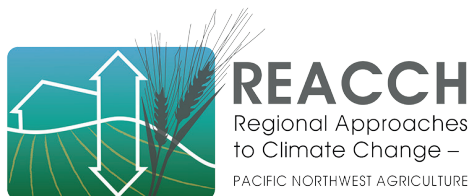


This an excerpt of

Advances in Dryland Farming in the Inland Pacific Northwest

Advances in Dryland Farming in the Inland Pacific Northwest represents a joint effort by a multi-disciplinary group of scientists from across the region over a three-year period. Together they compiled and synthesized recent research advances as well as economic and other practical considerations to support farmers as they make decisions relating to productivity, resilience, and their bottom lines.

The effort to produce this book was made possible with the support of the USDA National Institute of Food and Agriculture through the REACCH project. This six-year project aimed to enhance the sustainability of Pacific Northwest cereal systems and contribute to climate change mitigation. The project, led by the University of Idaho, also convened scientists from Washington State University, Oregon State University, the USDA Agricultural Research Service, and Boise State University.



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Chapter 12

Farm Policies and the Role for Decision Support Tools

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Abstract

This chapter provides an overview of farm policies up to the most recent 2014 Farm Bill, the expected focus of future policies, and the potential role decision support and precision agriculture tools can play in both developing and analyzing farm policies. Farm policies have often been designed to manage risk and incentivize desired management practices and will continue to do so. The defining characteristic of future policy is expected to reside around the use of spatially explicit data and decision support tools that will inform policymakers regarding the design of future farm policies and inform farmers regarding the effect farm policies will have on net returns. The same spatially explicit data will also help farmers optimize the use of inputs, reduce costs, and improve environmental outcomes. In addition, this chapter will provide a sampling of decision support tools as they relate to agricultural policies and a reference guide for additional sources for tools and resources. We then provide an example of how spatially explicit data and a decision support tool such as AgBiz Logic can be used by growers and policymakers to examine the impact on net returns of a targeted conservation policy.

Key Points

- Policy will play a key role in influencing management practices in inland Pacific Northwest grain production systems including: conservation cropping, residue and soil water management, crop rotations, and pest management.
- The influence of policy will occur through the development of risk management options, management recommendations and incentives, and the adoption of agricultural technologies.
- The use of spatially explicit data and regional impact models will likely play a larger role in the design and implementation of future farm policies.
- Precision farming tools allow for spatially explicit management and have the potential to improve sustainability of management practices.
- Decision support tools, such as AgBiz Logic, can be used by growers and policymakers to assess potential impacts a variety of agricultural policies may have on farm level net returns and profitability.

Brief History of Farm Policy (up to the 2014 Farm Bill)

Prior to 1933, the policy of the United States Department of Agriculture (USDA) was primarily directed toward on-farm support and services. Services included agricultural research projects at land grant institutions, marketing services, and Extension programs. The Great Depression and the Dust Bowl changed farm policy. During this time, farm households accounted for nearly a quarter of the US workforce and 8 percent of gross domestic product, or GDP (Dimitri et al. 2005). Farm prices were falling and farm foreclosures were on the rise. In an attempt to increase the welfare of many rural Americans, Congress passed the Agricultural Adjustment Act of 1933 in order to raise the value of crops. The act created the first income-support subsidies and production controls for basic commodities, which at that time consisted mostly of corn, wheat, cotton, rice, and dairy products. Shortly thereafter, the Agricultural Adjustment Act of 1938 created a more permanent farm bill with a built-in requirement to update it every five years and the Federal Crop

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Insurance Corporation was also created. The act was made permanent in 1949, but subsequent farm bills have regularly amended its provisions roughly every five years since then.

The various farm bills since 1949 have represented an evolution of farm policies in response to various market factors and political and social pressures of the time. This evolution is evident in the summary of the major changes in farm policies presented in Table 12-1. For example, the 1985 Farm Bill introduced a major new environmental provision: the Conservation Reserve Program. Changes in the 1996 Farm Bill eliminated deficiency payments and replaced them with production flexibility contract payments. These changes were precipitated by a gradual decrease in the reliance on Commodity Credit Corporation storage programs and more on direct payments to support commodity prices and farm incomes as well as the rising popularity of deregulation and less governmental interference (Ray 2001). The 2002 Farm Bill reinstated deficiency payments in the form of counter-cyclical payments. The 2008 bill created a new revenue support program called Average Crop Revenue Election (ACRE). The most recent 2014 Farm Bill brought about several more changes by eliminating direct payments, counter-cyclical payments, and ACRE, and replaced them with two new commodity programs aimed at risk management called Agriculture Risk Coverage (ARC) and Price Loss Coverage (Efland et al. 2014). The 2014 bill also consolidated environmental programs, expanded the crop insurance program, and tied crop insurance closer to commodity programs and conservation programs (Chite 2014; ERS n.d.). The Wildlife Habitat Incentive Program (WHIP) was combined with the Environmental Quality Incentives Program (EQIP); The Grassland Reserve Program, Wetlands Reserve Program, and Farm Ranchland Protection Program were combined into one easement program titled Agricultural Conservation Easement Program. The 2014 Farm Bill also strengthened and expanded the Federal Crop Insurance (FCI) program to include a whole farm policy, and required conservation compliance in order to receive premium subsidies. Although the features of the farm bill have changed over time, the idea of supporting income and minimizing risk for farmers and food production has remained constant.

The new farm bill also slightly increased funding for Research, Extension, and Related Matters: Title VII. Part of this funding went to establish the

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Table 12-1. Summary of key agricultural policies, 1933–2015.

Program Title	Policy Enacted
Agricultural Adjustment Act of 1933	Introduced price and income-support programs, created the Commodity Credit Corporation (CCC), and made price-support loans for designated basic storable commodities (corn, wheat, and cotton). The government also agreed to buy excess grain from farmers, which could be released in later years when bad weather affected yields.
Soil Conservation and Domestic Allotment Act of 1936	Provided for soil conservation and soil-building payments to participating farmers. First link between soil conservation and commodity programs.
Agricultural Adjustment Act of 1938	Requirement to update the farm bill every five years. Created mandatory price supports for corn, cotton, and wheat.
Federal Crop Insurance Act of 1938	Also established the Federal Crop Insurance Corporation.
Agricultural Act of 1949	Established high, fixed-price supports and acreage allotments as permanent farm policy. Programs revert to the 1949 provisions anytime a new farm bill fails to pass.
Agricultural Act of 1954	Introduced flexible price supports for basic commodities, and authorized a CCC reserve for foreign and domestic relief.
Agricultural Act of 1956.	Created the Conservation Reserve Program (CRP), and the Acreage Reserve Program (ARP) for wheat, corn, rice, cotton, peanuts, and tobacco.
Agricultural Act of 1965.	Introduced new income-support payments in combination with reduced price supports and continued supply controls.
Agriculture and Consumer Protection Act of 1973	Established target prices and deficiency payments to replace former price-support payments, and authorized disaster payments and disaster reserve inventories to alleviate distress caused by natural disaster.

