



Effects of Marketing Loans on U.S. Dry Peas and Lentils

Supply Response and World Trade

William Lin and Gary Lucier



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National Agricultural Library Cataloging Record:

Lin, William

Effects of marketing loans on U.S. dry peas and lentils : supply response and world trade.

(Economic research report (United States. Dept. of Agriculture. Economic Research Service) ; no. 58)

1. Dried peas—United States—Marketing.
2. Lentils—United States—Marketing.
3. Agricultural subsidies—Economic aspects—United States.

I. Lucier, Gary.

II. United States. Dept. of Agriculture. Economic Research Service.

III. Title.

HD9235.P42

Photo credits: PhotoDisc. Food and Dining

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United States
Department
of Agriculture

Economic
Research
Report
Number 58

June 2008



A Report from the Economic Research Service

www.ers.usda.gov

Effects of Marketing Loans on U.S. Dry Peas and Lentils: Supply Response and World Trade

William Lin and Gary Lucier

Abstract

The 2002 Farm Act required USDA to implement marketing loans for the 2002-07 crops of dry peas, lentils, and small chickpeas. This provision led to expanded acreage for dry peas and lentils, crops analyzed in this study. The analysis found that marketing loans played a role in expansion for dry peas in 2003-05 and for lentils in 2003. For dry peas and lentils, marketing loans contributed to acreage expansion in North Dakota and Montana. Simulation model results suggest that marketing loans had negligible impacts on world prices for dry peas and lentils in 2003-05. Impacts on U.S. exports were minor, increasing by about 2 percent in 2003.

Keywords: dry peas, lentils, marketing loan, supply response, world trade

Acknowledgments

For their insightful comments and suggestions on an earlier draft of this report, the authors thank Economic Research Service colleagues Linda Calvin, Demcey Johnson, and Steven Zahniser; Dennis Shields and Thomas Tice of USDA/Farm Service Agency; Robert Miller of USDA/National Agricultural Statistics Service; Daniel Sumner of The University of California at Davis; and Andrew Swenson of North Dakota State University Extension Service. The authors also thank Stan Skyrpetz of Agriculture and Agri-Food Canada for providing information about the U.S. and Canadian dry pea and lentil industries through his previous reports. We are also grateful to Courtney Knauth for editorial expertise and Wynnice Pointer-Napper for layout and design.

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Summary

The 2002 Farm Act extended the marketing loan program for the first time to dry peas and lentils. The marketing loan program provides producers with a minimum return for their crop, thereby reducing their market risk. Since passage of the 2002 Act, acreage for dry peas and lentils has steadily increased. This study investigates the role of marketing loans in that increase and the implications for world prices and U.S. exports.

What Is the Issue?

With passage of the 2002 Farm Act, many observers believed that the protection against financial risk offered by marketing loans for dry peas and lentils would lead to greater production of these legumes. If true, that development would expand U.S. exports and lead to lower world prices. Key questions posed in this study are:

- What share of acreage expansion for U.S. dry peas and lentils can be attributed to marketing loans, as opposed to market forces?
- How did expected marketing loan benefits affect world prices and U.S. exports of dry peas and lentils?
- Given the proximity of U.S. dry pea and lentil growing areas (North Dakota and Montana) to Canada and the fact that Canada is the largest U.S. export market for pulse crops, what are the likely impacts on Canadian pulse growers if U.S. exports rise significantly?

What Did the Study Find?

Effects on Acreage

Dry Peas—U.S. dry pea production started to increase in 2000, due to a 36-percent increase in planted acreage in North Dakota. This expansion was largely attributed to an increase in the expected dry pea yield and to lower costs of production. The 2002 Farm Act created further incentive to expand production. Marketing loans have an impact on acreage whenever the expected grower price is lower than the loan rate. The presence of marketing loans in 2003 contributed to the expansion of dry pea acreage of one-third in North Dakota and one-fifth in Montana, above and beyond any increase due to market forces. In 2004 and 2005, the expected price and loan rate differential was considerably smaller, and marketing loan benefits provided only a limited stimulus to dry pea acreage, with an effect only in North Dakota.

Lentils—In North Dakota and Montana, the presence of marketing loans had an influence on 2003 expansion of lentil acreage similar to that for dry peas, but loans played a minor role in 2004 and 2005 lentil expansion.

Effects on Prices

Dry Peas—Marketing loans for dry peas had a negligible impact on world prices during 2003-2005, according to a simulation model adapted for this study. Critical factors in determining this result include the small U.S. share of world markets, the share of U.S. producer revenue attributable to

marketing loans, and inelastic supply and demand elasticities. Model results showed that marketing loans contributed to a reduction in the world price of 0.33-0.55 percent in 2003, depending on the demand price elasticity, and had an even smaller impact in 2004 and 2005.

Lentils—The effect of marketing loans on the world price of lentils in 2003 was likewise minimal, and was virtually zero for the 2004 and 2005 lentil crops.

Effects on Exports

Dry Peas—Marketing loans have had a minor impact on the volume of U.S. exports of dry peas, increasing exports by at most 1.8 percent in the 2003 crop year, with a smaller estimated impact in 2004 and 2005.

Lentil—Marketing loans for lentils are estimated to have led to an increase of 2.2 percent in exports in 2003, with no impacts found for 2004 and 2005.

Effects on Trade with Canada

U.S. dry pea and lentil exports to Canada have increased substantially since 2003. However, these increases were largely attributed to factors other than U.S. marketing loans (such as the stronger Canadian dollar). The direct impact of U.S. marketing loans on Canadian imports of U.S. dry peas and lentils has been negligible.

Long-Term Trade Effects

The study's assessment of future effects of marketing loans on the U.S. dry pea and lentil industry is dependent on certain conditions:

Dry Peas—Growth of the U.S. dry pea trade will depend on whether sustainable feed markets can be developed in the United States to absorb the additional production. Any increase in feed markets, in turn, will depend on a consistent supply of dry peas for use as feed. Until a larger domestic market for dry peas is assured, the dry pea industry will continue to rely on export markets to sell any production growth induced by marketing loans.

Lentils—While lentils are used primarily for human food, conditions similar to those for dry peas apply to the development of a larger domestic market.

How Was the Study Conducted?

This analysis is based on an acreage response model, which treats the acreage response for dry peas and lentils, along with spring wheat, durum wheat, barley, and other minor field crops, as a system of acreage allocation decisions. The model consists of four acreage share equations for dry peas, lentils, spring wheat (including durum), and barley, which are estimated using pooled time-series (1997-2005) and cross-sectional (four States) data. Expected net returns include a nitrogen credit generated by dry peas and lentils (nitrogen-fixing), used in a rotation with grains.

