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From turf to table: Grass seed to edible grains in the Willamette Valley

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Abstract

Western Oregon's Willamette Valley has a rich history of agricultural production and, like an increasing number of regions globally, a growing local food movement. Recent declines in grass seed markets and an increased consumer interest in local grains have raised the possibility of a transition from grass seed land to edible grain production for local markets. We used geographic information systems (GIS) to determine if the Willamette Valley population's dietary grain needs could be met if current grass seed land were converted to production of soft white winter wheat. In order to explore transitional obstacles and opportunities, we conducted interviews with local farmers, a wholesaler, an agriculture extension worker, and seed developers. The GIS analysis indicated that such a transition could exceed the recommended grain needs of the region's 2008 population. The interviews revealed technical and cultural aspects of transitioning from grass seed production to wheat and other edible crops, identifying insufficient infrastructure (storage, processing, distribution, and market outlets) as the primary barrier to producing for local markets. This combination of GIS analysis (predictive of the food-producing capacity of a region) with in-depth contextual information and practical insights from farmers' voices provides a robust model for planners seeking to analyze and address local food system challenges and possibilities. Our research, while focusing on the Willamette Valley's transition toward a more locally based food system, explores the potential steps for any region looking to transition from nonedible to edible crop production for local consumption.

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crop transitioning, edible grains, food system analysis, GIS, grass seed, local food systems, Willamette Valley

Introduction

Local Food

Eating locally has been endorsed in popular literature by authors such as Michael Pollan (2006) and Barbara Kingsolver (Kingsolver, Hopp, & Kingsolver, 2007), as well as in a growing body of research promoting local food and assessing community food production and consumption capacities (see Allen, FitzSimmons, Goodman, & Warner, 2003; Colasanti & Hamm, 2010; Delind, 2006; Feagan, 2007; Feenstra, 1997; Giombolini, Chambers, Schlegel, & Dunne, 2010; Herrin & Gussow, 1989; Hinrichs, 2000; Hinrichs, 2003; Ilbery, Watts, & Simpson, 2006; Marsden, 1995; Selfa & Qazi, 2005). However, recent studies have shown that current local food production may be insufficient to meet local food needs (Desjardins, MacRae, & Schumilas, 2009; Giombolini et al., 2010; Peters, Bills, Lembo, Wilkins, & Fick, 2008). One avenue to increasing local food production may come from transitioning cultivation from non-edible to edible crops, thus strengthening local food systems[1] for consumers and producers. Understanding the obstacles to and opportunities for such a transition requires analyzing yield potentials and examining the challenges that may be faced by those involved. Our research addresses these goals by exploring a transition from non-edible grass seed to edible grain production for local consumption in Oregon's Willamette Valley. While we acknowledge the importance of growing a diversity of crops and a variety of edible grains, we have chosen wheat for our case study because of its importance as a dietary staple, the history of wheat production in the region, the absence of wheat in common local food venues, the relative similarities in grass seed and edible grain production, and the availability of research on wheat yields.

According to the United States Department of Agriculture (USDA) and United States Department of Health and Human Services (USHHS) 2005 *Dietary Guidelines for Americans,* a balanced diet should consist of a combination of grains, meat and beans, vegetables, fruits, dairy, and oils, with grains making up the majority of a healthy diet. In the context of local food venues such as farmers' markets and community supported agriculture (CSA), grains in large quantities are frequently absent, compared to seasonal fruits and vegetables, dairy, and meats. While grains may be available through food cooperatives, retail stores, and bakeries, the relative absence of local grains from these venues as well speaks to a gap in our local food systems. This lack largely stems from grains, such as wheat, generally being produced as large-scale commodity crops for export from regions known for high yields, such as the Great Plains in the central United States (USDA, 2009a). When looking at how to transition to increased local food production, it is important to consider the issue of scale of production and the argument for competitive advantage in grain production on larger fields with more mechanization. This, however, does not diminish how the relative lack of local grains creates challenges for communities and individuals working to build local food systems.

This research focuses on crop transitioning to wheat and other edible grains within Western Oregon's Willamette River Basin due to the region's history of rich agricultural production and its vibrant local food movement. Much of the region's agricultural land is currently in nursery crop, hayseed, and grass seed production (ODA, 2008a) (see table 1 for 2009 Willamette Valley crop data in acreage and value).

Wheat is an important cash crop in Oregon and is predominantly grown in the eastern part of the state. The Willamette Valley also produces wheat for national and international markets, although the amount harvested fluctuates greatly from year to year (ODA, 2009a) in response to national and

[1] Feenstra (1997, p. 28) summarizes local food systems as adapted to particular places where "local environmental and community health priorities" become integral aspects of food production and markets.

Table 1. Willamette Valley, Oregon 2009 Field Crop Data by Acreage and Value (all values in US$)

	Land in Production		Value
Field Crops	**Acres**	**Hectares**	**(US$)**
Barley	32,000	13,000	4,896,000
Corn, grain	32,000	13,000	28,208,000
Corn, silage	26,000	10,500	23,230,000
Hay, alfalfa	400,000	162,000	221,400,000
Hay, all other	630,000	255,000	243,432,000
Hops	6,106	2,471	43,185,000
Oats	22,000	9,000	6,710,000
Peppermint	21,000	8,000	38,107,000
Potatoes	37,000	15,000	151,293,000
Sugarbeets	10,600	4,300	16,590,000
Wheat	877,000	355,000	223,633,000
Seed Crops			
Alfalfa seed	2,300	900	3,432,000
Bentgrass seed	6,680	2,700	10,262,000
Bluegrass seed	19,880	8,050	22,539,000
Fescue seed	179,000	72,000	124,093,000
Ryegrass seed annual	118,520	47,960	40,946,000
Ryegrass seed perennial	107,420	43,470	81,984,000

Source: Oregon Department of Agriculture (ODA) and National Agricultural Statistics Service (NASS). (2009). *Facts and Figures.* Retrieved from http://www.oregon.gov/ODA/statistics.shtml

international markets. Based on the recommended dietary requirements of the USDA and USHHS 2005 *Dietary Guidelines for Americans,* edible grain production in the Willamette Valley growing region would not have met the 2008 population's requirements for any of the last five years of production. In 2004 crop yields equaled 73% of the 2008 population's dietary requirements; in 2005 it met 34%; in 2006 and 2007 it met 29%; and in 2008 it met 67% (Giombolini et al., 2010). Within these fluctuations, even the relatively high numbers can be deceiving. In 2006, 92% of the wheat produced in Oregon was exported, principally to Asian markets where it was used to make such items as steamed buns and noodles (ODA, 2007). This last fact is not to recommend that international trade should cease, but to illustrate that while Willamette Valley grain yields have the potential to meet a significant percentage of the local population's recommended dietary requirements, local consumers are not benefitting from it.

The demand and marketing of local food is expanding beyond farmers' markets and community supported agriculture to community organizations, large and small grocers, cooperatives, and supermarkets (Blake, Mellor, & Crane, 2010; Borst, 2008; Dunne, Chambers, Giombolini, & Schlegel, 2010; Guptill & Wilkins, 2002; Morris & Buller, 2003). As Feagan (2007) has noted, community is an important component of local food systems because food is intertwined with community. There are several emerging community organizations in the Willamette Valley that support the expansion of a local food system and play an important role in expanding production and markets for local edible grains.