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Program Title	Policy Enacted
Agricultural Adjustment Act of 1980	Amended the Food and Agriculture Act of 1977 primarily to raise the target prices of wheat and corn.
Federal Crop Insurance Act of 1980	Expanded crop insurance into a national program with the authority to cover the majority of crops.
Federal Crop Insurance Reform Act of 1994	Made participation in the crop insurance program mandatory for farmers to be eligible for deficiency payments under price-support programs, certain loans, and other benefits.
The Food Security Act of 1985	Created a Conservation Reserve Program under which the Federal Government entered into long-term retirement contracts on qualifying land.
Federal Agricultural Improvement and Reform Act of 1996	Introduced a 7-year phase-out of government income-support payments by replacing price support and supply control programs with direct payments. Repealed the mandatory participation requirement for crop insurance, but required farmers who accepted other benefits to purchase crop insurance or waive their eligibility for disaster benefits.
Farm Security and Rural Improvement Act of 2002	Brought back price supports with the Direct and Counter-cyclical Payments program (DCP). Introduced working-lands conservation payments through the Conservation Security Program (CSP).
Food, Conservation, and Energy Act of 2008	Created Supplemental Revenue Assurance (SURE) – insures against crop revenue losses and Average Crop Revenue Election (ACRE), an alternative to counter-cyclical payments.
Agricultural Act of 2014	Replaced Direct and Counter-cyclical Program, and ACRE with Price Loss Coverage (PLC) and Agriculture Risk Coverage (ARC)

For a complete description of these agricultural policies and others, see Becker (2002), Bowers et al. (1984), Dimitri et al. (2005), Limpton and Pollack (1996), Mercier (2012), O'Donoghue (2016), or Womach (2005).

Foundation for Food and Agriculture Research, which is designed to encourage public-private partnerships in research by requiring private matching funds. This slightly reduced the downward trend in public funding of research and development, but also encouraged the shift from public funding to private funding. This may increase total funding for research and development, but it also changes the research focus more towards post farm research and development and less towards productivity, efficiency, and conservation issues (Pardey et al. 2015).

Policy Impacts in the Pacific Northwest

According to the 2007 Census of Agriculture, 38% of US farms received some form of government payment. Using individual responses to the 2007 Agricultural Census, Antle and Houston (2013a; 2013b) examined the distribution of the major types of farm program payments for the wheat region of the Pacific Northwest (PNW), along with three other regions of the country. These farm programs included Direct Payments; Conservation Programs, such as the Conservation Reserve Program (CRP), Wetlands Reserve Program (WRP), Conservation Security Program (CSP), and EQIP; Market Assistance Loans; and Loan Deficiency Payments. The census does not provide information on crop insurance premium subsidies or insurance indemnity payments so these types of payments were not included in the analysis. About 44% of farms in this region received government payments from these programs. Direct payment subsidies represented about 40% of total mean government payments for most farms, and as much as 83% for some large farms (Antle and Houston 2013a; 2013b). The recent elimination of direct payments in the 2014 Farm Bill, along with current and upcoming changes in crop insurance, may significantly change the amount and distribution of farm payments. It may also play a role in the ability of farmers in the region to adopt new technologies, such as **precision agriculture** technologies, that have the potential to both improve net returns and environmental outcomes. The magnitude of the impact will depend on the extent to which changes in crop insurance subsidies compensate for the losses from direct payments (Antle and Houston 2013b).

The Center for Agricultural and Environmental Policy at Oregon State University has provided a preliminary analysis of the impacts of the most

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recent Farm Bill on California, Oregon, and Washington (Olen and Wu 2014). Most notably, for the major commodities (including small grains) and the dairy/livestock sectors, the 2014 Farm Bill ends direct payments, counter-cyclical payments, and crop revenue election programs; establishes price loss coverage and risk coverage programs; establishes margin protection programs for dairy; establishes supplemental agricultural disaster assistance programs for livestock; establishes payment limits and income caps for payments; and provides weather-related coverage for commodities not included in crop insurance policies. Farmers in the West, including wheat farmers in Oregon and Washington, will benefit from the expanded crop insurance program known as the Supplemental Coverage Option (SCO) (Olen and Wu 2014). According to the Risk Management Agency (RMA n.d.) state profiles, 77% of the wheat acreage in Oregon and 90% of the wheat acreage in Washington was insured in 2013. This is expected to increase in 2015 and 2016 as a result of the SCO. The flexibility to choose different levels of protection for irrigated and non-irrigated crops may also boost insurance usage for many crops (Olen and Wu 2014).

Agriculture also depends on support from the research programs and Extension efforts of land-grant universities. These institutions provide essential research regarding many aspects of agricultural production, such as improvements in crop varieties, food safety, environmental conservation, effectiveness of cropping systems, and short-term and long-term climate projections and their effects on crop yields and soil quality, just to name a few. The agriculture industry also depends heavily on outreach and Extension efforts such as field days and a variety of special workshops.

Better prediction of the impacts of farm policies will be possible as the analyses of farm programs are spatially downscaled. The use of farm-level decision support tools coupled with regional impacts models is needed for fine-tuning the effects on individual growers and regions, and for predicting overall participation rates in numerous federal programs. Big data initiatives will help to provide some of the data necessary to accurately assess the impact of current and future farm programs on farm welfare, sustainability, food security, and environmental outcomes. Big data refers to extremely large data sets that may be analyzed computationally to

reveal patterns, trends, and associations. The Agriculture and Technology department of The State University of New York is currently in the process of building a cloud-based big data clearinghouse for agriculture they call BRAG cloud (short for Broadband Rural Agriculture cloud). Their goal is to help farmers and others in the food industry make use of the large amount of data that is being generated from the increasing use of precision agriculture tools and strategies (Desmond 2016).