Estimated impacts of marketing loans for dry peas and lentils on world prices are based on an adaptation of a simulation model. U.S. supply elasticities and shares of revenues from marketing loan benefits are taken directly from the acreage response analysis. The simulation model is cast in an ex ante context with and without the policy change, based on the expected grower price and expected marketing loan benefits.

Introduction

The 2002 Farm Act required the U.S. Department of Agriculture (USDA), for the first time, to implement marketing loans for dry peas, lentils, and small chickpeas—three pulse crops grown in the United States—for the 2002-07 crops.¹ The Marketing Loan Program sets the Loan Rate, a fixed return for the crops, and guarantees it to the grower even if the market price falls below it. This protection against downside price risk could potentially lead to expanded acreage for these crops, particularly when expected market prices fall below the loan rates. In 2000 and 2001, U.S. plantings of dry peas and lentils were around 200,000 acres for each. Since then, acreage planted to these crops has shown a steady upward trend, reaching nearly 1 million acres for dry peas and over 400,000 acres for lentils in 2006. Acreage decreased in 2007, to about 880,000 acres for dry peas and 305,000 for lentils, still considerably higher than in 2000 (fig. 1).

Although the pulse crop marketing loan program may have little significance for overall U.S. farm policy, it is important to producers of pulse crops in the United States, as well as of interest to competing producers in Canada. If domestic markets do not absorb the expanded production, U.S. exports of dry peas and lentils could increase and world prices could fall. This possibility is being closely watched by Canadian pulse growers and shippers, since large increases in U.S. pea and lentil shipments could chip away at Canada's status as a world leader in pulse exports.

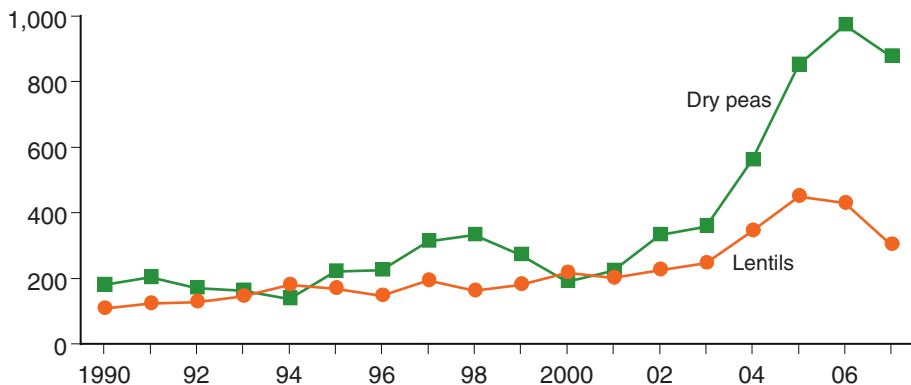
The purpose of this study is twofold: (1) to investigate the role of marketing loans on supply increases of U.S. dry peas and lentils, and (2) to gauge trade implications of the marketing loans in terms of their impact on world prices and U.S. exports. For this analysis, the authors developed two models:

¹In North American agriculture, the term "pulse crop" commonly refers to dry (mature) peas, lentils, dry beans, and chickpeas (garbanzo beans) used as food or feed crops (with "food" referring to human use and "feed" to animal use) (Lucier and Jerardo, 2002). Although small chickpeas are covered by marketing loans, that crop is not within the focus of this report.

Figure 1

U.S. planted acreage for dry peas and lentils: 1990-2007¹

1,000 acres



¹Excludes chickpeas.

Sources: USDA, National Agricultural Statistics Service, *Field Crops* and *Crop Production Annual*.

- A supply response model for dry peas and lentils, which separates out the impacts of the marketing loans on the production of those commodities from the impacts of market forces.
- A policy simulation model, adapted from a model by Sumner (2005) that incorporates the share of expected farm returns from marketing loan benefits vs. those from market revenues, along with supply elasticities and other key parameters, to estimate the impacts of the marketing loans on world prices. Additional production induced by the marketing loans is used to estimate the impact on U.S. exports.

The Dry Pea and Lentil Industry: United States vs. Canada

This section briefly discusses market developments in the dry pea and lentil industry in the United States in terms of their supply, demand, and factors that affect net returns. The development of the dry pea industry in Canada is also discussed to provide insights into the prospects of developing feed markets for dry peas in the United States.

U.S. Production of Dry Peas and Lentils

The U.S. dry pea crop consists mainly of green and yellow peas, with the former more common and the latter expanding rapidly. In the 2004/05 marketing year, which began on July 1, 2004, green peas accounted for 75 percent of all dry pea production, and yellow peas accounted for 20 percent (with other pea varieties accounting for the rest). Dry peas are destined for both food (the term for human use) and a small feed market, while lentils are destined largely for the food market. Until 2007 for dry peas and 2006 for lentils, acreage planted to these pulse crops expanded in the United States. In 2006, U.S. planted acreage reached 925,500 acres for dry peas and 429,000 acres for lentils, compared with 308,700 and 226,000 acres in 2002 (USDA, 2004; USDA, Nov. 9, 2006).² U.S. production in 2006 reached 13.2 million hundredweight (cwt) for dry peas and 3.2 million for lentils.

Traditionally, dry pea and lentil production was concentrated within a 90-mile radius of Pullman, Washington—an area called the Palouse that also encompasses portions of nearby Idaho and Oregon. Pea and lentil growers in the Palouse are able to produce and pack a large percentage of top-grade product that commands a premium price, a fact that—along with the strength of the dollar—sometimes placed exports of U.S. dry peas and lentils at a disadvantage before the 2002 farm legislation. The Marketing Loan Program has served as an income support, providing growers with incentives to expand dry pea and lentil acreage, particularly when market prices fall below the loan rate. The lower priced product grown in the upper Midwest (mainly in North Dakota and Montana) has largely moved into export markets for use as both human food and animal feed. Meanwhile, growers in the better quality, higher cost Palouse area appear to be still responding to market signals from the human food market and have yet to expand their production area.

U.S. dry pea production started to increase in 2000, due to a 36-percent increase in planted acreage in North Dakota. This expansion was largely attributed to an increase in the expected dry pea yield and to lower costs of production. The 2002 Farm Act created further incentive to expand production. After its passage, most of the increased production of dry peas was attributed to higher acreage, thought to have been largely triggered by the Marketing Loan Program established by the act (World Perspectives, Inc.).