In the southern Willamette Valley two community groups, The Ten Rivers Food Web[2] (TRFW) and Willamette Valley Farm and Food Coalition[3] (WVFFC), have partnered to support the Southern Willamette Valley Bean and Grain Coalition (SWVBGC).[4] These groups publish blogs to document their meetings at which they discuss successes and challenges in production as well as provide information on growing and purchasing edible grains (for example, see Armstrong, 2008; MacCormack, Kise, & Augerot, 2008). Both the

[2] TRFW (http://www.tenriversfoodweb.org) was founded in 2004 and is dedicated to building a resilient food community in Oregon's Benton, Linn, and Lincoln counties.
[3] WVFFC (http://www.lanefood.org) was founded in 2000 and is dedicated to building "a secure and sustainable" food system in Lane County, Oregon.
[4] The SWVBGC has been meeting since 2008 (Southern Willamette Valley Bean and Grain Project, 2010). See the website at http://www.mudcitypress.com/beanandgrain.html

TRFW and WVFFC focus on community initiatives, grower networking, and food education. The SWVBGC consists of farmers, distributors, activists, and community members interested in developing economically sound organic bean and grain production methods, as well as local markets for their sale. According to the SWVBGC's blog, the group formed and has grown in response to a number of perceived issues, including the increased cost of petroleum products, fluctuating world grain prices, and concern over nonexistent local bean and grain distribution infrastructure (Armstrong, 2008). It is through community organizations such as these that much research, education, and policy initiatives about community food systems are conducted.

From Grass Seed to Grains

Grass seed — cool season forage and turf grass — has been an important commodity for Oregon's economy as well as its landscape. Oregon growers produce essentially all of the U.S. production of annual ryegrass, perennial ryegrass, bentgrass, and fine fescue. Smaller amounts of Kentucky bluegrass, orchardgrass, and tall fescue are also grown in Oregon (OSU, 2009). It is the third highest value commodity crop grown in Oregon, grossing over US$500 million in 2008 (ODA, 2008a). The temperate climate of Oregon's Willamette Valley, with wet winters and arid summers, makes it one of the world's most productive regions for grass seed farming (Young, 2003). According to 2008 crop production data from Oregon State University Extension Service's (OSUES) Oregon Agriculture Information Network database (OAIN), over 450,000 acres (180,000 hectares) of agricultural land in the Willamette Valley is in grass seed production; in 2003 this represented more than one third of the growing region's cropland (Young, 2003). In 2009, the numbers dropped slightly to just over 410,000 acres (170,000 hectares) of grass seed cultivated in the Willamette Valley growing region (OSUES, 2008).

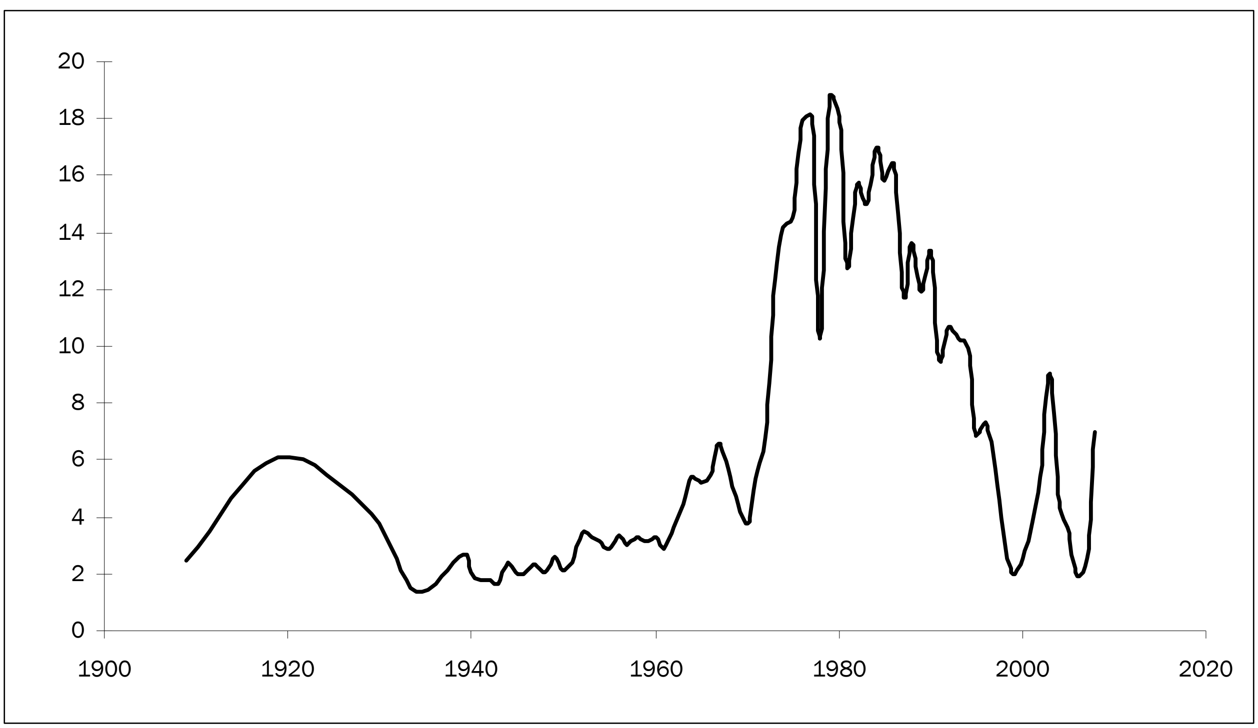
Grass seed production in the region faces challenges as new laws influencing agricultural practices for producing crops as well as declining market values cause farmers to consider possible alternative crops. The near-total ban on field burning that passed Oregon's legislature in the summer of 2009 (SB-528) may speed a change in the percentage of land producing grass seed (Oregon Legislative Assembly, 2009). Field burning has been a popular grass seed farming technique since its implementation in 1948. It is used to control weeds, remove straw residue, and eliminate crop diseases (Chilcote, 1969). Although limited burn restrictions have been in place since the late 1980s, the recent legislation is a far stricter ban, which creates more obstacles to grass seed production (ODA, 2008b). The greatest effects of the ban will be on land currently in annual ryegrass, the most commonly grown but lowest value grass seed variety (Young, 2003). According to an OSU extension service field crops agent, because annual ryegrass is the most successfully grown but has the lowest returns, the increased costs of inputs and maintenance as a result of being unable to burn the fields will make growing annual ryegrass economically unfeasible.

Recent global economic conditions have also influenced the grass seed market. A 2009 article in *The Oregonian* highlighted decreased demand due to reduced planting of lawns and golf courses as one of the challenges grass seed farmers face (Read, 2009). Market prices for annual ryegrass seed in August 2009 hovered around US$0.18 per pound, while grass seed costs approximately US$0.26 per pound to produce (Dietz, 2009). Different varieties of grass seed command different prices. In spring 2010, annual ryegrass sold for US$0.15 per pound while perennial ryegrass sold for US$0.40 to US$0.50 cents a pound (T. Silberstein, Oregon State University Extension Service field crops agent, personal communication, February 4, 2010). Due to adverse market conditions, economic factors such as the decline in housing starts, and legal restrictions on field management practices, the future of the grass seed industry is unclear (Repko, 2009). This has spurred many regional grass seed farmers to begin to seek out alternative crops (Lies, 2009).

Given the widespread use of wheat in the United States, the growing market demand for local foods, and the similarities in cropping techniques to nonedible grains, wheat has potential as a grass seed replacement crop. In the past, it was grown widely throughout the Willamette Valley (Bunting, 1995). According to Brumfield (1968), the region was one of the primary wheat-growing areas in the Pacific Northwest during early European settlement. Wheat milling and processing facilities were built throughout the area beginning in the 1830s. Wheat production was phased out over time due to competing grass seed markets. Malone (2010) provides a detailed history of the rise of grass seed production in the lower Willamette Valley, describing it as resulting from economic and social changes (e.g., World War II and increased demand for turf and forage seed). Figure 1 illustrates the change in wheat yields in the Willamette Valley over the past century.