Prospects for Agricultural Policy in the Future

United States farm policies cover a wide range of objectives such as stabilizing farm income, assuring adequate nutrition, food security, and safety, and protecting the environmental. Among all these objectives, there are several possible directions for agricultural policy. It is fairly certain however, that these basic priorities will remain and that the projected expansion of the world's population along with climate change will shape future policy. With the world's population expected to grow by more than 2 billion people by 2050 (UN 2015), the stagnated yields of the world's major cereal crops (Ray et al. 2012), and the projections that climate change will have a detrimental impact on crop yields in the future (Hatfield et al. 2014), agricultural policies will need to focus on reducing waste, improving the equitable distribution of food, and increasing production efficiencies, food quality, and nutrition while managing risk and environmental outcomes. In order to feed more than 2 billion additional people under these conditions, we will need to make more efficient use of our resources.

Future agricultural policies will likely focus more on sustainable management of agricultural landscapes with an aim to maintain and improve food availability and quality while also maintaining and enhancing the natural resource base and risk management. Sustainable management will target soil quality, water quality, nitrogen (N) cycles, and greenhouse gas emission reductions including nitrous oxide (N₂O), carbon dioxide (CO₂) and methane (CH₄). These goals are evident in the current calls for climate-smart agriculture, sustainable intensification, managing agro-ecosystems to enhance ecosystem services, and land-use policies calling for land sparing or land sharing (Power 2010; Phalan et al. 2011; Garnett et al. 2013; The World Bank 2011; 2014). The current Strategic Plan for the USDA

encourages voluntary practices such as **conservation tillage**, manure and nutrient management, fertilizer efficiency, increasing energy efficiency, and developing renewable sources of energy (USDA 2014). The USDA has also established seven Regional Climate Hubs in order to deliver science-based knowledge and practical information to farmers. The information and guidelines within previous chapters are also geared toward understanding how to more effectively meet these goals and provide timely information to growers and land managers.

One way to address these concerns about sustainable management is through policies and programs that address plant breeding to increase resiliency, yields, and nutritional qualities of crops while also reducing input requirements. Genetically modifying organisms has the potential to increase crop yields, reduce herbicide and pesticide use (Klümper and Qaim 2014), as well as increase shelf life, vitamin content, and resistance to diseases (NAS 2016). The debate over genetically modified organisms (GMOs) and the strict regulations in some countries concerning them, may hinder this mode. However, there are new plant breeding techniques that use genome editing which may potentially be more acceptable to consumers (Hartung and Schiemann 2014). Genome editing allows breeders to determine if a plant will have the desired characteristics before the plant is fully mature. It is a much quicker process that imitates the traditional mutation process of conventional breeding. Unlike GMO techniques that introduce genes that do not arise naturally in the species into a plant's DNA, genome editing allows breeders to develop plants that do not differ in any way from a plant whose genome was altered through breeding (Rosch 2016). Hartung and Schiemann (2014) and the National Academies of Sciences (2016) argue that new plant varieties should be regulated based on novel characteristics and hazards rather than the technique used to create it. Current policy in the US is product-based in theory, but the USDA and the Environmental Protection Agency determine which plants to regulate at least partially on the process by which they are developed (NAS 2016). We view this as an emerging field that agricultural policy will grapple with in the near future as more varieties are developed using genome editing.

Another way to meet these goals is by closely linking commodities, crop insurance, and environmental conservation programs and by designing

targeted agricultural policies that will strengthen the farm financial safety net. The next farm bill may introduce hybrid conservation-risk policies that incorporate counter-cyclical and risk components of current farm programs and crop insurance (Coppess 2016). Currently, crop insurance has links to commodity programs, but these two programs work mostly independent of conservation programs. By linking these policies, there should be less adverse consequences from policies that target only one goal. As a move in this direction, the USDA plans to expand crop insurance availability and product coverage, and to use geographical information systems, remote sensing, precision agriculture and data mining, to improve crop insurance products and rapidly assess damage (USDA 2014). A Working Landscapes Initiative, regarding conservation and crop insurance advocated by the Meridian Institute, is also supporting a policy move in this direction (AGree 2016). This initiative supports several research and advocacy efforts to assess the correlation between soil type and yield risk; update the USDA's data collection system to increase the efficiency of data collection and integration of data and reduce respondent burden; and initiate changes in crop insurance that will support innovation and conservation. These initiatives will require gathering spatially explicit data. Until recently, designing targeted agricultural policies was virtually impossible on a large scale due to lack of data and the cost of obtaining it. However, advances in technology and data management have begun to make processing large quantities of spatially explicit climatic, geographic, and economic data possible and affordable. (For more detail about data and precision agriculture, see Chapter 8: Precision Agriculture.) Privacy and confidentiality concerns regarding such data gathering and sharing have been a concern of many farmers and commodity organizations (AGree 2014). In response, the American Farm Bureau together with a consortium of farmer organizations and agriculture data technology providers, is developing data privacy and security principles in order to ensure that data not be misused (Plume 2014). For a larger discussion on the use of big data for agro-environmental policies, see Antle et al. (2015).

Climate initiatives will also frame future agricultural policies. The USDA Building Blocks for Climate-Smart Agriculture and Forestry: Implementation Plan and Progress Report (USDA 2016) provides details regarding the USDA's framework for helping farmers, ranchers, and forestland owners respond to climate change. The framework will work

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within many existing conservation programs such as EQIP and CRP, and make them more flexible to unique conditions on farms in different parts of the country. The plan also focuses on soil quality to increase organic matter and improve microbial activity. This will sequester more carbon, which will have several benefits beyond the reduction of greenhouse gases, such as improved water management, improved wildlife and pollinator habitat, as well as improved yields. The USDA also established a Soil Health Division at the Natural Resources Conservation Service (NRCS) in 2015, to focus on providing financial and technical assistance to farmers to implement conservation practices such as tillage management, **cover crops**, and grassed waterways. Additionally, 'sensitive lands' will be identified and NRCS will target owners of this land and encourage the adoption of conservation systems using financial and technical assistance incentives.

Future policies will likely take advantage of 'big data' to design spatially explicit policies to enhance the efficiency and reduce the cost of farm programs such as crop insurance subsidies, which are expected to increase substantially in the next ten years and to outpace spending on traditional commodity programs by about one-third (Shields 2010). An example of a policy that could benefit from a more targeted approach would be the requirements in the 2014 Farm Bill which states that farmers must practice soil and water conservation measures on vulnerable lands in exchange for receiving subsidies for crop insurance premiums. Having spatial information about the effectiveness of various practices at specific locations would allow policymakers to target highly sensitive parcels and provide landowners with information necessary to make informed decisions at the farm level to maximize net returns and minimize environmental impacts. Landowners with highly sensitive parcels of land could then be incentivized to adopt specific conservation practices on these lands by offering larger subsidies or lower crop insurance premiums for farmers with the most effective conservation outcomes, sometimes referred to as precision conservation. This would increase the efficiency by increasing enrollment of highly sensitive lands, and possibly reduce the subsidy payments for less sensitive land, improve the environmental benefits, and reduce the social cost of achieving the environmental benefits. Thus, we foresee a movement toward a more spatially oriented form of policy that is more efficient and better able to meet both the needs of growers and policymakers by providing risk

management while also emphasizing sustainability. We also note, however, that better data and targeted approaches that are parcel-specific may not be applicable for all conservation strategies, especially ones that require conservation efforts across large areas of land encompassing many different landowners and land uses.