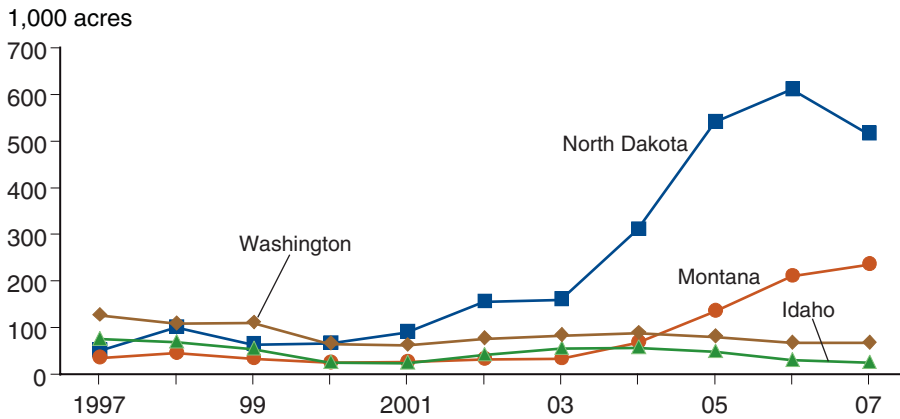
Acreage expansion for dry peas was particularly dramatic in North Dakota and Montana for the 2004 and 2005 crops, but it slowed down in 2006 (fig. 2).³ In addition to the price protection offered by the Marketing Loan Program, higher expected yield, lower costs of production, and the benefits of dry peas as a rotation crop contributed to higher expected returns for dry peas

²The use of 2002 as the reference year is due to the fact that the 2002 Farm Act was not signed into law until mid-May of that year—too late to have an impact on farmers' planting decisions (Lin and Dismukes). While many producers may have perceived the likelihood of having the Marketing Loan Program for pulse crops included in the farm legislation, few knew with certainty what the loan rate would be at planting decision time for the 2002 dry pea and lentil crops.

³Most of the growth in North Dakota reportedly was in yellow peas, which are easier to grow and higher yielding. As a result, yellow peas were the choice for most new growers. Lower expected yield for dry peas, and a greater increase in the expected farm price for spring wheat than for dry peas, contributed to the slowdown in dry pea acreage expansion in 2006.

Figure 2

Planted area for dry peas in North Dakota, Montana, Idaho, and Washington: 1997-2007¹



¹Excludes chickpeas.

Sources: USDA, National Agricultural Statistics Service, *Field Crops* and *Crop Production Annual*.

than for spring wheat—the major alternative crop for dry pea farmers—in North Dakota and Montana than in the western region. As a result, the bulk of production growth in recent years came from expanded acreage in North Dakota and, to a much lesser degree, Montana.

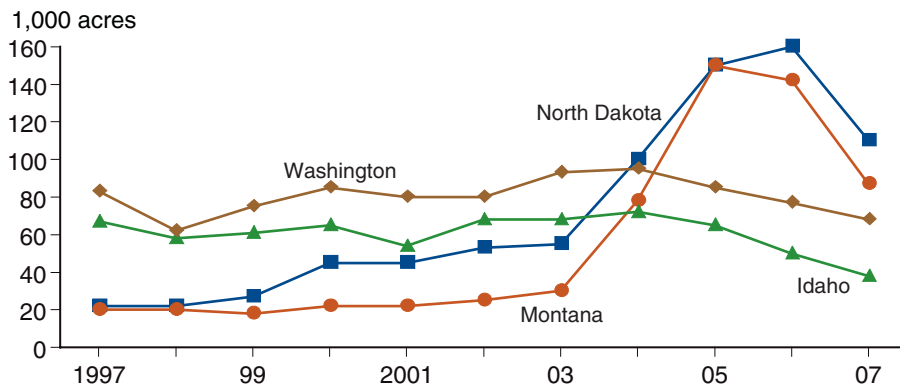
Acreage planted to dry peas has remained largely flat over the last decade in Washington and Idaho, the traditional growing States. In 1997, Washington and Idaho were the first- and second-largest producing States; however, in 2006 they were dwarfed by North Dakota and Montana production. Relatively higher costs of production in Washington and Idaho contributed to lower net returns for dry peas than for competing crops like spring wheat. In addition, wheat yields are much higher in the Pacific Northwest relative to pulses than in North Dakota and Montana.

U.S. lentil production expanded rapidly in 2004, increasing from 2.4 million hundredweight (cwt) in 2003 to 4.2 million cwt in 2004 and 5.2 million in 2006 (USDA, Nov. 9, 2006). The pace of expansion for lentils, however, was not as strong as for dry peas. During 2003-04, for example, while acreage planted to U.S. lentils expanded by 40 percent (99,000 acres), acreage for dry peas expanded by 57 percent (192,500 acres). The lower cost of growing lentils in North Dakota and Montana, relative to Idaho and Washington, also contributed to the acreage expansion in the former two States after 2001 (fig. 3). The spike in seeded area for lentils in Montana reportedly came from a small number of large growers.

U.S. dry pea yields fluctuated between 13 and 24 cwt per acre over the last 15 years (through 2007), with no upward or downward trend. During 2000-2006, while dry pea yields in Idaho were either comparable with or below the national average, yields in North Dakota were mostly higher. Relatively high yields in North Dakota probably contributed to the expansion in planted acreage there. Similarly, U.S. lentil yields exhibited no trend during 1992-2006.

Figure 3

Planted area for lentils in North Dakota, Montana, Idaho, and Washington: 1997-2007



Sources: USDA, National Agricultural Statistics Service, *Field Crops* and *Crop Production Annual*.