For our research, we used the Willamette Valley as a case study for transitioning grass seed acreage to wheat production. Given the potential for this growing region to produce its own grain, as well as its population's interest in purchasing local foods, it is uniquely suited to testing strategies for creating local markets for grains, a staple not commonly sourced locally. Using geographic information systems (GIS) analysis, we projected estimated soft white winter wheat yields for land currently in grass seed production to determine whether wheat production on transitioned lands could meet the regional population's dietary grain requirements. Interviews were conducted in order to more holistically illustrate the necessary steps and attendant challenges in transitioning from grass seed to edible grain production. Local food system planning must address all aspects of grain production — cultivation, processing, transportation, distribution, and policy — if it is to support these agricultural and societal transitions. This research illustrates a method of investigating transitions to more local food production and the importance of including many voices in the research, planning, and policy processes. An important finding of our research for building more resilient local food

Figure 1. Annual Wheat Yields for Oregon's Northwest District, 1990–2010 (Millions of bushels)



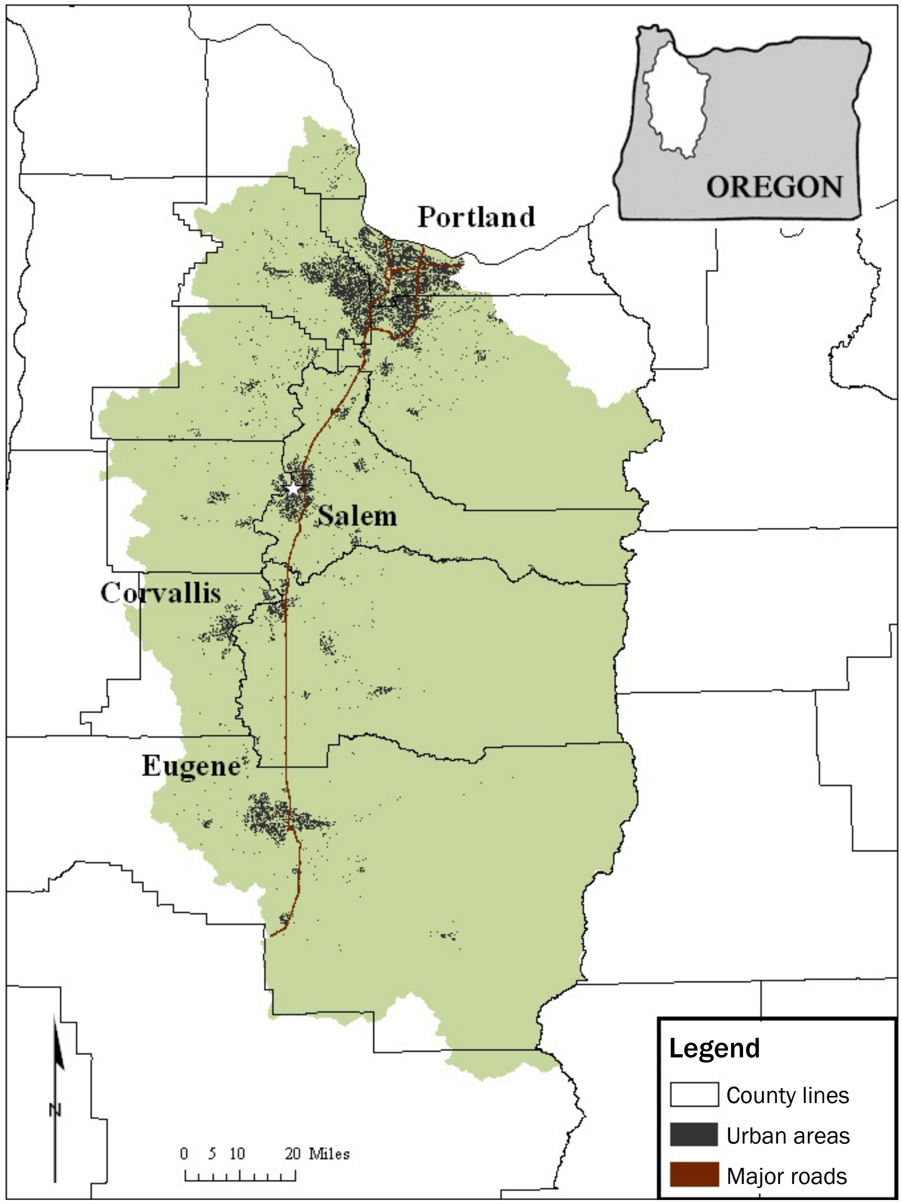
Note: The Northwest District encompasses the following counties: Benton, Clackamas, Clatsop, Columbia, Lane, Lincoln, Linn, Marion, Multnomah, Polk, Tillamook, Washinton and Yamhill.
Source: USDA and NASS, 2010. Figure derived from historical survey data and annual data.

systems is the need to further investigate local infrastructure.

Study Area

The Willamette Valley, bound between the Coastal and Cascade Mountain ranges on the west and east, with the Columbia River to the north and the drainage divide of the Umpqua River to the south, encompasses approximately 11,500 square miles (29,800 square km) (USGS, 1996) (see figure 2). The floor of this valley holds some of the most productive soils in the world, developed over time through volcanic activity and periodic flooding (Bell & McDaniel, 2000). Cool, wet winters and warm, dry summers allow for over 170 different crops to be grown in this fertile region (ODA, 2009b). Steady rainfall occurs from December through February, followed by relatively aridity in summers, which average only five percent of the total annual average precipitation (PNW-ERC, 2002).

Figure 2. The Willamette Valley Growing Region



Sources: Pacific Northwest Ecosystem Research Consortium 2002; Oregon Geospatial Clearing House, 2008.

In 2009 there were over 38,000 farms in the Willamette Valley, which encompasses the counties of Benton, Clackamas, Columbia, Lane, Linn, Marion, Multnomah, Polk, Washington, and Yamhill, with an average farm size of 425 acres (172 hectares) (ODA, 2009a). The majority of farms (80%) are 180 acres (73 hectares) or less, and over 60% are 50 acres (20 hectares) or less (ODA, 2009a). These numbers can be slightly misleading and may suggest a more diverse farming economy in the Willamette Valley than actually exists. When comparing 2007 farm data for Oregon on the basis of annual sales, acreage, and number of farms, 7.1% of farms accounted for 85.7% of total annual sales and 48.5% of total acreage (Coba, 2010). Despite these numbers representing Oregon as a whole (rather than the Willamette Valley growing region alone) and the arid landscape of the majority of the state necessitating larger farms for profitability, they doubtless portray what is basically true for the Willamette Valley: A few larger farms account for a majority of total acreage and revenue.

The Willamette Valley growing region also has relatively high population density. According to 2008 U.S. Census estimates, there are over 2.5 million people living in the Willamette Valley (Proehl, 2009) with four of Oregon's six Standard Metropolitan Statistical Areas (SMSAs) — Eugene, Portland, Salem, and Corvallis — located in the region.

Methods

To visually represent current grass seed crop production land in the Willamette Valley and provide numerical projections for soft white winter wheat yields from land in grass seed, we used the GIS software ArcMap (ESRI, 2008) to analyze crop production data. We used the yield projections, along with recommended dietary requirements for the 2008 population in the region (based on the USDA and USHHS's 2005 *Dietary Guidelines for Americans*), to determine if yields from areas converted from grass seed to wheat production could meet the dietary grain needs of the local population. In order to better understand the process of transitioning from grass seed to wheat, we conducted semistructured interviews with farmers either transitioning their land or currently growing wheat, edible grain, and/or beans for both local and commercial markets, as well as individuals connected to increasing local food production in the Willamette Valley. Interviewees represented the most central characters in the transitioning process in the growing region at the time of the research (2009–2010).