Additional Sources of Information for Farm Policies

Farm policies are constantly changing and it is often difficult to find current information regarding farm policies and what they mean at the farm level. This section does not provide specific information on current farm policies due to the changing nature of policies. However, we provide several sources for obtaining information about current policies as well as sources that analyze current or proposed policies.

United States Department of Agriculture

<http://www.usda.gov/wps/portal/usda/usdahome?navid=farmbill>

The most current information about the current farm bill can be obtained from the United States Department of Agriculture's (USDA) website for the farm bill. This page also contains links to the latest farm bill news and blogs.

National Agricultural Law Center

<http://nationalaglawcenter.org/farmbills/>

The National Agricultural Law Center provides a complete list of web links to both current and historical farm bills as well as Congressional Research Service reports related to farm bills and agricultural programs.

Farm Services Agency

<http://www.fsa.usda.gov/programs-and-services/farm-bill/index>

<http://www.fsa.usda.gov/programs-and-services/index>

The Farm Services Agency (FSA) within the USDA also provides information about the farm bill. This site provides highlights of the farm bill as well as specific information on various policies. Individuals can sign

up to receive email updates on a regular basis. A listing of all Programs and Services offered by the Farm Service Agency such as Farm Loan Programs and Price-Support Programs is also provided on this page.

Economic Research Service

<http://www.ers.usda.gov/topics/farm-economy/farm-commodity-policy.aspx>

The Economic Research Service (ERS), which is also part of USDA, has a webpage for Farm & Commodity Policy. This page covers evolving farm and commodity policies. Often new farm bills extend, revise, and replace provisions of previous farm bills. In other cases, provisions of a new farm bill extend, revise, and replace language in laws regulating areas that overlap farm bill authorities, including food and nutrition, food safety, trade, credit, research and Extension, forestry, food safety, organic production, pesticides, and crop insurance. Details on farm bill provisions and related legislation are available at this site as well as reports and articles that analyze the impacts and implications of these policies.

National Association of Wheat Growers

<http://www.wheatworld.org/>

National Association of Wheat Growers provides weekly news updates on activities and policies that directly impact wheat producers.

OreCal

<http://oregonstate.edu/caep/>

<http://aic.ucdavis.edu/>

OreCal publishes briefs as a collaboration between the Center for Agricultural & Environmental Policy at Oregon State University and the University of California Agricultural Issues Center at UC Davis. Their mission is to improve public and private decision making by providing objective economic analysis of critical public policy issues concerning agriculture, natural resources, food systems, and the environment, with an emphasis on the western United States.

Center on Budget and Policy Priorities

<http://www.cbpp.org/research>

The Center on Budget and Policy Priorities is a research and policy institute that analyzes federal budget priorities.

Farm Policy Facts

<http://www.farmpolicyfacts.org/about-farm-policy-facts/>

Farm Policy Facts is a coalition of farmers and commodity groups created to educate Congress about the importance of agriculture and to ensure farmers have a voice in the legislative process.

Decision Tools for Sustainable or Climate-Smart Agriculture

The projected impacts of alternative farm policies are dependent upon who adopts the policy changes or who agrees to participate in the new or revised policies. For example, if only 10% of eligible farms are enrolled in a given policy in a specific area, the impacts will be quite different than if there is 90% participation. Often times, policy analysts make assumptions about the level of participation or adoption that may not reflect the actual behavior of farmers in the area. These projections may be significantly off base, especially regarding policies that require substantial changes to existing practices. Without a tool that farmers can use to project or explore the advantages of changing their management practices, and without some means to communicate the resulting changes in net returns to research and policy community, there is little information to guide adoption decisions and little information to make informed ex-ante participation rates projections for proposed policy or policy changes. For example, recent changes in the 2014 Farm Bill have expanded crop insurance and eliminated direct payments, which could lead to marginal lands being brought into production due to the absence of risk. Decision support tools that examine effects of these programs on farm-level decisions and net returns could be used to examine the extent to which this would be true, and to target or adjust problematic areas of the policy.

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Being able to make informed decisions at the farm scale is essential to enhancing and expanding sustainable and climate-smart agriculture. Without information that is readily accessible to farmers on the farm-level economic costs and returns of taking certain actions farmers may be reluctant to take those actions (GAO 2014). With this in mind, the USDA is working to provide this type of information to farmers, and the regional climate hubs will be a clearing house for supporting, collecting, and disseminating this type of information.

The advent of mobile computing and communication devices has enhanced our ability to make these informed decisions (Antle et al. 2015). Therefore, it is critical that farmers and land managers have access to decision support tools that will allow them to make more efficient use of inputs and capital and better analyze outcomes and tradeoffs of alternative management pathways. Many farm-level data and decision tools from private and public sources are currently in use and are developing rapidly (Antle et al. 2015). These tools can help farmers better understand the likely impacts external factors, such as changing weather patterns, long-term climate projections, and agricultural policies, could have on the sustainability of their operations. They can also help farmers track and understand the spatial variability on their farms, which can lead to greater efficient use of inputs and enhance the economic and environmental sustainability of their farm.

Presented here is a small sampling of tools and resources that can aid farmers in informed decision making regarding the economic implications of various farm bill policies, daily and long-term management options, as well as enhancing the ability to track and monitor spatial variations in fields which is necessary for efficient allocation of inputs. The reader should be aware that this is not a comprehensive list of tools, nor is it an endorsement of these tools, rather it is a compilation of resources that are available, and some may be more appropriate for individual applications than others. The reader should be aware of that. The decision tools discussed in this section provide users with likely changes in directions and relative magnitudes of key outcomes and indicators. Thus, many of these tools are most useful from a comparative or relative perspective and are not intended as prescriptive recommendations.

Policy Tools and Resources

National Association of Agricultural and Food Policy

<https://usda.afpc.tamu.edu/>

Several departments within the USDA provide tools and resource aids to farmers. For example, the National Association of Agricultural and Food Policy has developed several tools to better understand the economic implications of choices under the 2014 Farm Bill. The suite of integrated tools is designed to help farmers make the choices required for participation in the 2014 Farm Bill and for choices available under crop insurance.