During 2003-05, acreage planted to dry peas and lentils expanded rapidly in North Dakota, reflecting that the expected net returns for these crops exceeded those for spring and durum wheat, the major alternative crops for the State’s pulse farmers. The expected net returns include market sales, marketing loan benefits, and the extra value of reducing wheat yield losses from the wheat-pulse rotation and nitrogen credit due to peas and lentils after variable costs of production are subtracted (see box, “Benefits of Growing Peas and Lentils as Rotation Crops”). For example, the expected net returns averaged \$62.20 (inflation-adjusted) per acre for dry peas in North Dakota in 2005, compared with \$53.60 for spring and durum wheat.⁴

U.S. Trade in Dry Peas and Lentils

Since 2000, more than half of the lentils and about half of the dry peas produced in the United States have been exported. The U.S. dry pea and lentil industry has historically been geared toward the production of a high-quality, food-grade (U.S. No. 1) product, a large portion of which is purchased by the Federal Government for foreign food aid distribution under programs such as PL-480. During the 2000-04 crop years, food aid accounted for about half of U.S. dry pea exports and 70 percent of U.S. lentil exports (Lucier and Jerardo, 2006; Skrypetz, Feb. 24, 2006). The remainder of the dry pea and lentil crop was mostly sold domestically or exported privately into a very competitive world market, where Canada is the leading supplier

The United States is a net exporter of dry peas and lentils. U.S. dry pea imports have been small and stable, accounting for only 1.5 percent of the world trade. U.S. dry pea exports, which were generally destined for food markets, averaged 7.8 percent of the world trade during 2003-05 (table 1). U.S. exports of dry peas (excluding chick peas) have been trending upward, from 74,000 metric tons in 2000 to 395,000 metric tons in 2005/06. This rising trend also applies to U.S. exports to Canada, which reached 53,000 metric tons in 2005/06, up from 6,000 metric tons in 2000. Canada is the leading foreign market for U.S. dry peas, accounting for about 14 percent of U.S. exports in 2005. Other export destinations include India, Kenya, the Philippines, and Cuba.

⁴Peas and lentils as spring crops, often grown as rotation crops with grains, directly compete with spring wheat (including durum) for cropland. In Washington and Idaho, winter wheat is double-cropped with peas and lentils, leaving spring wheat as the main competing crop. In Montana, winter wheat does compete with spring wheat. Due to a high correlation between winter wheat and spring wheat prices, however, including spring wheat in our analysis as a major competing crop will capture the essence of competition between wheat and pulse crops in that State.

Benefits of Growing Peas and Lentils as Rotation Crops

Dry peas and lentils are good rotation crops with grains. According to a crop yield response model developed by the Northern Great Plains Research Laboratory, a USDA Agricultural Research Service (ARS) facility at Mandan, North Dakota, a dry peas-wheat rotation in North Dakota would average a wheat yield of 49.5 bushel per acre (bu/ac), up from 45 bu/ac for continuous wheat operations, reducing yield losses by about 10 percent. (These trial yields are larger than recent actual wheat yields in North Dakota, mainly because they are obtained from good soil under a controlled environment and best-management practices.) A major benefit of rotating dry peas with grains is the interruption of pest cycles. Soil-borne root rot in continuous cereal systems may cause yield losses up to an average of 10 percent (Saskatchewan Agriculture and Food), which is consistent with the USDA/ARS modeling result. The same yield-enhancing effect applies to dry peas in other States, as well as to lentils in major producing States, because lentils are an equally good rotation crop.

As legume crops, dry peas and lentils are capable of fixing the bulk of their nitrogen requirements.¹ Total nitrogen fixed by field peas was estimated to range from 155 to 175 pounds per acre per year in Missouri (Killpack and Buchholz). Similarly, total nitrogen content fixed by Austrian winter peas was estimated at 128 and 203 kg/ha in separate trials in Idaho (Mahler and Auld). Almost all of the nitrogen fixed by dry peas goes directly into the plant—56 percent of the total nitrogen fixed was contained in the seed, 37 percent in the stubble, and only 6-8 percent in the root system (Herdina and Silsbury). Little fixed nitrogen is left in the soil for the following non-legume crop in the rotation system, especially if the legume crop is cut and removed from the field (Lindemann and Glover). Applying the 6-8 percent of the nitrogen fixed in the root system to the total fixed nitrogen, as estimated in the previously mentioned studies, yields nitrogen for the following crop of about 10.2-11.6 pounds per acre. This estimate is conservative, because nitrogen in pulse crops' stems and leaves, if incorporated back into the soil, could also be available for the ensuing crop. The amount of nitrogen left for other crops is often referred to as the "nitrogen credit" attributable to dry peas and lentils.

¹Farmers can obtain atmospheric nitrogen for their crops by growing inoculated legumes, such as dry peas and lentils. Inoculation of legumes means the introduction of legume bacteria into the soil to enable the plants to fix atmospheric nitrogen, that is, to change it into usable form. The inoculating process consists of mixing legume seeds with the correct strain of bacteria before the seeds are planted. Soon after the legumes begin to grow, the legume bacteria invade the root hairs. The legumes form growths on the roots called nodules. The bacteria live in these nodules and do their beneficial work (Erdman).

U.S. lentil exports also have been trending upward, from 75,000 metric tons in 2000/2001 (July to June) to 159,000 metric tons in 2005/06. Imports of lentils, mostly from India and Canada, have been low and variable, reaching nearly 12,000 metric tons in 2005/06. U.S. lentil exports go mostly to Europe, Africa, and the Americas, with Spain the largest importer (Skrypetz, May 12, 2006). U.S. lentil trade with Canada has been relatively small.

Table 1

Shares of U.S. and Canadian dry peas and lentils in the world market¹

Item	United States	Canada	Rest of the world
	<i>Percent</i>		
Dry peas			
Production	4.2	25.1	70.7
Export	7.8	50.5	41.7
Lentils			
Production	5.0	25.6	69.5
Export	10.7	39.0	50.3

¹Three-year average of 2003-05.

Source: United Nations Food and Agriculture Organization, *FAOStat* (11/07).

The feed market for dry peas and lentils is largely undeveloped in the United States. While dry peas were grown for food use in the Pacific Northwest areas, expanded production in North Dakota and Montana has been increasingly used as a feed crop. Dry peas are an inexpensive but nutrient-dense source of protein, essential amino acids, and carbohydrates, which makes them an attractive ingredient for animal feed rations. Lentils are primarily used as human food. To the extent that the expanded production is exported because of the lack of an established domestic feed market, the marketing loan program could have an impact on the world price, as was seen in recent years. The timeline of growth in the feed market for dry peas in Canada thus might offer insights into the prospects of developing feed markets for dry peas in the United States.