GIS and Crop Production Analysis

Datasets. We used three publically accessible datasets to assess the potential for soft white winter wheat production in 2007 of fields planted in grass seed in the Willamette Valley.[5] We began with a National Agricultural Statistics Service (NASS) raster-based file for 2007 Oregon cropland that was clipped to the Willamette River Basin. Secondly, we used a personal geodatabase file based on Soil Survey Geographic (SSURGO) surveys that give the predicted weighted average soft white winter wheat yields for each soil type in bushels per acre[6] (NRCS, 2009). Soil productivity (measured in bushels per acre) was obtained from soil survey data conducted by the NRCS, which used a variety of methods, including interviews with agricultural producers, review of crop yield data collected by USDA Farm Service Agency county offices, interviews with Oregon State County extension agents who are familiar with wheat yields on soils in their counties of responsibility, and rod row sampling, to determine soil productivity. Another geodatabase file was used to intersect the Willamette Valley SSURGO wheat yields feature class with the polygon grass seed shapefile converted from a raster. This feature class contained the SSURGO soil survey polygons and weighted average soft white winter wheat yields for all areas identified as grass seed land in the NASS 2007 crop cover raster dataset. This final dataset was used to calculate the potential soft white winter wheat yields for areas currently in grass seed production.

Crop production potential calculation. Each of the classified soils had specific weighted average soft white winter wheat yields (in bushels per acre) that were used to calculate total projected yields. We used only land yielding 100 bushels per acre or greater to calculate total potential soft white winter wheat crop production because economically viable land in western Oregon must produce an average of at least 100 bushels of wheat per acre (T. Silberstein, Oregon State University Extension Service field crops agent, personal communication, February 11, 2010). The benchmark of 100 bushels per acre used in this study is not, however, presented

[5] Steve Campbell of the National Resource Conservation Service (NRCS) in Portland, Oregon, provided the datasets used for this first stage of the analysis.
[6] Acres rather than hectares were used in this study because available agriculture data was given in bushels per acre.

as a prescription to farmers; there is a complexity of factors that influence a farmer's decision to grow particular crops. The total number of bushels was then converted to pounds of wheat flour based on the most recent version of the USDA and NASS *Agricultural Statistics* (2007), a publication of commodity conversion factors for various agricultural crops and livestock. Using the conversion factor for bushels of wheat to pounds of wheat flour (2.3 bushels yields to 100 pounds of flour), we determined how many pounds of flour would be produced. Finally, in order to determine if the yielded number would match the 2008 Willamette Valley population's recommended dietary requirements for grain we converted the pounds to grams, because serving sizes are designated in grams (see the following equation):

$$\frac{\text{Total \# of bushels}}{2.3} \times 45359.24 \div 30 = \text{Total servings produced}$$

It is important to note that this conversion factor is based on hard red wheat bread flour (i.e., white unbleached flour). There is a difference in weight between white and whole-wheat flour. The process of making white wheat flour retains only approximately 75% of the original grain weight after key nutritional components such as the bran and germ are removed from the grain kernel (Kansas State University Extension Service, 1997). The actual weight depends on the processing technique (stone ground, steel bur ground, removal of germ and bran, etc.). With this in mind, the final produced weight of whole-wheat flour may be higher.

Population and dietary grain requirements. We acquired detailed population data from the 2008 *Oregon Population Report,* an annual publication of Portland State University's Population Research Center (Proehl, 2009). This population data was used in conjunction with USDA and USHSS (2005) *Dietary Guidelines for Americans* recommended daily requirements to calculate grain servings for the region's population. These calculations were based on data used in previous research conducted by Giombolini et al. (2010).

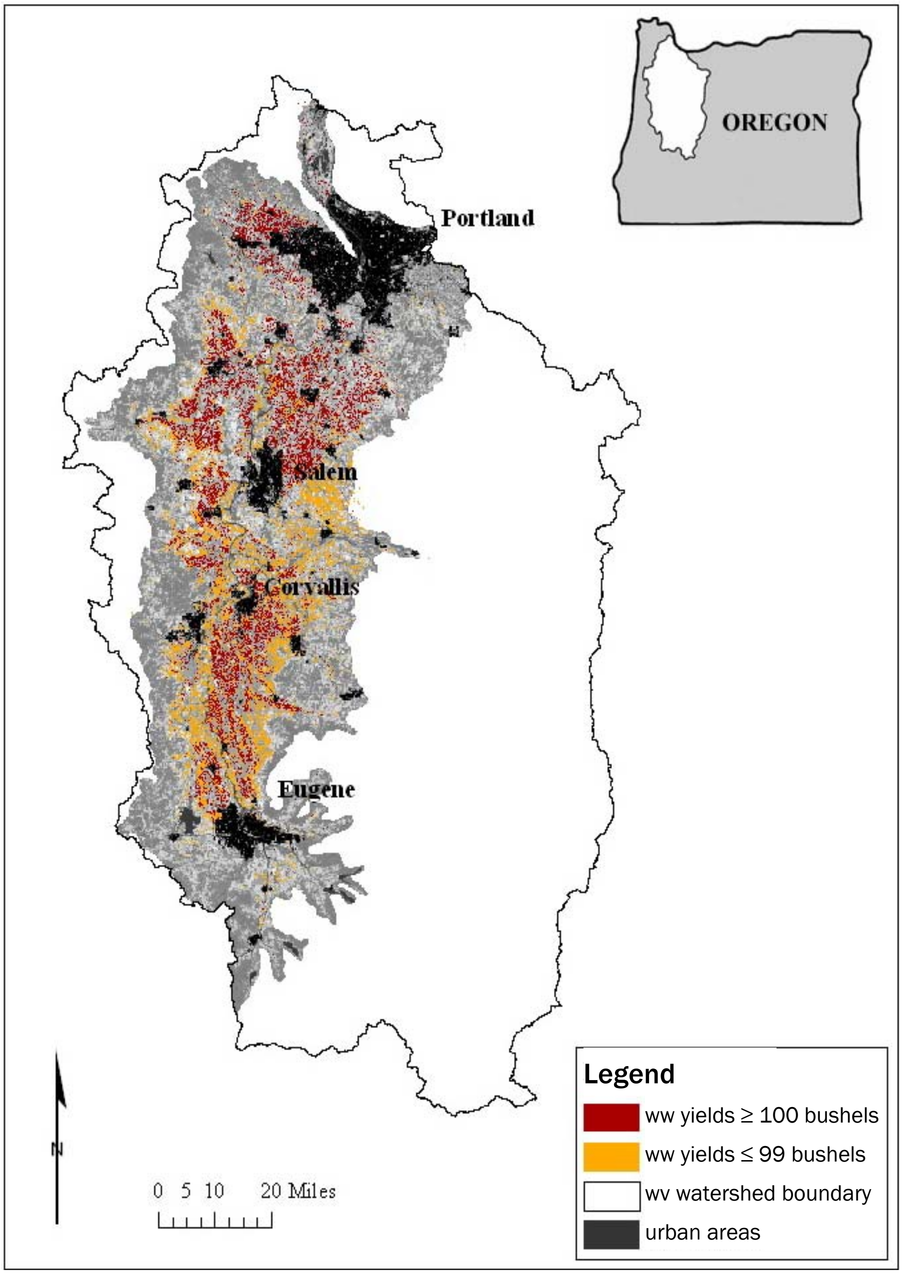
Soil ratings and cartography. In order to visually represent the potential growing regions for soft white winter wheat in the Willamette Valley, we created a weighted map highlighting the areas of greatest wheat yields. Some soils exhibited much higher wheat yields than others. Two categories, based on information from Oregon State University Extension Service (T. Silberstein, Oregon State University Extension Service field crops agent, personal communication, February 11, 2010), were used to differentiate potential soft white winter wheat yields: equal to or less than 99 bushels, and 100 bushels or greater. These categories were selected because we only used land with predicted yields of 100 bushel or greater for the analysis to reflect economic viability of yields. The map comprehensively illustrates the Willamette Valley's grass seed acreage (see figure 3).