Natural Resource Conservation Service

<http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/technical/tools/>

The NRCS also has a suite of tools and resources available to farmers. This site offers links to information, tools, and technical assistance regarding climate change, energy use, cover crops, nutrient management, and many other resources. In the economic tools section for example, there are links to tools in information about general conservation planning, watershed protection, general economic planning, financial functions, investments and retirement, etc. Each link also has a contact person so individuals can quickly email knowledgeable personnel regarding questions they may encounter while researching the tools and resources provided.

Cover Crop Economics Tool

<http://www.conservationwebinars.net/webinars/cover-crop-economics-decision-support-tool>

An example of one of the tools offered on the NRCS website that would be particularly useful tool for wheat growers in the PNW considering incorporating cover crops into their rotation is the Cover Crop Economics Tool. This is a spreadsheet that measures direct nutrient credits, input reductions, yield increases and decreases, seed and establishment costs, erosion reductions, grazing opportunities, overall soil fertility levels, and

water storage and **infiltration** improvements. The tool focuses on monetary benefits and costs. Though there are many benefits to cover crops, they may not always be cost effective in the short run. This tool helps the farmer determine if a cover crop makes sense for their individual situation.

Web Soil Survey (3.1) Tool.

<http://websoilsurvey.sc.egov.usda.gov>

Another useful tool for planning is the Web Soil Survey (3.1) tool. This tool can be used for general farm, local, and wider area planning by providing maps and tables of soil property data and information. The information is downloadable for use in a local geographic information system. It will also generate a custom soil survey report for any selected area.

Energy Estimators

Other useful tools that estimate economic gains or losses from farm activities include:

Energy Estimator for Irrigation

<http://ipat.sc.egov.usda.gov>

The Energy Estimator for Irrigation which estimates potential energy savings associated with pumping water for irrigation.

Energy Estimator for Nitrogen

<http://nfat.sc.egov.usda.gov>

The Energy Estimator for Nitrogen which calculates the potential cost-savings related to N use on a farm or ranch.

Energy Estimator for Tillage

<http://ecat.sc.egov.usda.gov>

The Energy Estimator for Tillage which estimates diesel fuel use and costs in the production of key crops in a region and compares potential energy savings between conventional tillage and alternative tillage systems.

Other commonly used NRCS tools can be accessed at:

<http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/programs/?cid=STELPRDB1261051>

Decision Support Tools Developed and Assembled by the Regional Approaches to Climate Change Project

<https://www.reacchpna.org/tools>

The decision support tools assembled on the Regional Approached to Climate Change (REACCH) website have been developed based on specific needs faced by dryland cereal farmers in the PNW. Below is a sampling of some of the tools currently available.

- Wireworm Identification Tool—this tool helps identify the species of wireworms in your field.
- Aphid Tracker Map and Aphid Tracker Calculators—interactive maps and aphid calculators are designed to help manage for aphids and aphid viruses in cool season legumes.
- Weather and Winter Wheat Yield—this tool allows the user to visualize year-to-year variability in winter wheat yields for Oregon, Washington, and Idaho over the past three decades and its relationship to variability in climate.
- A variety of climate and weather tools allow users to explore past climate, short-term forecasts and long-term projections for specific locations, these include:
 - ◆ Climate Dashboard
 - ◆ Climate Projections
 - ◆ Seasonal Climate Forecasts
 - ◆ Climate Historical Averages
 - ◆ USDA Plant Hardiness Zone Maps

AgWeatherNet

<http://www.weather.wsu.edu/>

This website provides access to current and historical weather data from Washington State University's automated weather station network along with a range of models and decision aids. Weather variables include air

temperature, relative humidity, dew point temperature, soil temperature at 8 inches, precipitation, wind speed, wind direction, solar radiation, and leaf wetness. Some stations also measure atmospheric pressure. These variables are recorded every 5 seconds and summarized every 15 minutes by a data logger.

Precision Farming Tools

With the recent proliferation of spatially oriented technologies and data processing, the use of precision agriculture technologies is on the rise, but not all farming locations can take full advantage of these technologies due to lack of broadband data services. The Palouse area, for example, has historically been a difficult region to secure effective broadband coverage due to the terrain. This is partly why President Obama signed an Executive Order in 2012 to make broadband construction along federal roadways and properties up to 90% cheaper and more efficient. Additionally, the Precision Farming Act of 2016 was introduced to help expand the adoption of precision agriculture by providing funding for the expansion of broadband infrastructure and services to cover rural areas. If this act or some variation of this act is passed, more farmers in rural areas will be able to take advantage of precision agriculture technologies that require the use of broadband services to guide tractors, manage data, and access mobile apps.

Precision farming techniques will also help farmers adapt to policies that will likely result from recent initiatives focused on climate-smart agriculture, sustainability, spatially explicit management such as precision conservation, risk management, and environmental policies. Tools such as variable rate technology, unmanned aerial vehicles, and global positioning systems (GPS) will allow farmers to be more precise in their input use, thus benefitting quality and yield outcomes and environmental impacts. For example, variable rate technology can automatically adjust seeding, spraying, and spreading based on such variables as slope, soil texture and moisture content. It can be either map-based or sensor-based; unmanned aerial vehicles can fly over fields and inform farmers about the spatial differences in their fields regarding N needs on specific areas of their fields, or the extent of weeds or insect damage in certain zones; and GPS can enable farmers to geo-reference trouble spots in fields or

to guide machinery for more precise tillage and application of seeds and sprays.

Large agricultural and chemical companies such as Monsanto, DuPont, and John Deere have been investing heavily in precision agriculture technologies. For example, Monsanto has developed a system which provides field-by-field recommendations for ways to increase yield, optimize inputs and enhance sustainability, as well as an iPad app that combines historical yield data, satellite imagery, field information about soil and moisture, and plant varieties to make customized variable rate seeding prescriptions for individual fields in order to maximize yield potential on a field-by-field basis. Similarly, DuPont has also developed software to help growers make informed management decisions. Their software combines current and historical field data with real-time agronomic information. They have also developed an app for taking field notes and photos with GPS tags to track field agronomic status. Likewise, John Deere has also invested in the development of GPS guidance and variable rate application systems that help control input costs.

Smartphone Apps for Agriculture

There are numerous smartphone apps for agriculture that range from storm and frost alarm weather apps to weed identification apps. A few sources for farm apps are AgWebAppFinder, Farms.com, and Croplife.com. These sites have application directories that allow users to search for apps by key word. The AgWebAppFinder site also has an Editor's Best and Highest Rated tab to help you find useful apps. Croplife.com and AgWebAppFinder also post periodic reviews of farm apps.