Canadian Production of Dry Peas and Lentils

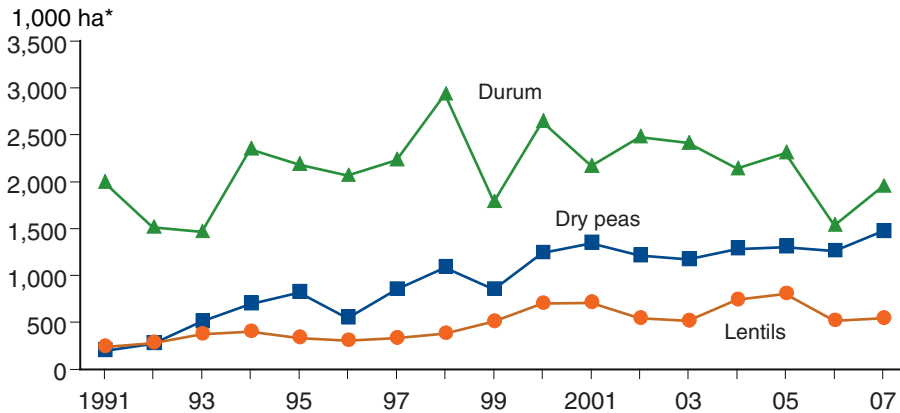
Canadian dry pea production has increased more than sixfold since the early 1990s, reaching 1.4 million tons in 2002/03 and 3.1 million tons in 2005/06. Production increased as producers diverted cropland from traditional grains, such as durum wheat, in response to the relatively higher net returns from dry peas (fig. 4). In 2004/05, pulse crops accounted for 8 percent of Canadian grain, oilseed, and pulse production—up from 2 percent in 1991/92, with dry peas accounting for most of the growth (Skrypetz, Feb. 3, 2006).

Canada's share of world dry pea production rose from 11 percent in 1996-97 to 28 percent in 2004-05 and 2005-06. That growth stems largely from industry efforts beginning in the early 1990s to develop Canada's feed markets (Skrypetz, Feb. 3, 2006). The growth in dry pea production has taken place largely in Saskatchewan, which in 2005/06 accounted for 78 percent of Canadian production, while Alberta and Manitoba accounted for 20 percent and 2 percent, respectively. These Prairie Provinces are located directly north of the U.S. dry pea high-growth areas, North Dakota and Montana. Canada produces several types of dry peas, with yellow peas accounting for about two-thirds of production.

Canada exports all but 35 percent of its dry pea production. The largest end-use in the domestic market is livestock feed, followed by seed and food. Most of the increase in domestic use is due to feed use in the major producing areas, especially for hogs, for whom dry peas are a good source of

Figure 4

Canadian area planted to dry peas, lentils, and durum wheat: 1991-2007



* 1 ha (hectare) = 10,000 square meters or 2.471 acres.

Source: Skrypetz, Stan. *Dry Peas: Situation and Outlook* and *Lentils: Situation and Outlook*, Agriculture and Agri-Food Canada, 2007.

protein and energy. When protein quality and amino acids, such as lysine, are considered in the dietary formulation for hogs, peas are very price competitive. Dry peas usually displace soybean meal and high-energy grains and can comprise from one-third to two-thirds of hog rations (Skrypetz, Feb. 3, 2006). A common feed product is a mixture of two-thirds ground peas and one-third canola meal. But feed use of dry peas remains a niche use in Canada, despite the fact that the area planted to dry peas has expanded rapidly since the early 1990s, reaching nearly 1.5 million hectares in 2006 (fig. 4). This area is not considered large enough to ensure a sustainable supply for feed use.

The Canadian experience suggests that exports will be key to continuing the expansion of U.S. dry pea production for several more years. Feed markets will be slow to develop until there are several million acres and the dry pea industry proves it can deliver a consistent supply to feed mills. With the potential for the United States to become an important competitor in the world market, developing sustainable domestic feed markets will become more critical for the Canadian dry pea industry.

The U.S. Marketing Loan Program

The 2002 Farm Act required USDA to implement marketing loans for the first time for the 2002-07 crops of dry peas, lentils, and small chickpeas. Under the Commodity Credit Corporation (CCC) loan program, producers may pledge all or part of their production of a commodity as collateral and, in turn, receive a loan equal to the product of the loan rate per unit (e.g., cwt) and the number of product units placed under loan. The loans are “nonrecourse,” which means that the Government must accept the commodity under loan as repayment of the loan principal plus interest, if the producer so desires.

The marketing loan program provides producers with an effective grower price not lower than the loan rate, thereby reducing market risk.⁵ Under marketing loan provisions, producers may (under certain conditions) repay a 9-month nonrecourse loan at the CCC estimated local market price when it is less than the loan rate plus accrued interest and other charges. The difference between the loan rate and the repaid value is called a marketing loan gain (MLG). Thus, the loan rate becomes the effective grower price when the market price falls below the loan rate. Alternatively, producers may opt to receive a loan deficiency payment (LDP), the difference between the loan rate and the marketing loan repayment rate. To be eligible for an LDP, the producer must have ownership of the commodity. The producer must also agree not to put the commodity under loan. Most producers have elected to take the LDP rather than the CCC loan.

If the producer holds the grain after taking an LDP, he or she no longer has price protection from the marketing loan program and may end up with an effective price (LDP + market sale price) higher or lower than the loan rate, depending on the eventual sales price.

The marketing loan program has changed over time. For the 2002 dry pea and lentil crops, the original loan rate and posted marketing loan repayment rates used to calculate the LDPs and MLGs were based on U.S. No. 1 grade, with discounts for lower grades. In 2003, the base grades used for the marketing loan repayment rates were lowered to feed grade for dry peas and No. 3 grade for lentils and small chickpeas (Skrypetz, Feb. 24, 2006). This change raised the per unit level of LDPs and MLGs for these pulse crops and raised the possibility of achieving an effective price greater than the loan rate. Two regions for dry pea loan rates were established to better reflect the prices received by producers—the West region (including Washington and Idaho) and East region (including North Dakota and Montana). The difference in the regional loan rates reflects local supply and demand conditions, as well as a quality differential for dry peas between the two regions. When the marketing loan program was implemented, LDPs for dry peas were identical across the West and East regions. Loan rates for lentils were differentiated for the two regions beginning in 2006 (table 2).

Loan program benefits vary for dry peas and lentils, depending on whether posted weekly loan repayment rates exceed or fall short of the loan rate. For the 2002 crop, the loan program was used for both dry peas and lentils in limited quantities; however, more than 75 percent of the loans were redeemed without marketing loan gain. LDPs were also received by lentil

⁵The marketing loan can raise the expected grower price and lower price risk, even when the market price is expected to exceed the loan rate.

growers. In 2003, marketing loan program benefits (both LDPs and MLGs) were received by dry pea growers. A few lentil growers also used the loan program, but did not receive marketing loan benefits. For the 2004 crop, dry peas were eligible for benefits throughout the year, but lentils were not eligible until late in the crop year (Lucier and Jerardo, 2006). Table 3 shows details of price support program activity for dry peas and lentils from 2002/03 to 2006/07.

