A decision support tool for optimizing integration of specialty crop enterprises in grain production systems

Hoagland L\textsuperscript{1}, Hodges L\textsuperscript{2}, Brandle JR\textsuperscript{3}, Helmers GA\textsuperscript{4}, Francis C\textsuperscript{2}

\textsuperscript{1}Department of Horticulture and Landscape Architecture, Purdue University, 625 Agriculture Mall Dr., West Lafayette, IN 47907 USA; lhoaglan@purdue.edu
\textsuperscript{2}Department of Agronomy and Horticulure, University of Nebraska-Lincoln, USA
\textsuperscript{3}Department of Natural Resources Sciences, University of Nebraska-Lincoln, USA
\textsuperscript{4}Department of Agricultural Economics, University of Nebraska-Lincoln, USA

Keywords: sustainability, livestock, cabbage, woody florals

Introduction

Agricultural production in the Midwestern US is highly concentrated with 85% percent of cropland acreage planted to only corn and soybeans (NASS, 2006). Crop specialization has improved the productivity and market efficiency of grain based commodity crops, but maintaining profitability has become increasingly difficult as input prices continue to rise while grain prices fluctuate substantially (Dimitri et al., 2005). In addition, limited diversity has resulted in a number of negative environmental and social consequences. Diversification is one alternative to help farming operations become more sustainable and survive in today's unpredictable climate. Crop diversification and livestock integration can result in a series of synergisms and complementarities among farming system components, leading to more balanced nutrient and pest management cycles (Altieri and Rosset, 1996), greater farm income (Barbieri and Mahoney, 2009), and reduced income variability and risk (Helmers et al., 2001). Dramatic shifts away from the production of corn and soybeans are unlikely as farmers possess the skills and equipment to produce these crops. However, the integration of livestock or specialty crops as supplementary enterprises could help grain producers obtain the benefits of diversification. Our research was undertaken to determine the feasibility of integrating various supplemental enterprises into a traditional Midwestern corn-soybean rotation system. The objective was to identify supplemental cropping alternatives that have agronomic and market feasibility, would contribute to the environmental and economic sustainability of the operation, fit in during times of low labor requirements for corn and soybean operations, and not require substantial additional specialized machinery or knowledge by the farmer.

Materials and Methods

A model of a typical farming unit in eastern Nebraska was developed and detailed enterprise budgets established for each alternative enterprise based on values obtained in 2002. Data to generate the model and enterprise budgets were obtained from local growers for corn-soybean activities and researchers conducting field trials at the university research farm for supplemental crop enterprises. Enterprise budgets included accounting of the labor needed to perform each individual activity, when it needed to take place, and compensation for the farmer’s labor. The four farm options considered were: 1) a base farm with a 256 hectare corn-soybean rotation; 2) the base farm plus crop residue grazing by cattle (\textit{Bos taurus} L.); 3) the base farm plus either winter wheat followed by fall-planted cabbage (\textit{Brassica oleracea} L. \textit{var. capitata} L.) or spring-planted cabbage followed by oilseed sunflowers (\textit{Helianthus annuus} L.); 4) the base farm protected by shelterbelts that included woody species selected for production of decorative floral stems, referred to henceforth as the agroforestry alternative. A Linear Programming (LP) model was developed to evaluate the alternative enterprises and
determine the optimal allocation of the farm’s acreage to maximize net profits given agronomic, labor and market constraints. The initial LP model focused on the labor constraints of one full-time farm producer and was performed with and without subsidy payments. Analysis of the agroforestry alternative was conducted with and without market constraints. Availability of an additional full-time farm operator or part-time seasonal labor, and a greater share of Nebraska and Midwestern woody floral markets were included in subsequent sensitivity analyses.