AgWebAppFinder

<http://www.AgWebAppFinder.com>

Farms.com

<http://www.farms.com/agriculture-apps/>

Croplife.com

<http://www.croplife.com>

Fertilizer and Spray Application Decision Tools

Washington State University Fertilizer Application Tools

<http://wheattools.wsu.edu/Applications/Fertilizer%20Use%20Calculator/>

Nitrogen fertilizer represents a significant portion of input costs. Overuse of N also contributes to air and water pollution. Therefore, it is important to be able to accurately evaluate the need for fertilizer on a variety of different terrains and soil types. Washington State University has two fertilizer application tools, one is an N calculator and the other is a post-harvest calculator.

Nitrogen Index App

<https://play.google.com/store/apps/details?id=gov.usda.ars.spnr.driver&hl=en>

This tool can be used to assess the potential risk of N losses associated with a given set of management practices. Users can evaluate how changes in management can reduce the potential risk of nitrate leaching.

The Nitrogen Index for desktop and laptop computers is also available for download at the USDA-ARS Soil Plant Nutrient Research Unit website: *<http://www.ars.usda.gov/npa/spnr/nitrogentools>*.

Aphid Calculator

See the section on REACCH decision support tools above.

Greenhouse Gas Tools

Agriculture in the United States produces about 9% of total US greenhouse gas emissions (EPA n.d.). With growing concerns about climate change and the push for either a carbon market or a carbon tax, carbon calculators will be useful tools for analyzing sources of on-farm emissions that will allow producers to determine sources of emissions on their farm as well as possible sequestration options. NRCS has developed three carbon planning tools: COMET-Farm, COMET-Planner and COMET-Energy.

COMET-Farm

<http://www.comet-farm.com>

COMET-Farm calculates farm-scale greenhouse gas emissions and carbon sequestration associated with farm management practices and strategies. It allows producers to evaluate alternative management strategies and the associated impact on greenhouse gas emissions and carbon sequestration. The user inputs site-specific management data, and then site-specific soil and climate data is used to generate reports that compare current greenhouse gas emissions with emissions from alternative management scenarios that are accurate estimates tailored to an individual's specific situation. It is applicable to all agricultural lands in the lower 48 states.

COMET-Planner and COMET Energy

COMET-Planner and COMET Energy evaluate potential carbon sequestration and greenhouse gas reductions from adopting NRCS conservation practices and reductions in greenhouse gas emissions based on anticipated fuel savings.

For an overview and comparison of more than 30 publicly accessible carbon calculator tools for the agriculture and forestry sectors, see Deneff et al. (2012).

Crop Simulation/Yield Tools

The crop simulation and yield tools consist primarily of agronomic relationships among key biophysical factors and management inputs. For the most part, they do not explicitly incorporate economic variables or optimization algorithms and approaches. These tools are essential for building economic tools that require changes in projected yields associated with policy, weather, and management changes.

Decision Support for Agro-Technology Transfer

<http://dssat.net/>

Decision Support for Agro-Technology Transfer (DSSAT) is a crop simulation model that has been in use for over 20 years, developed through

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a collaboration of scientists at the University of Florida, University of Georgia, University of Guelph, University of Hawaii, the International Center for Soil Fertility and Agricultural Development, USDA-Agricultural Research Service, Universidad Politecnica de Madrid, Washington State University, and other scientists associated with the International Consortium for Agricultural Systems Applications. The simulated yields are based on site-specific daily weather data, soil characteristics, and crop management activities. The tool is used to evaluate how changes in crop characteristics, management and environmental conditions may impact crop yields.

Kansas Wheat Yield Calculator

<https://itunes.apple.com/us/app/kansas-wheat-yield-calculator/id925624508?mt=8>

The Kansas Wheat Yield Calculator is a phone app developed by the Kansas Wheat Commission and allows growers to estimate potential wheat yields by collecting information about wheat fields to assess potential yield ahead of harvest.

CropSyst

http://modeling.bsye.wsu.edu/CS_Suite/CropSyst/index.html

CropSyst is a user-friendly, multi-year, multi-crop daily time step simulation model. The model simulates the soil water budget, soil-plant N budget, crop canopy and root growth, dry matter production, yield, residue production and decomposition, and erosion. Management options include cultivar selection, crop rotation (including fallow years), irrigation, N fertilization, tillage operations (over 80 options), and residue management. The model is designed to be an analytic tool to study the effect of cropping systems management on productivity and the environment.

Whole Farm Assessment Tools

Whole farm assessment tools address impacts and tradeoffs at the farm scale rather than on a field-by-field basis. These are more complex tools

that capture the scale and complementarities inherent in farm-level planning, and, for the most part, allow for tradeoffs among operations. For example, we describe two whole farm assessment tools here: AgBalance™ and AgBiz Logic™.

AgBalance

AgBalance is an assessment tool designed by BASF Corporation to analyze agricultural practices on the farm and throughout the chain of production. It is based on environmental, economic, and social indicators that are aimed at helping producers balance demand with sustainable production. It can be used to assess current agricultural practices, identify areas for potential improvements, assess the impact of regulations on products and farming practices, and demonstrate the relationship between farming practices and biodiversity or resource consumption. Findings from this process can be presented to policymakers and partners throughout the food production chain.

AgBiz Logic

AgBiz Logic developed at Oregon State University (with support from REACCH, the Northwest Climate Hub, and a USDA-SCRI grant) consists of several modules: AgBizProfit, AgBizLease, AgBizFinance, AgBizClimate, and AgBizEnvironment (Figure 12-1). The modules are designed help growers assess operational investment choices to make profitable decisions. AgBizProfit can help make short-, medium-, and long-run investment decisions based on profitability. AgBizLease can help establish equitable short- and long-run crop share and cash rent payment leases based on each party's contributions to the lease. AgBizFinance can assist in making long-run decisions on a whole farm and ranch basis based on financial ratios and performance measures. AgBizClimate and AgBizEnvironment (both under development) will incorporate climatic projections and environmental considerations into the decision-making process.