Table 2

Loan rates for dry peas and lentils in the United States

Item	2002	2003	2004	2005	2006	2007
<i>Dollars per cwt</i>						
National average:						
Dry peas	6.33	6.33	6.22	6.22	6.22	6.22
Lentils	11.94	11.94	11.72	11.72	11.72	11.72
West region:						
Dry peas	6.33	6.68	6.63	6.61	6.63	6.63
Lentils	--	--	--	--	12.76	13.31
East region:						
Dry peas	6.33	5.89	5.84	6.03	6.1	6.12
Lentils	--	--	--	--	11.36	10.97

Sources: Lucier and Jerardo, 2002; USDA news releases.

Table 3

Marketing loan program outlays for U.S. dry peas and lentils

Item	Unit	2002/03	03/04	04/05	05/06	06/07
—Dry peas—						
Loan deficiency payments:						
Applications	<i>Number</i>	0	3,626	5,612	7,931	7,608
Quantity	<i>1,000 cwt</i>	0	5,203	13,174	14,878	14,013
Value	<i>\$1,000</i>	0	13,914	31,416	35,207	29,246
Unit value	<i>\$/cwt</i>	0	2.67	2.38	2.37	2.09
Marketing loan gains:						
Loans made	<i>Number</i>	57	16	50	172	139
Gain quantity	<i>1,000 cwt</i>	0	73	281	909	640
Gain value	<i>\$1,000</i>	0	119	710	2,129	1,020
Average gain	<i>\$/cwt</i>	0	1.62	2.53	2.34	1.59
—Lentils—						
Loan deficiency payments:						
Applications	<i>Number</i>	1,442	0	177	2,765	2,806
Quantity	<i>1,000 cwt</i>	1,898	0	355	3,527	2,600
Value	<i>\$1,000</i>	2,375	0	114	6,059	12,650
Unit value	<i>\$/cwt</i>	1.25	0	0.32	1.72	4.86
Marketing loan gains:						
Loans made	<i>Number</i>	9	57	230	363	179
Gain quantity	<i>1,000 cwt</i>	0	0	502	769	404
Gain value	<i>\$1,000</i>	0	0	579	3,169	1,578
Average gain	<i>\$/cwt</i>	0	0	1.15	4.12	3.91

Source: Compiled by USDA, ERS from data of USDA, Farm Services Agency.

The Acreage Response Model

The acreage response model employed in this study follows the same conceptual framework as the model in Lin et al., which postulates that the goal of producers is to maximize expected net returns—the difference between expected market revenues and variable costs of production. Acreage response equations in the model are treated as a system of acreage allocation decisions for dry peas, lentils, spring wheat, durum wheat, barley, and other minor field crops such as sunflower, canola, flaxseed, and rapeseed. The model consists of four acreage share equations for spring crops: (1) dry peas, (2) lentils, (3) spring wheat (including durum), and (4) barley. Spring wheat, durum, and barley are considered the major alternative crops to dry peas and lentils.

The dependent variable in the empirical model is the share of total cropland for spring crops planted to dry peas, lentils, spring wheat (including durum), and barley. The sum of the shares for these four crops and other minor field crops equals one.⁶ However, only the shares of dry peas, lentils, spring wheat (including durum), and barley are estimated, using pooled time-series (1997-2005) and cross-section (four-States) data. The share for other minor field crops is treated as a residual that is not directly estimated, to avoid the singularity of the disturbance covariance matrix (Greene). The model takes the form:

$$(1) \quad S_i = a_{i1} + b_j \sum_{j=1}^4 \text{NRT}_j + c_{i1} S_{i,t-1} + \sum_{j=1}^3 D_j + \mu_i \text{ and}$$

$$(2) \quad \sum_{i=1}^5 S_i = 1.0$$

where S_i = the share of combined acreage of dry peas, lentils, spring wheat (including durum), barley, and other minor crops planted to the i^{th} crop (1= dry peas, 2= lentils, 3= spring wheat, including durum, 4=barley, and 5= other minor field crops that potentially compete with dry peas and lentils),

NRT_j = expected net returns (\$/ac) for j^{th} commodity,

$S_{i,t-1}$ = lagged dependent variable for i^{th} commodity,

D_j = State dummies (D_1 = North Dakota, D_2 = Montana, and D_3 = Washington), and

μ_i = the error term.

This specification explicitly recognizes that as the share of the combined cropland planted to one commodity—say, dry peas—increases, the expanded dry pea acreage has to come from cropland that would otherwise be planted to competing crops or summer-fallowed land. The share specification stipulates that total cropland planted to crops that compete with dry peas or lentils is fixed, an assumption widely adopted in this kind of empirical work (Lin and Dismukes).

⁶Summer-fallow and pasture lands are not included in this category because of a lack of publicly available data for the former and relatively poor soil quality, not well suited for pulse crops, for the latter. Cropland planted to hay has the potential to be switched to pulses, which could be included in this residual category in future studies.

USDA data on State-level yields and prices for dry peas and lentils are not available for all major producing States before 1998.⁷ The limited number of observations in this data series makes a study of supply response based on time-series data virtually impossible. In this study, pooled time-series (1997-2005) and cross-section (four-States) data are used in the analysis. The pooled data yields 36 (9 x 4) observations, which provide sufficient degrees of freedom.⁸

The acreage share equations are estimated using Seemingly Unrelated Regressions (SUR). SUR recognizes that the residuals across the share equations are correlated because each of the crops included in the system is competing with others. Both symmetry and linear homogeneity constraints are considered and tested for statistical significance in the estimation process (Barten and Vanlout; Chavas and Holt; Lin et al.). The symmetry restriction requires that cross-net return regression coefficients across the share equations be equal; that is, $b_{12} = b_{21}$, $b_{13} = b_{31}$, $b_{14} = b_{41}$, $b_{23} = b_{32}$, $b_{24} = b_{42}$, $b_{34} = b_{43}$. The linear homogeneity constraint requires that the sum of all own- and cross-net return regression coefficients be zero; that is, for example, $b_{14} = -(b_{11} + b_{12} + b_{13})$.