Interviews

We conducted semistructured interviews to create a broad overview of the grass seed industry, regional agriculture, and the process of transitioning to edible grain production in the Willamette Valley. The semistructured format allowed for comparability and consistency. As the goals of this component of our research were qualitative in nature rather than quantitative, participants were chosen using purposeful sampling (Bickman & Rog, 1998; Patton, 1990). We focused primarily on a group of farmers, distributors, and community members in the southern Willamette Valley dedicated to local food security and transitioning to a more localized food system.

Most of the farmers interviewed were key informants who represented the core of the transitioning movement at the time of our research (2009–2010) and were associated with the Southern Willamette Valley Bean and Grain Coalition (SWVBGC). Three of the participants interviewed were large-scale grass seed farmers (their acreage ranged from 800 acres to 9,300 acres, or 300 hectares to 3,800 hectares) transitioning to edible grain production for local markets. One interviewee was a small-scale organic farmer engaged in growing test plots of different wheat varieties to determine their suitability to the region before

Figure 3. Map of the Willamette Valley's (WV) Projected Soft White Winter Wheat Yields (ww) in Bushels per Acre on Grass Seed Land



Sources: 2007 NASS (2007) crop data, SSURGO (2009) soil data, and 2000 land cover use from the Pacific NorthWest-Ecosytem Research Consortium (2002).

recommending their use to large-scale grass seed farmers. We also interviewed a wholesaler spearheading the transition's marketing aspect. Additional interviews were conducted with four others not directly connected with the SWVBGC: one agriculture extension representative, two grass seed growers not transitioning, and one small-scale farmer/seed researcher. The number sampled is representative of the key actors and reflects the majority of attitudes of those involved with this small movement and initiative.

Interview questions included a variety of survey, specific, attribute, and structural questions (Bickman & Rog, 1998) focused on grass seed and wheat production, farming ideology, and marketing. Farmers were asked different questions from those asked of local distributors and other community members working to facilitate the transition from nonedible export crops to edibles grains for local markets. Interviews were held at participants' offices, farms, or public locations of their choosing. Each interview lasted about 60 minutes. They were recorded and transcribed with the consent of the participant. Triangulation was used when possible in order to verify the validity of the interviews by comparing the information provided to other sources such as statistics or alternative references (Bickman & Rog, 1998).

Results

After summing the total areas of each soil type (for those yielding 100 bushels per acre or greater) and multiplying this number by the associated soft white winter wheat yields (bushels/acre), we combined the totals to give projected bushels of soft white winter wheat from land in grass seed production. Of the total area, 264,581 acres (107,072 hectares) yielded less than 99 bushels, and 250,537 acres (101,389 hectares) yielded 100 bushels or greater. Based on calculations determining the total yields of winter wheat in bushels from land in grass seed production in 2007, the recommended dietary grain needs of the Willamette Valley's 2008 population would be met two times over. The total projected number, 25,324,934 bushels of soft white winter wheat, converts to 16,648,112,453 servings. The recommended dietary grain needs (based on gender and age) for the 2008 population of the Willamette Valley is 6,836,647,100 servings.

Discussion: The Transitioning Process

The projected numbers from our GIS model have shown that it is possible to meet the recommended dietary grain needs for the Willamette Valley's 2008 population by transitioning from grass seed to wheat production. The GIS model, however, is based on predicted outcomes without taking into account the various and complex factors that influence crop production. With this in mind, what are the perceived obstacles to this transition? The following discussion uses information gathered through interviews to contextualize the calculated numbers for potential wheat production.

Farmers interviewed described transitioning as a holistic process with a need to focus not only on transitioning to different crops but also to different farming techniques and marketing strategies. They saw that transitioning is not limited to changing from grass seed to wheat, but from grass seed to other edible grains, beans, and seeds as well, bringing crop rotation particularly into focus due to the potentially higher yields to which it can lead. Farmers also discussed transitioning from conventional agriculture to more organic-based production. Interviewees stressed their reasons for feeling that a transition to organic production was important to make, how this influenced their farming practices, and the attendant risks and barriers. Members of the SWVBGC have coalesced around organic production due to the environmental and health benefits of organic food, in addition to their sense that many consumers interested in local food prefer that their food be organic (Armstrong, 2008). Production by members of the SWVBGC has grown from humble beginnings of less than 50 acres (20 hectares) of transitional or organic beans and grains to more than 600 acres (250 hectares) transitioning to organic, and over 100 acres (40 hectares) certified organic (Armstrong, 2010a; MacCormack et al., 2008).

Our interview results reveal that transitioning from grass seed to edible grains in the Willamette Valley would involve building local food systems, technical farm changes, and a cultural shift. We believe that these practical insights from local voices on the requirements for transitioning from nonedible crops to edible grains are not unique to the Willamette Valley. The following insights represent individuals' perspectives and provide contextual information and a robust model for planners in other communities seeking to analyze and address local food system challenges and opportunities.

Building Local Food Systems

Our interview findings reveal the need for the transition from grass seed crops to edible grains and beans to extend beyond the farmers and their fields to building local food systems with increased infrastructure, along with market creation that includes expanded community involvement.

Rebuilding infrastructure. According to the interviewees, one of the greatest barriers to the transitioning process is the lack of infrastructure that is needed to adequately promote local food production, processing, distribution, and consumption. Without these infrastructure elements, creating a reliable market where local crops can be sold is difficult. Most farmers do not have the time or skills to create infrastructure or develop markets. While several farmers currently provide the storage facilities, process, and distribute their crops out of necessity, many made a point of emphasizing that they were farmers — not processors. While multiple roles may be evolving for farmers, each part of the food system requires different skill sets. Farmers represent only one part of that system.

Grain production is highly regionally specific and generally requires primary or secondary processing before marketing to consumers (USDA, 2009a). This presents what some perceive as a barrier to creating local food systems for grains, as appropriate infrastructure must be created to process harvests from raw and often inedible states (MacCormack et al., 2008; Merlo, 2005). On one hand this can be considered a barrier, but growing a local food system also creates an opportunity for new businesses and entrepreneurs. The Willamette Valley currently has little infrastructure to support the storage, processing, and distribution of local grains, beans, and edible seeds. That which existed historically disappeared with the increase in grass seed production.

Storage is a particularly significant issue. One farmer observed:

> Storage, to a big degree, is going to rely on the farmer. For us, we are taking bins at our seed warehouse that would normally be for grass seed and we are going to be storing different grains.

Farmers themselves, especially those who clean seed and have extra storage space, will initially house the seed before it enters the market. One farmer who owns a 17,000-acre (7,000-hectare) grass seed farm commented that he is increasing his facilities for wheat storage as a method of avoiding the saturated wheat harvest market and commanding a higher price during other times. Malone (2010) identifies grain storage and processing facilities located in Oregon and notes that only one elevator in the Willamette Valley is licensed to store and transport organic wheat. Lack of storage space is a critical factor in making it difficult for farmers with limited storage space to grow for the local market. Farmers are taking on multiple roles since current conditions are leaving them without many options, but as operations grow increased infrastructure will be needed. The SWVBGC blog notes that members express concerns that additional storage infrastructure will need to be developed in order to accommodate larger future harvests of grain and beans (Armstrong, 2010a).