Using a Whole Farm Assessment Tool to Evaluate Tradeoffs

In this section we use AgBiz Logic to illustrate how whole farm decision support tools can be used to evaluate farm-level decisions related to

The AgBiz Logic™ Platform

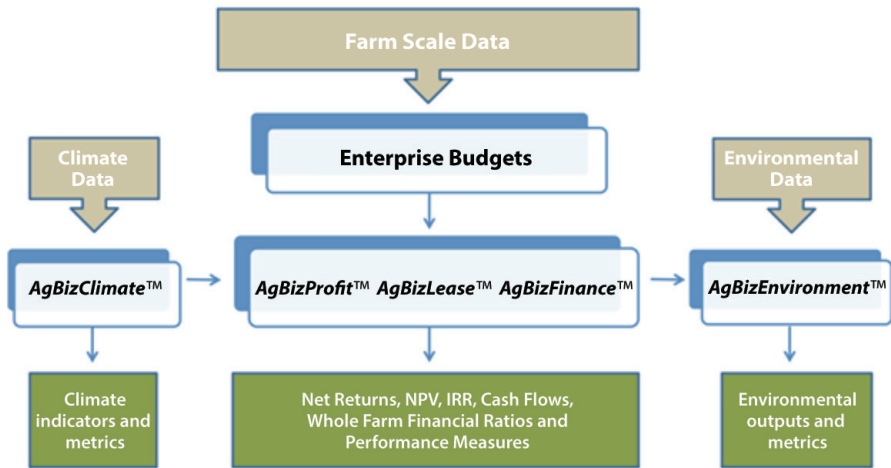


Figure 12-1. AgBiz Logic platform. (NPV = net present value; IRR = internal rate of return.)

agricultural policies and related investment decisions. As mentioned earlier, requirements in the 2014 Farm Bill state that farmers must practice soil and water conservation measures on vulnerable lands in exchange for receiving subsidies for crop insurance premiums. There is also a movement towards more targeted farm policies. Let's assume, then, that in the future, NRCS will be able to offer farms with highly vulnerable land a higher subsidy for crop insurance premiums if they enroll those lands in CRP or some other conservation program. We will illustrate how farmers can use AgBiz Logic to determine if it makes economic sense for their operation to target their conservation efforts.

What follows is an example of a hypothetical case study using the mid-Columbia region of Umatilla County, Oregon, to examine the impacts on profitability and feasibility of alternative cropping systems on leased land when considering precision conservation practices. (In other words, can a grower make money in an investment and does the grower have the financial resources to implement the decision?) We will first present an example of how the AgBizProfit module can be used to evaluate the profitability of various cropping systems using precision conservation. Then we show how AgBizLease can determine if current lease arrangements are equitable given the changes in cropping systems

AgBiz Logic Platform

<http://www.agbizlogic.com/>

AgBiz Logic consists of the following economic and financial calculators:

AgBizProfit is a capital investment tool that evaluates an array of short-, medium-, and long-term investments. The module uses the economic concepts of net present value, annual equivalence, and internal rate of return to analyze the potential profitability of a given investment.

AgBizLease is designed to help agricultural producers establish equitable short- and long-run crop, livestock and other capital investment leases. The module uses the economic concept of net present value to analyze an equitable crop share or cash rent lease for a tenant and landowner.

AgBizFinance is designed to help agricultural producers make investment decisions based on financial liquidity, solvency, profitability, and efficiency of the farm or ranch business. After an AgBizFinance analysis has been created, investments in technology, conservation practices, value-added processes, or changes to cropping systems or livestock enterprises can be added to or deleted from the current farm and ranch operation. Changes to a business's financial ratios and performance measures are also calculated.

AgBizClimate (under development at the time of this publication) delivers essential information about climate change to farmers and land managers that can be incorporated into projections about future net returns, via changes in expected yields. By using data unique to their specific farming operations, growers can develop management pathways that best fit their operations and increase net returns under alternative climate scenarios.

AgBizEnvironment (under development at the time of this publication) uses environmental models and other ecological accounting to quantify changes in environmental outcomes such as erosion, soil loss, soil carbon sequestration, and greenhouse gas emissions resulting in the ability to incorporate on-farm and off-farm environmental outcomes into the decision support software and platform.

and, if not, what would make a lease equitable and how AgBizFinance can be used to evaluate the feasibility of working capital and solvency when investing in the new equipment and technologies. We then examine the tradeoffs that the farm manager must weigh when making precision agriculture and precision conservation decisions.

Initial setup

In this hypothetical example the farm operation is a representative 2,000-acre dryland farm growing annual crops in a region that receives between 18 to 24 inches of precipitation annually. In keeping with common practice, the producer uses a winter wheat, spring barley, and dry pea crop rotation that includes **direct seeding** to conserve soil moisture, increase yields, reduce soil erosion, and reduce fuel usage. The farm's average yields for winter wheat are 104.5 bushels of winter wheat, 1.8 tons of spring barley, and 1,900 pounds of dry peas per acre. Approximately 867 acres are leased and the farm operator owns the remaining acres. The land lease is based on the landowner receiving 1/4 of the crop and paying 1/4 of the weed control, fertilizer, and crop insurance costs (hail, fire, and crop revenue coverage) and 100% of the property insurance and taxes.

On the 867 acres of leased land the farmer has 307 acres that are identified as highly vulnerable and qualifies the farmer and landowner to receive the higher crop insurance premium subsidy offered for highly vulnerable land areas. The soil on much of this acreage is very cobbly loam, consisting of 45% sand, 43% silt, and 12% clay with 1–7% slope; other vulnerable soils are heavy clays that are extremely saturated in years with above average moisture, which greatly reduces yields (Figure 12-2). Note that this type of soil information can be obtained for any parcel of land from the Web Soil Survey Tool developed by NRCS. Due to the soil quality on these acres, crop yields are generally about 15% lower than average yields for the rest of the farm.

Before the farmers decide to enroll these acres in the conservation program, they will want to examine the cost of investing in precision agriculture equipment that will be necessary for this targeted conservation as well as the impact on net returns. In this example, the initial costs to the tenant for the GPS technologies is assumed to be \$25,000, with a 5-year life and a maintenance cost of 2% of the initial cost, resulting in \$2.75 per acre

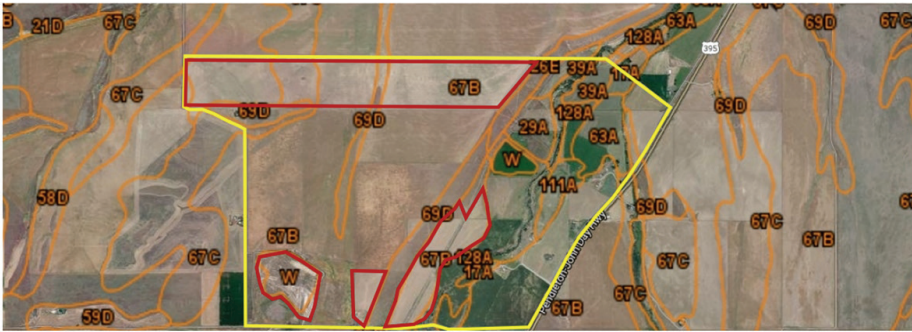


Figure 12-2. Aerial view of the rented land, within the yellow boundary line. Thirty-five percent (or 307 acres) of the leased land that qualifies as highly vulnerable land, within each of the four red boundary lines. The majority of the vulnerable soils are very cobbly loam, consisting of 45% sand, 43% silt, and 12% clay with 1–7% slope. The other vulnerable soils are heavy clays that are extremely saturated in years with above average moisture, which greatly reduces yields.

for all acres on the farm. The landowner has agreed to pay \$1,700 for the upfront costs to establish the conservation practices, and the tenant pays the annual costs to maintain the land of \$52.