Results and Discussion

Fluctuating grain prices, changes in government subsidies, and growing concerns about soil and environmental quality have stimulated interest in changing land use practices (Smith and Young, 2000). Integration of supplemental crop enterprises can increase farm profitability as well as improve the agronomic and environmental sustainability of the operation (Dagliotti et al., 2005; Cittadini et al., 2008). However, farmers will adopt a new cropping system only if it is perceived to provide a net economic benefit relative to a currently used system in terms of lower production costs or higher returns (Zentner et al., 2002). Computer based land use models offer a low-risk, cost effective means to evaluate the feasibility of alternative production scenarios and provide suggested optimal decisions regarding land use. To aid growers in their decision making process concerning the integration of supplemental enterprises, detailed enterprise budgets of a traditional corn-soybean operation and four alternative farming scenarios were evaluated in a linear programming model and the optimal crop allocation to maximize profitability was determined. Without crop subsidies an average farm of one section (256 ha) in eastern Nebraska operated with a net deficit of $4,753 (Table 1). Grazing stalk residues with livestock increased returns by $3,840, but did not change optimal crop allocation. Integration of winter wheat-fall cabbage was the most profitable single alternative, providing a net return of $34,503 with only 8.1 ha allocated to the supplemental crop enterprise. The spring cabbage-sunflower alternative also improved profitability, but was constrained by labor allocated to corn-soybean production. The agroforestry system was the second most profitable single alternative, but was limited by market constraints imposed for woody floral crops. When all options were considered simultaneously, acreage was allocated to each of the enterprise alternatives and the farm received a net return of $40,637. The addition of part-time seasonal labor increased acreage allocation to the spring cabbage-sunflower and woody floral enterprises and the farm received a net return of $86,758. Diversification of Midwestern grain farms through integration of supplemental specialty crop enterprises can increase profitability, as well as reduce reliance on agricultural subsidies and contribute to social and ecological sustainability. The intention of this paper is not to suggest that the specific specialty crop enterprises outlined have broad implications for adoption, but to highlight the potential to improve profitability and sustainability through enterprise diversification. Our linear programming model provides corn-soybean growers with a practical decision support tool to evaluate the feasibility of integrating new supplementary enterprises with adaptability and available market opportunities given fluctuating grain and input prices, and labor and market constraints.
Table 1. Optimal acreage allocation and annual net return for a 256-hectare farming enterprise (2002).

<table>
<thead>
<tr>
<th>Enterprise alternatives</th>
<th>Grazing constraint</th>
<th>Market constraint</th>
<th>Land allocation (ha)†</th>
<th>Net return ($) without subsidies</th>
<th>Net return ($) with subsidies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn-soybean alone</td>
<td>no</td>
<td>no</td>
<td>CS: 256</td>
<td>-4,765.44</td>
<td>21,480.96</td>
</tr>
<tr>
<td>Grazing considered</td>
<td>yes</td>
<td>no</td>
<td>CS: 256</td>
<td>-925.44</td>
<td>25,320.96</td>
</tr>
<tr>
<td>Winter wheat/fall cabbage considered</td>
<td>yes</td>
<td>no</td>
<td>CS: 247.90; WW/FC: 8.10</td>
<td>34,502.7</td>
<td>60,754.79</td>
</tr>
<tr>
<td>Spring cabbage/sunflower considered</td>
<td>yes</td>
<td>no</td>
<td>CS: 254.54; SC/S: 1.46</td>
<td>3,489.66</td>
<td>29,686.05</td>
</tr>
<tr>
<td>Windbreak and woody florals considered</td>
<td>yes</td>
<td>no</td>
<td>CS: 254.96; WB: 3.75; SC: 0.30</td>
<td>13,052.4</td>
<td>38,883.63</td>
</tr>
<tr>
<td>Windbreak and woody florals considered</td>
<td>yes</td>
<td>yes</td>
<td>CS: 254.96; WB: 3.75; SC: 0.10; GW: 0.13; BR: 0.02</td>
<td>4,174.37</td>
<td>30,011.95</td>
</tr>
<tr>
<td>All options considered</td>
<td>yes</td>
<td>no</td>
<td>CS: 243.54; WW/FC: 7.88; SC/S: 0.54; WB: 3.75; SC: 0.29</td>
<td>49,152.0</td>
<td>74,971.60</td>
</tr>
<tr>
<td>All options considered</td>
<td>yes</td>
<td>yes</td>
<td>CS: 243.54; WW/FC: 7.88; SC/S: 0.54; WB: 3.75; SC: 0.10; GW: 0.13; BR: 0.02</td>
<td>40,637.4</td>
<td>66,456.97</td>
</tr>
<tr>
<td>All options considered with part-time labor</td>
<td>yes</td>
<td>yes</td>
<td>CS: 233.23; WW/FC: 8.32; SC/S: 10.2; WB: 3.75; SC: 0.10; GW: 0.13; BR: 0.02</td>
<td>86,758.2</td>
<td>111,443.93</td>
</tr>
</tbody>
</table>

†CS, corn-soybeans; WW/FC, winter wheat-fall cabbage; SC/S, spring cabbage-sunflower; WB, windbreak; SC, scarlet curls; GW, goat willow; BR, bailey redtwig

References


Dagliotti S, van Ittersum MK, Rossing WAH 2005 A method for exploring sustainable development options at the farm scale: a case study for vegetable farms in south...
Uraguay, Agricultural Systems, 86, 29-51.
Helmers GA, Yamoah CF, Varvel GE 2001 Separating the impacts of crop diversification and rotations on risk, Agronomy Journal, 93, 1337-1340.