In addition to lacking sufficient storage, the Willamette Valley has few processing plants and mills. Its dominant flour mill is Cereal Food Processors, Inc., a privately held corporation and America's largest independent flour milling company. This mill processes 760,000 pounds (340,000 kg) of flour per day. The majority is produced from hard red wheat grown not in Oregon, but in Montana (Cereal Food Processors representative, personal communication, April 21, 2010). While there are smaller processors such as Bob's Red Mill in Milwaukie and Grain Millers in Eugene, they typically do not process the small quantities of grain that many producers are looking to sell locally. In 2009, approximately 500,000 pounds (over 200,000 kg) of wheat produced in the Willamette Valley was available to be milled for the local market. A small mill[7] with a grinding capacity of 750 pounds (340 kg) of wheat a day would only need to operate 12 to 14 hours a week to meet the processing needs of the local population (J. Henderson, sales coordinator for wholesaler, personal communication, April 21, 2010). Farmers note that the lack of small processing plants makes it hard to market local wheat, but wonder at what point is enough grain produced to justify investing in this infrastructure.

Without mills, wheat is sold as a whole grain, a form which is inconvenient as well as unfamiliar to the many who prefer flour for cooking and baking. One option may be to sell whole grain to consumers and develop the infrastructure for personal grinding. Located in Corvallis, Oregon, the First Alternative Co-op has installed two flour grinders, one for whole wheat bread flour and one for whole

[7] Small mills are available for approximately US$50,000, not including system development charges, rent for the building, utilities, labor to run the machine, the costs of the dust control system (about US$20,000), a bagging line, a fork lift, and other costs (J. Henderson, sales coordinator for wholesaler, personal communication, April 21, 2010).

wheat pastry flour, giving customers the ability to grind whole grain wheat in quantities suitable for home use. Approximately five pounds (2.3 kg) of bread flour and two pounds (0.9 kg) of pastry flour are processed daily. This is an example of a positive, if very small step, as a wide range of milling options including both small and larger scale grinding facilities may be needed in order to seriously promote wheat locally.

In their blog posts, the SWVBGC farmers detail how in 2010 they took steps toward infrastructure development with the addition of four organic seed cleaning facilities and two small organic grain mills (Armstrong, 2010a; Rea, 2010). They note, however, that despite these steps, securing adequate facilities for storing harvested grains and processed flour remains essential if grain products are to be kept free of vermin and mold (Armstrong, 2009). While SWVBGC members have thus far been able to overcome structural barriers to the production, processing, and sale of organic grains and dry beans, increased production and markets (with the ultimate goal of profitability for farmers) will require expansion of critical local food system infrastructure components.

Market Creation. In the Willamette Valley, the development of local food markets for grains has begun through the work of community organizations, a wholesaler, and individuals who share risks with the farmers. This step is critical, as farmers will not produce if market demand is not there. Some local organizations are working to develop markets, such as the SWVBGC, which has the stated intention of helping farmers transition and sell locally and is considering producer cooperatives as a potential option for increasing farmers' capacity to do so (Armstrong, 2008; Armstrong, 2010a; MacCormack et al., 2008).

Many questions surround the long-term strategies needed to develop a local market for grains. For example, although producers report that demand continually outstrips supply, the local market's ability to absorb these crops may be tested in the next couple years as more than 500 acres (200 hectares) of grass seed are transitioned to beans and grains (Armstrong, 2010a). The question of how to manage production so that the supply of grains and beans does not flood the market has been raised for the future of the SWVBGC (Armstrong, 2010a; Armstrong, 2010b). To avoid overproduction it is important to develop a diversity of markets and different avenues to market the increasing supply of beans and grains.

A wholesale company based in Eugene has been working diligently alongside local farmers to provide markets for their crops. The CEO of the company notes:

> If we had enough market there would be a lot more farmers interested in growing these [crops]. If we could provide contracts for the farmers then they would definitely grow.

The wholesaler is interested in establishing contracts with farmers in order to have stable agreements between both parties with an agreed upon price and quantity. Economic incentives to providing local crops exist because they tend to command higher prices, but reliable markets are needed in order to sell the grain. Farmers rely on the support from such companies to create avenues for distribution, in order to successfully transition from grass seeds to edible crops for local markets.

Personal interaction plays an important role in gaining customer trust and support for establishing alternative food systems (Watts, Ilbery, & Maye, 2005). The wholesaler in question has invested time, energy, and resources into understanding its customer base and creating new markets for the local crops being grown. It has sent a questionnaire to customers asking if they would be willing to buy transitional, not organic, products locally during the three years the farmer transitions to organic. Overall, it found customers supportive of buying transitional crops.

Given the risks inherent in the transitioning process, financial support from wholesalers is crucial to transitioning farmers. The CEO states,

> We go in with the farmer where we give the farmer money down, plus we also provide the seed; we really want to take the risk with the farmer if we know that we can sell the crop.

Such companies share risks with farmers to make the system work by providing financial support through a difficult growing season or providing some of the inputs. In general, a farmer is risk-averse and does not want to take transitional risks alone; partnerships with companies such as whole-salers are crucial. Many farmers commented that the transition from grass seed to edible grains and beans would not be possible without support from the wholesaler: it was the catalyst for the transitioning process. Future support from community members and other entities such as buying clubs may be another option to help mitigate some of each farmer's risk.

All farmers necessarily take some risk as a poor crop year could lead to financial hardship, but for farmers transitioning to edible grains for local markets the risks are unique in that they are doing something different from the norm. One farmer interviewed stated,

> We need guaranteed income or we can't make it; it is a really scary feeling like we could lose everything if we have a bad year.

For many farmers grass seed has provided a relatively risk-free crop for decades, if not generations. Yet farmers often operate on the margin and the current situation with grass seed sales is reducing some farmers' opportunities to diversify. A grass seed farmer who is not transitioning to edible grain crops for the local market commented on those who are transitioning away from grass seed:

> It's how much risk you can take. When times are good, you can set aside some acres to experiment with. Right now we are kind of hunkering down and scraping through until times get good.

Farmers frequently find it difficult to take the initial steps toward moving outside of conventional practices because growing something different and failing may be worse than waiting it out and continuing production of crops that in the past have been dependable.

Many SWVBGC farmers have relied upon a single wholesaler to purchase and sell their transitional organic beans and grains (Armstrong, 2010b). Sole reliance on this one distributor for their product may result in overlooking the possibility of large contracts with other significant consumers, such as bakeries and restaurants. While the incremental steps taken by the SWVBGC have thus far been effective at growing and distributing organic beans and grains, more long-term market strategies will be needed (see Armstrong, 2010c). Continued growth and networking between organizations will be instrumental in supporting the transitioning process from grass seed to edible grains and beans.

On-farm Technical Transitions
Farmers interviewed described the relative ease of transitioning from farming grass seed to raising wheat and other crops, but also outlined the obstacles to such a transition. Farming contains many technical elements, and transitioning farmers must consider not only the change in crop types, but also technical transitions involving farm equipment, marketing and transport tools, seed stock, and organic production methods.