To make a fully informed decision, the landowner and the tenant will want to examine the impacts on the lease arrangement to determine if the current 1/4 crop share lease to the landowner is equitable if the additional land is taken out of production, as well as examine financial feasibility of investing in the new equipment necessary for each scenario. With this information, they can then determine how much of a premium would be needed to compensate for taking land out of production. To do this, the farm operator would initially use the AgBizProfit module to analyze this precision conservation investment strategy based on three options.

The first option is to continue with the current situation of winter wheat, spring barley, and dry peas. The other two options require the farmer to purchase precision agriculture technology such as a GPS guidance and yield mapping systems. Option two is to plant less valuable crops such as canola and camelina on the vulnerable acreage that has lower yielding soils. These crops generally result in lower returns but also have less input costs and have the added benefit of diversifying the crop mix to include bioenergy crops. The third option is to implement a long-term conservation plan of a CRP-type planting. Options two and three require the farmer to purchase precision agriculture technology such as

GPS guidance and yield mapping systems. The next step would be to use AgBizLease to analyze the most profitable cropping strategy to determine how the lease arrangement might change based on the costs of new technology and alternative crops. Then an AgBizFinance analysis can be used to determine if required investments for options two or three can be implemented and funded from annual cash flows or must be financed with a loan. Finally, the results from the analysis can be used by the farmer to examine the tradeoffs involved in each decision and make a fully informed decision.

Data needs

Data needs for AgBizProfit: To use precision farming techniques effectively, it is essential that the producer generate profit and loss maps on a field-by-field basis. This would include identifying the higher and lower yielding areas of a field as well as any variation in production input costs associated with the fluctuating yields. Profit and loss maps generally provide net returns over and above fixed costs. Overlaying the maps of net returns to NRCS soil maps could also validate the variation in yields and profits by soil characteristics, thus illustrating the potential economic benefits of changing cropping systems and purchasing precision farming technologies.

The next set of data includes establishing projected yields for winter wheat, spring barley, and dry peas planted on the higher productive areas of the field as well as the canola and camelina planted on marginally productive soils and any associated production input cost differences. The final set of data required for an AgBizProfit analysis are the costs to establish and maintain the conservation planting on the 307 acres identified as highly vulnerable.

Data Needs for AgBizLease: Equitable land leases are usually calculated based on the cost contributions of the tenant and landowner to the lease. As with the current crop share lease, it is assumed that the tenant provides 3/4 of the costs (labor, machinery, production inputs, etc.) and the landowner 1/4, which includes any production inputs, a reasonable return to the market value of the land, property taxes, insurance, etc. The data required for this analysis are any changes in costs by the tenant and landowner when considering either option two or three.

Data Needs for AgBizFinance: The requirements to conduct a whole farm analysis include balance sheet information, principal and interest payments on current loans (short-, medium-, and long-term), capital leases, and family withdrawals from the business. The outcomes from a whole farm analysis varies greatly by the amount of working capital in the year of the decision, how much farm equity is the owner's versus the lender's, and the anticipated net income from the future investment.

The Informed Decision

Output regarding changes in net returns, the tenant and landowner contributions to total costs, as well as debt-to asset ratios and working capital generated from the AgBiz Logic tool can now be used to make a fully informed financial decision regarding these options. Output regarding differences in net returns as well as the contributions to total costs by the landowner and tenant from our hypothetical example are presented in Table 12-2.

The current lease for Option 2 may not need to be adjusted. However, due to the considerable shift in the landowner's and tenant's contributions of total costs, adjustments to the lease arrangement may be desired in Option 3. An issue with changing lease arrangements is the willingness of the landowner and tenant to modify the current lease. In order to agree to changes in the agreement, there is an education effort that needs to take place so that each party understands and feels comfortable with the reasons behind the changes in input costs and crop returns.

Once it is determined that a particular option such as Option 2 or Option 3 is profitable, the next consideration is to determine if it is financially feasible. The AgBizFinance module is designed to make comparisons of the changes to working capital and debt-to-asset ratios for each option which can then provide the necessary information for a financial decision. Even without examining a specific financial scenario for this hypothetical scenario, it is likely that the tenant could be able to pay for the additional GPS technology from annual cash flows from the entire farm under either option. Therefore, the deciding factor would be determined by the size of the premium subsidy.

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Table 12-2. Pertinent Information from the AgBiz Logic modules (AgBizProfit and AgBizLease).

	Option 1	Option 2	Option 3
	Current	Add Canola + Camelina	Add Conservation
Crop Planted	Acres Planted		
Wheat	434	280.0	280
Dry Peas	217	140.0	140
Spring Barley	217	140.0	140
Canola	—	153.5	—
Camelina	—	153.5	—
Total Acres Planted	867	867	560
Tenants Net Returns	\$102,280	\$106,286	\$75,097
NR (Opt 2-Opt 1)		\$4,006	
NR (Opt 3-Opt 1)			-\$27,183
NR (Opt 3-Opt 2)			-\$31,189
Lease Information			
Tenant's Costs	\$190,659	\$174,007	\$118,744
Landowner's Share of Costs	25%	26%	34%
Tenant's Share of Costs	75%	74%	66%

Conclusion

Decision support tools, such as AgBiz Logic, and other tools that utilize spatially explicit data will likely help shape future agricultural policies. Such tools will aid in the design of policies that address risk management as well as encourage adoption of technology and management options that enhance sustainable climate smart agriculture. Many of these tools can be used by both growers and policymakers to assess potential impacts at the farm and regional landscape scales for a variety of agricultural policies. These policies may influence management practices in inland PNW grain production systems such as conservation cropping, residue and soil water management, crop rotations, and pest management—all of which have the potential to improve crop production and environmental outcomes.

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