evaluation review by research team Evaluation at regional summit
Indicators	Modeled market impact of processing facility, estimated market value	

	of agricultural product supplying processing community, estimated market value of processed product sold to intermediated buyers, modeled multiplier effect to community of facility in production, estimated market value of purchase and sales interest documented among producers and buyers,	
Actions	Are growers and buyers willing to grow and buy? Are facility functions determined? Is the community implementing project recommendations?	Buyer/seller workshops, facilitated summit outcomes (reach, readiness tally, facility function), AG summary report, post-project team reports, project tracking sheet
Indicators	Statement of production/purchase tallies at workshops, formation of a farmer cooperative and advisory board, designation of facility geographic reach, establishment of investment network, workshop/summit attendee readiness tally, region/state/national email, website, Facebook contacts/exchanges, project recommendations tracking sheet results	
Impact	Public-private invst network developed? Other communities collecting data to populate decision-making tool? Funding secured design and bid? Business plan developed? Decision-makers committing policy, planning, budgets to facility? Facility constructed and impacting farmers, ag land use and markets?	Post-project review team quarterly reports, project recommendations tracking sheet, evaluation embedded in conference presentations
Indicators	Yes/no record on tracking sheet, funds invested, policy/planning actions taken, acreage in processing vegetables, market value of processed produce, market volume served	

*OFM: Olympia Farmers Market; **EDC: Economic Development Council

f. How data will be analyzed or interpreted

Quantitative results will be used to estimate supply, demand data across a range of crops, windows of availability, and price ranges. Quantitative estimates of total supply and demand volume will provide valuable data that can be directly utilized in econometric models, in comparison with secondary data inputs. WSU DGSS will conduct quantitative analysis of survey data employing various techniques, including statistical group comparisons of opinions and perceptions, demand forecasting based on buyer/consumer surveys, supply and demand analysis that combines grower and buyer quantitative data. These analyses will allow for detailed modeling of consumer/buyer demand and the available supply, as well as forecasting growth, long-term sustainability, and potential differences in buyer populations. These quantitative analyses will be supplemented with thematic analysis of interview data that explores additional feasibility concerns, such as insurance requirements and food safety. Where applicable, interview data will be quantified and included in feasibility and supply and demand analysis. Since supply is vital to whether feasibility goals can be met, quantitative and qualitative analysis of current

supply and projected growth utilizing both primary data and secondary data will receive emphasis initially, with supply and demand analysis conducted that accounts for crop variation, enterprise and seasonality.

f. Plans to communicate results to appropriate audiences, including relevant scientific peers, stakeholders and the public, as appropriate

The research team will utilize opportunities for local, state, regional and national outrech related to food processing facility development, and present economic opportunities associated with the facility to agricultural producers, buyers, decision-makers and potential investors through:

- Five-session regional workshop series, with interactive small-group work utilizing the decision-making tool
- A WSU Extension technical bulletin providing information on development of regional data collection efforts and utilization of the decision-making tool
- Two published manuscripts in peer-reviewed journals
- Presentation of findings at two regional and two national conferences.

h. Pitfalls that might be encountered

Potential pitfalls that may be encountered include ability to source sufficiently specific start-up and operating expense data to evaluate a local processing facility, while developing a transferrable model. Additionally, creating enough model flexibility for research teams in other parts of the county to enter site-specific data while ensuring an accessible and user-friendly analytical tool may be limited by excessive model complexity and data collection requirements to adequately conduct regional site-specific analyses.

The research team is also aware that a model could become overly complex in attempting to provide capacity for sensitivity analyses that link local supply, demand, revenue and enterprise data, while also allowing for multiple combinations of different processing activities. The team is cognizant of not overwhelming input data collection capacity.

i. Limitations to proposed procedures

Agricultural producers have diverse food processing interests beyond what this study can evaluate. Three processing types and six crops would generate 18 possible individual enterprises, with 18 associated enterprise budgets, supply/demand/revenue data, and price ranges for both buyers and producers. Every related operating and overhead costs for the diversity of enterprise types cannot be accommodated by the procedure proposed here. Buyer and grower data will be collected on six or fewer processed products as individual enterprises. Emphasis will be placed on four to six crops that can be frozen processed individually and in combination, and one canned and one dehydrated enterprise.

Additionally, survey and interview questions need to be limited to reduce shopper impact, and to reduce interview transcription workload. Economic models will need to be proportionate to student econometric work; yet involvement with an economics faculty will enable model development and refinement to continue on where student time and capacity ends. Web application programming is also envisioned to be costly; with a limited budget, the interactive

product will focus on three to four processed crop enterprises. Additional enterprises can be evaluated utilizing spreadsheet tools by the research team; whereas the first phase of the web application development will only allow for a smaller selection of enterprise types; however selection will be sufficient for participants to develop different scenarios based on three to four enterprises, seasonality, pricing, and product volume.

3. PROJECT TIMETABLE

Yr	1								2								3							
Qt	1		2		3		4		1		2		3		4		1		2		3		4	
Obj	I	P	I	P	I	P	I	P	I	P	I	P	I	P	I	P	I	P	I	P	I	P	I	P
1a		x		x	x																			
1b								x		x	x	x												
1c										x	x													
1d										x	x		x											
1e						x		x	x															
2				x		x	x			x	x													
3				x		x	x			x		x		x	x									
4											x		x		x									
5														x		x		x	x		x		x	

Yr: Year; Obj: Objective; 1/2/3/4: Quarters; I: implementation; P: Planning meeting with Advisory Group; 1a: Grocery shopper survey; 1b: CSA customer survey; 1c: grocery retailer & restaurant buyer survey; 1d: institutional buyer survey; 1e: grower survey; 1d: independent processor survey; 2: TESC cohort survey implementation; 3: St. Martins cohort model development; 4: web app development; 5: engage community