Equipment. Grass seed equipment requires few significant changes in order to process wheat and other such crops. According to farmers we interviewed, the main change involves investing in combine headers designed to harvest wheat. In general, given suitable header selection, wheat and grass seed (as well as most other edible grains, beans, and seeds) can be seeded, harvested, and cleaned using the same large equipment. One farmer interviewed commented:

> That's the beauty. Beans, grains, and edible seeds we can harvest using grass seed equipment. We don't have to change anything.

Economically, the initial mechanical transition does not require great financial inputs. Malone (2010) presented an alternative view based on her research that found grain is more costly to produce than grass seed. Grain requires more processing (e.g., crushing and grinding the grain), but farmers interviewed said that cleaning and harvesting wheat should require few mechanical alterations. Growing dry farmed beans presents further difficulties due to the Willamette Valley's relatively short summers and inconsistent weather patterns. Having reliable harvests has been and continues to be a challenge for farmers trying to bring beans into the crop rotation and to the local market. (These comments are expressed in detail in the SWVBGC blog; see Armstrong, 2010c.)

The scale of edible crop acreage can be a determining factor in equipment selection. The farmers we interviewed were transitioning anywhere from 2 to 400 acres (0.8 to 160 hectares) of land. One couple employed a 1965 combine to harvest their hard winter wheat because:

> It's probably 25% the size of our conventional combines. The older combine works perfect because we're only doing 30 or 20 acres [12 or 8 hectares].

In considering equipment changes, farmers face relatively few barriers; the real challenges concern the lack of available infrastructure for distributing, marketing, and transporting other crops.

Marketing and transport. Marketing and transporting grass seed is different than marketing and transporting wheat. Grass seed, although a commodity crop, is not sold on the commodity market and tends to be produced under contracts, which serve as a type of risk-management plan. Grass seed companies create contracts with farmers each year to determine the type and amount of grass seed to be planted. The farmer then grows the seed and holds it until the seed contractor picks up the seed for distribution. In this way, the farmers do not own their seed, but grow it. Two of the grass seed farmers we interviewed said that with the decline of the grass seed market, contractors are not completely fulfilling their contracts, leaving many grass seed farmers to store grass seed from the past year that the contractor could not sell.

As wheat is a commodity, farmers are responsible for selling, transporting, and distributing the wheat they produce. Wheat value depends on volatile market prices. The break-even price for wheat grown on land yielding 100 bushels per acre is approximately US$5.50 to US$6.00 per bushel (T. Silberstein, Oregon State University Extension Service field crops agent, personal communication, February 11, 2010). Wheat prices in 2007 peaked at a high of US$10.30 per bushel, which inspired many Willamette Valley grass seed farmers to grow more wheat (USDA, 2010). The spike in wheat prices proved temporary, however, and by 2009 wheat prices hovered around US$4.50 to US$5.00 per bushel (USDA, 2010). The volatility of market prices is an important consideration when providing recommendations from the 100 bushel yield benchmark used in our GIS model. The current marketing structures in place for wheat will need to be altered to establish a more stable market price, perhaps to a contract-based system similar to grass seed, in order to serve the local market.

Seed stock. The question of seed stock and seed varieties suited to the Willamette Valley is also critical to transitioning farmers, particularly which varieties of wheat to grow and what the availability of organic seed supplies might be.

The projected bushel yields from the GIS data are for soft white winter wheat varieties as opposed to hard wheat varieties. The main difference between the two varieties has to do with their respective protein levels (although gluten and ash levels are also components). Hard wheat is typically used for breads and is primarily grown in the Midwestern states, whereas soft wheat is commonly used for pastries and flatbreads and is frequently grown in the Pacific Northwest (USDA, 2009a). There is a potential market for both soft and hard wheat to meet local demand. Soft wheat can address local pastry needs, while hard wheat can address local bread baking needs. Cultivating the knowledge and ability to use both appropriately in the long term will support increased production and consumption of local grains.

Protein levels and uniformity dictate the types of wheat grown, and grade and quality standards have limited the number of commercially produced varieties of wheat due to farmers' inability to receive government funding and loans for "undesirable" seed (Malone, 2010). Farmers interested in growing grains for the local market are diverging from these past influences on seed selection and are not necessarily relying on government subsidy programs, as they are growing seed varieties that are more rigorous for the Willamette Valley climate. During the historic boom in wheat production, both hard and soft wheat varieties were grown in the Willamette Valley. Brumfield (1968), in describing popular wheat types grown in the late 1800s and early 1900s, mentions names such as Turkey Red, Bluestem, and Marquis, all of which are hard red varieties (Carleton, 1916). These heirloom hard wheat types are now being re-introduced into the Willamette Valley as viable options.

Several farmers interviewed commented on the commonly held belief that hard wheat cannot be grown in the Willamette Valley because the climate does not allow it to develop protein levels sufficient for bread making (12% to 14% protein). Trials with hard spring wheat done by some of the farmers interviewed refuted this idea. One farmer commented:

> People say you can't raise high enough protein wheat here in the valley to make good protein. We have been successful in doing that one field, one year.

"One field, one year" speaks both to the farmer's optimism and realism, as the possibility exists but there is still uncertainty about consistency. Given that these experiments are in their infancy, it bears mentioning that the consistency of such local hard wheat's protein levels from year to year is unknown. Many factors may affect these levels, particularly weather and soil; further research and variety development is needed.

Oregon State University has continually developed different cultivars of wheat suited to successful growth in the region (Ross, 2007). While the majority are types of soft white wheat, the variety commonly grown by farmers in the Willamette Valley, within the past decade researchers have also developed cultivars of hard wheat (Peterson, 2008). Although hard spring wheat trial yields are much lower than for soft white wheat, they have demonstrated that it is possible to produce adequate protein levels (Peterson, 2008). Over time and through various factors such as farm management, selection, and soil development, these yields could increase.

Some farmers also participate collaboratively in seed development. One farmer interviewed stated that he is testing out many new varieties developed by Washington State University and other breeders, both nationally and internationally. Others have dedicated small plots of land to growing out several varieties in order to gauge their success in the local climate. One farmer interviewed is growing three new hard red wheat varieties from three distinct regions — Argentina, Washington state, and North Dakota — to look at protein levels and milling qualities. In determining the type of crops to grow in the Willamette Valley on large-scale farms, farmers will have the added task of assessing a wider variety of crops with some level of trial and error. Partnerships with universities and small and large-scale farmers, as well as with community members, will be important in developing successful seed varieties.

In order to find truly suitable wheat varieties, experimentation with growing a greater diversity of crops is important. Also important is the need to recognize that achieving standard protein levels, which Malone (2010) cites as a significant barrier to local processing, does not necessarily need to be viewed as the goal. Part of the advantage of organizing on a local level is that it allows for transparency and open communication between the producer and consumer. Farmers can account for fluctuating protein levels while consumers still find the product usable. It is innovative ideas and experimentations that will create successful new crop varieties for the Willamette Valley growing region. What is needed now is more research into growing out hard wheat varieties developed for this climate.

Organic production. The shift from conventional to organic agriculture requires changing farming techniques. Hanson, Dismukes, Chambers, Greene, and Kremen (2004) describe the steep learning curve farmers face in the conventional-to-organic transition as they learn biological pest controls, manage nutrient cycles without synthetic fertilizers, plant different crops, and supply new markets. Two major changes noted by farmers transitioning to organic edible grains were reduced use of chemical pesticides and the substitution of crop rotation in place of synthetic fertilizer. One farming couple transitioning part of their land stated:

> Conventional farmers can learn a lot more from organic farmers than we can teach them. Chemicals are not an option with them. They look at strictly keeping that plant healthy. It's just easier to spray it with a chemical pesticide and say we've done everything we can; well, we haven't. It's not the easiest thing to do.