The symmetry restriction reflects the notion that the cross-price elasticities are linked to the ratios of the acreage shares and expected net returns for two competing crops. The linear homogeneity constraint reflects the fact that the same proportional change in net returns for dry peas, lentils, and competing crops does not alter the share of all the combined acreage planted to a specific crop. Intuitively, this restriction means that if both output and input prices change by a fixed proportion, the share of the combined acreage planted to a specific crop would remain unchanged.

Expected net returns equal the expected yield times the expected price by State, plus the value of using dry peas or lentils as the rotation crop with grains (including the reduction in yield losses for grains and nitrogen left for other crops by dry peas or lentils through nitrogen fixation), minus variable cash costs of production.⁹ Unlike many grains in the Midwest whose yields have shown an upward trend, peas and lentils mostly show no discernable trends at national or State levels. As a result, 5-year moving averages of yields are taken to be the expected yields. Similarly, 5-year moving averages are taken as the expected yields for spring wheat and barley in North Dakota and spring soft white wheat in Washington. In contrast, trend yields estimated from data from 1979 to 1996 for spring wheat and barley in Montana and Idaho are regarded as the expected yields because of the statistical significance of trends in the yield equations.

The expected price that farmers will receive for lentils, and competing crops is based on an adaptive expectation scheme, augmented by a behavioral hypothesis that farmers adjust their price expectations based on the discrepancies between the expected farm prices and actual market prices in the past (Chavas and Holt). The absence of futures trading for pulse crops prevents us from directly forming the expected farm price based on futures settlement prices, although later studies can explore the possibility of linking component pricing based on energy and protein content of dry peas for feed use in the

⁷Lentil data for North Dakota and Montana, where most of the growth in dry pea and lentil area has occurred this decade, were not published separately by USDA for these two States until 1998. Dry pea data publication for North Dakota and Montana was resumed by USDA after being discontinued in 1972. However, price and yield data in 1997 for "Other States" (which includes North Dakota and Montana), as reported in USDA's *Crop Values*, are used to represent those for North Dakota and Montana in that year.

⁸The pooled data has its limitations. Multicollinearity and endogeneity issues arising from the limited number of observations are addressed through the use of extraneous estimates from the Lin et al. study (Maddala). Also, the 36 observations obtained from the use of pooled time-series and cross-section data in this study are not much different from the methodology of another study on supply response, which yields 40 observations (Lin et al.). While the use of extraneous information from previous studies offers some remedies, future studies that include longer time-series data as they become available would be warranted.

⁹This study abstracts from a formal treatment of risk about prices and yields, which otherwise requires the inclusion of a covariance term between crop yields and farm prices in expected net returns calculation (Lin and Dismukes). Also, truncation (from below) of the price distribution from the marketing loan program would have to be explicitly taken into consideration and incorporated into the calculation of expected net returns and the expected variance of revenues. Finally, acreage response equations would include expected covariance of revenues if commodity prices are correlated.

East region to corn and soybean futures prices.¹⁰ The adaptive expectation scheme takes the form:

$$(3) \quad E_i(P_t) = \alpha_i + \sum_{j=1} w_j P_{i,t-j}$$

where

$$\alpha_i = E \left(P_t - \sum_{j=1}^3 w_j P_{i,t-j} \right)$$

A weighting scheme, which is consistent with a few previous studies, has the following weighting factors: 0.5 for t-1, 0.3 for t-2, and 0.2 for t-3 (Lin; Chavas and Holt; Lin and Dismukes).¹¹

Tables 4 and 5 show how the expected grower prices for dry peas and lentils are calculated for North Dakota during 1997-2005. For example, the unadjusted expected grower price is estimated at \$5.64 per cwt for dry peas in North Dakota in 2003, based on the fixed-weights scheme described above. However, based on the comparisons between the expected grower prices and actual market prices in the past (1996-2002), growers would expect actual market prices, on average, to fall short of the expected grower prices by \$0.93 per cwt. Adding this adjustment factor to the expected grower price brings an adjusted expected grower price of \$4.71. Similarly, this “learning-by-doing” adjustment process changes the expected grower price for lentils in North Dakota in 2003 from \$10.53 to \$9.08 per cwt (table 5). Prior to this year, unadjusted expected grower prices overestimated actual grower prices by an average of \$1.45 per cwt. This error of overshooting results in a lower expected grower price after the adjustment. Similar illustrations for Montana are presented in appendix tables A-1 and A-2.

Effective expected grower prices are simply the loan rates if the expected grower price (after correcting errors through the adjustment process) falls short of the loan rate. Starting from 2003, the first time that marketing loan programs in the 2002 Farm Act could have had an impact on producers’ planting decisions, expected farm prices are replaced with loan rates if the expected prices are smaller. Expected LDP or MLG for producers, if applicable, equaled the difference between loan rates and the expected farm prices for dry peas, lentils, and competing crops. For example, while dry pea producers in North Dakota in 2003 faced the expected grower price of \$4.71 per cwt, the effective expected price was \$5.89—the loan rate—after adding the expected LDP or MLG to the grower price.¹² Similarly, the effective expected grower price for lentils in North Dakota in 2003 was altered from \$9.08 per cwt to \$11.94.

Producers also take loan rates into consideration in their production decisions in two further respects. First, the marketing loan program reduces price risk by truncating (from below) the producer’s subjective price distribution at the loan rate, which has to be explicitly taken into account for supply response under risk. Producers received MLGs or LDPs when farm prices fell below the loan rates. But this price-risk protection can have a downside when the market price is expected to exceed the loan rate. Second, producers, if selling food-quality dry peas below the loan rate, have the possibility of achieving an

¹⁰No similar extrapolation is applicable for the food-use component. In addition, this approach becomes even more difficult for dry peas in the West and lentils in both regions, because in the West dry peas and lentils are largely used for human food.

¹¹It is conceivable that these weighting factors may vary by commodity. However, this weighting scheme has shown the best estimated results for grains and oilseeds in previous studies (Lin, 1977; Chavas and Holt; Lin and Dismukes).

¹²This calculation implies that expected LDPs in an *ex ante* context differ across the West and East regions, which deviates from the way that the marketing loan program was implemented. In an *ex post* context, the program was implemented so that LDPs across the regions are identical, which is tantamount to requiring that the difference of the regional loan repayment rates is the same as that for the regional loan rates. However, the expected grower price is not governed by the way the program is implemented. Also, it is highly unlikely that growers in one region will take into account the expected grower price in the other region to ensure that the expected LDPs in the two regions are identical in forming their price expectations.