When discussing motivations for transitioning to organic, farmers also mentioned the impact of the recent ban on field burning:

> We just can't afford the pesticide anymore. We were burning some of these fields and field burning was taken away, so we had to replace field burning with more pesticides or more crop rotation.

Burning increased yields by killing pests that conventional farmers are now treating through the use of more chemical pesticides. Farmers we spoke with also emphasized the importance of diverse organic production, with one noting:

> Diversification became important; cutting down on fertilizer and chemical use brought crop rotation into focus.

The use of crop rotation and changing farming techniques to a greater focus on soil health is a key part of organic production. Transitioning to organic production of edible grains and beans may benefit Willamette Valley grass seed farmers by decreasing costly chemical and synthetic inputs.

Establishing the best organic practices for a specific farm or field such as the correct crop rotations takes time and experimentation. What works at one farm may not work at another, as they may have different soil types supportive of different crops. One farmer noted that much of the farm's soil lacks the proper drainage to grow high-protein spring wheat, and conditions in such marginal, poorly drained land is better suited to grass seed and other crops. While wheat was the focus of the present GIS analysis, this more marginal land potentially could be used to grow other edible crops, such as barley and rye. In addition to time and experimentations, the use of GIS and soil survey data will be helpful in identifying successful rotations for specific soil types. Farmers, however, must make the choice for their individual property based on a variety of complex factors.

Cultural Transition

Interviewees drew attention to additional challenges beyond technical transitions to farming. In addition to the actual technical transitioning away from grass seed production, farmers may experience a kind of cultural shift with regard to their agricultural experiences. This shift can relate to changes in which types of crops are grown, what is perceived as being an ideal field, the scale of farming, and novel market interactions. A number of benefits may accompany this cultural change, including the expansion and diversification of markets, increased food security, enhanced support for local communities, and greater opportunities to connect directly with consumers.

Quality grass seed production has a long and dignified history in the Willamette Valley, with some farming families focused on this form of agriculture for generations. Many farmers take great pride in their weed-free green fields and large storehouses of grass seed. One farming couple we interviewed said of their acres of grass seed:

> It was kind of nice in a way if you like the green lawn/golf course look. It was like "wow, we have the world's biggest lawn." Then you think about what's really gone into it. Now the occasional weed popping up doesn't bother us at all.

This couple's statement exemplifies the changes in thought and values which many such transitioning farmers confront. They realize that the chemical fertilizers and pesticides needed to maintain the aesthetic of a weed-free field is not worth the cost and possible environmental and health consequences. However, new forms of agriculture, which may carry some risk of failure, are difficult to undertake. Learning to build soil health, plant on a smaller scale, rotate crops, and decrease pesticide use challenge many in the transitional process.

Transitions in scale require a different mindset and demand greater attention to detail. Most farmers we interviewed were accustomed to large fields, often hundreds of acres in size. Although the goal in the Willamette Valley is transitioning large amounts of acreage from grass seed to edible grain production, the process will begin with smaller acreage — 20, 50, 100 acres or 8, 20, 40 hectares, rather than thousands. In transitioning, particularly to organic production, that kind of reduction to smaller plot sizes is a dramatic change for farmers used to planting thousands of acres of grass seed. One farmer interviewed observed that farmers "are not comfortable with 10 or 20 acres at a time." Smaller scale dictates a different interaction with their crops, as each 10 or 20 acre (4 or 8 hectare) plot requires greater attention and manual input than far larger grass seed plots.

Additionally, farmers may need to change how they view the established export-focused market system. One farmer said the following about the need to reconsider marketing:

> [Marketing] locally, regionally, then internationally as opposed to now where you sell it to these big outfits that sell it to Asia and whatever you've got left you dump off locally. If you flip that around you get paid more and food security will be increased.

Growing for the local market, a farmer is diversifying his or her operation by selling through a variety of outlets, while prioritizing local markets. Transcending economics, transitioning is also about supporting the local community. Our research demonstrates that farmers could produce more grain than the Willamette Valley's population requires. While dismissing the idea of selling surplus product on the global market would be short-sighted, providing for the needs of the local community is an important consideration.

Farmers are proud of their products and of their ability to produce for a local market; to see the face of their customer represents an important ideal to many of the farmers interviewed. In the current grass seed and commodity market system, farmers have lost the connection to the final consumer of their product. One farmer reflected:

> As a grass seed producer, I miss having my customer right here. We're really quite proud of what we produce; it would be nice to see how our customer appreciates it or not. So we could adjust or whatnot. We hardly ever see the end customer, and so you don't get that satisfaction.

In grass seed farming, there simply is no real connection with the consumer. The end product belongs by contract to seed companies who ship it in bulk to clients around the globe. Similarly the soft white winter wheat currently grown in the Willamette Valley is generally exported from the Port of Portland to Asian nations for milling and processing. In a local market system the farmer can have a connection to a local bakery and its customers. The ability to associate and form human connections with the end consumer is an important motivator in the transitioning process. The son of one farmer reflected on this personal motivation for selling directly to customers:

"Knowing that you had something to do with what everyone is having for dinner is kind of cool." Connecting local farmers with consumers is viewed as one of the broader benefits of local food systems, promoting positive community engagement, connecting people to each other through shared connection to place, and thereby creating an inclusive sense of community (Feagan, 2007; Hendrickson & Heffernan, 2002; Martinez et al., 2010).

Conclusion: Transformation of Agriculture in the Willamette Valley

In order to predict the food-producing capacity of the Willamette Valley, we used GIS analysis in conjunction with interviews to highlight practical issues and provide deeper contextual information. The combination of these methods provides a robust model for planners to analyze and address local food system challenges and opportunities. Viewed alone, GIS data is disconnected from the practical issues of implementation and the culture of agriculture, and is limited by scale and complexity. Thus interviews give greater depth to the model and open a more complex dialogue about transitioning land from nonedible to edible crops for local markets. With this type of GIS research, it is imperative to include the voices and insights of individuals because they not only provide possibilities for personal investment in the research or planning, but also give a more holistic perspective on the barriers and opportunities involved.

The Willamette Valley acts as an exciting model for how communities are organizing to support the transition to a more local food system as farmers, consumers, distributors, planners, marketers, and entrepreneurs come together to promote the well-being and resilience of their community. All actors in the food system need to be involved — from farmers transitioning to growing edible grains for local consumption rather than global grass seed markets, to organizations like the Southern Willamette Valley Bean and Grain Coalition connecting farmers, to wholesalers helping develop new markets, to community members buying local grains in order to support local production. This research digs deeper into the process of building local food systems, focusing on growing staple foods for local populations and the importance of incorporating a new demographic of farmer outside the traditional direct-market, small organic producer. Thinking broadly, this research directs our focus on transitioning land by promoting large-scale farmers currently growing inedible crops to growing edible crop production for the local market, as well as looking at the role that organizations and all actors in the food system must play to make this transition possible.

This research lays out several next crucial research areas as scholars, planners, and nongovernmental and community organizations continue to create and experiment with new frameworks to build local food systems. Specifically, further research needs to be done on how to increase infrastructure, develop markets for producers, and expand community involvement. What are the most pressing infrastructure needs and what are strategic ways to meet those needs? What will be the characteristics of a local market? How can ownership and prioritization be ensured in a local market? How can we foster greater community involvement and awareness about local food systems and food security? These questions are critical in furthering local food system research. These questions and others will best be answered through interdisciplinary research that combines quantitative and qualitative methods and includes the voices of the local participants. Through models such as the one that we have presented with this case study, researchers, policy advocates, and policy-makers can partner with communities to build resilient, strong local food systems for the future.

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