Table 4

Calculating the expected grower prices of dry peas in North Dakota: 1997-2005

Year	Grower price	Unadjusted expected	$P_t^1 - UEP_t^2$	Adjustment factor	Adjusted expected	Effective expected
		grower price			grower price	grower price
		\$/cwt				\$/cwt
1997	6.40	9.05	-2.65	0.00	9.05	9.05
1998	5.90	7.71	-1.81	-2.65	5.06	5.06
1999	4.50	6.81	-2.31	-2.23	4.58	4.58
2000	4.40	5.30	-0.90	-2.26	3.04	3.04
2001	4.70	4.73	-0.03	-1.92	2.81	2.81
2002	6.70	4.57	2.13	-1.54	3.03	3.03
2003	6.54	5.64	0.90	-0.93	4.71	5.89
2004	5.45	6.22	-0.77	-0.67	5.55	5.84
2005	n.a.	6.03	n.a.	-0.68	5.35	6.03

¹Expected grower price.²Unadjusted expected grower price has the following weighting scheme: 0.5, t-1; 0.3, t-2; and 0.2, t-3.

Table 5

Calculating the expected grower prices of lentils in North Dakota: 1997-2005

Year	Grower price	Unadjusted expected	$P_t^1 - UEP_t^2$	Adjustment factor	Adjusted expected	Effective expected
		grower price			grower price	grower price
		\$/cwt				\$/cwt
1997	13.20	15.49	-2.29	0.00	15.49	15.49
1998	9.10	14.54	-5.44	-2.29	12.25	12.25
1999	11.00	11.79	-0.79	-3.87	7.93	7.93
2000	10.50	10.87	-0.37	-2.84	8.03	8.03
2001	9.60	10.37	-0.77	-2.22	8.15	8.15
2002	11.10	10.15	0.95	-1.93	8.22	8.22
2003	15.00	10.53	4.47	-1.45	9.08	11.94
2004	14.80	12.75	2.05	-0.61	12.14	12.14
2005	n.a.	14.12	-0.27	-0.27	13.85	13.85

¹Expected grower price.²Unadjusted expected grower price has the following weighting scheme: 0.5, t-1; 0.3, t-2; and 0.2, t-3.

effective price greater than the loan rate because the LDP or MLG is based on the feed dry pea price, instead of the lower food dry pea price.

Variable cash costs of production for dry peas, lentils, and competing crops are from North Dakota State University Extension Service (Swenson and Akre, (a) and (b)) and the University of Idaho Cooperative Extension System (Smathers). In the North Dakota crop budgets, variable costs from the North Central and Northwest—the two most important regions in the production of dry peas and lentils—are averaged to arrive at State average variable costs of production. In addition, North Dakota crop budgets are used as a proxy for those in Montana. Northern Idaho crop cost budgets for dry peas and lentils are available for 1997, 1999, 2001, 2003, and 2005, as they are updated only every other year (Smathers). Cost budgets in the missing years are approximated based on year-to-year proportional variations of the budgets in North Dakota. The Idaho crop budgets were also used as a proxy for Washington costs due to the lack of a systematic, complete data series (tables 6-7 and appendix tables A-3 and A-4).

Table 6

Expected net returns for dry peas in North Dakota: 1997-2005

Year	Expected yield	Expected price	Variable cost of production	Undeﬂated expected net returns/acre	Value of yield loss reduction	Value of nitrogen credit for next crop	Augmented expected net returns/acre	Deﬂated (yr. 2000 \$) augmented expected net returns
	Cwt/acre			\$/acre				Constant 2000 \$/acre
1997	18.70	9.05	60.18	109.06	14.21	1.70	124.97	130.98
1998	18.90	5.06	60.8	34.83	10.86	1.70	47.39	49.12
1999	18.78	4.58	55.57	30.44	7.99	1.20	39.63	40.50
2000	18.82	3.04	53.77	3.44	7.59	1.25	12.28	12.28
2001	19.26	2.81	49.87	4.25	8.08	1.77	14.10	13.77
2002	19.72	3.03	53.06	6.69	8.82	1.50	17.01	16.33
2003	19.06	5.89	62.07	50.19	9.66	1.85	61.71	58.05
2004	18.92	5.84	62.73	47.76	11.29	2.30	61.35	56.24
2005	19.80	6.03	64.62	54.77	12.10	2.54	69.41	62.16

Source: Estimated and compiled by USDA, ERS from data of North Dakota State University Extension Service and Northern Great Plains Research Laboratory.

Table 7

Expected net returns for lentils in North Dakota: 1997-2005

Year	Expected yield	Expected price	Variable cost of production	Undeﬂated expected net returns/acre	Value of yield loss reduction	Value of nitrogen credit for next crop	Augmented expected net returns/acre	Deﬂated (yr. 2000 \$) augmented expected net returns
	Cwt/acre			\$/acre				Constant 2000 \$/acre
1997	9.00	15.49	50.96	88.45	14.21	1.70	104.36	109.38
1998	9.50	12.25	56.06	60.32	10.86	1.70	72.87	75.54
1999	10.23	7.93	55.21	25.91	7.99	1.20	35.10	35.87
2000	11.28	8.03	52.06	38.52	7.59	1.25	47.35	47.35
2001	12.32	8.15	53.50	46.91	8.08	1.77	56.75	55.42
2002	13.22	8.22	52.07	56.60	8.82	1.50	66.92	64.23
2003	13.22	11.94	60.43	97.42	9.66	1.85	108.93	102.47
2004	13.08	12.14	68.74	90.05	11.29	2.30	103.64	95.00

Source: Estimated and compiled by USDA, ERS from data of North Dakota State University Extension Service and Northern Great Plains Research Laboratory.

The benefits of dry peas and lentils as rotation crops are added to market returns and marketing loan benefits. Based on the crop yield response model developed by the Northern Great Plains Research Laboratory (2002), this study assumes that relative to wheat-wheat operations, a dry peas-wheat rotation would have a yield advantage of 10 percent (tables 6 and 7 and appendix tables A-3 and A-4). The value of yield loss reduction also applies to dry peas and lentils in other States.

Nitrogen credits are also regarded as a part of the expected net returns for peas and lentils. In this study, we assume that dry peas and lentils can fix the bulk of nitrogen needed for their own production and leave, after the growing season is over, about 10 pounds per acre of nitrogen on the soil for the crop following in the rotation. Based on this assumption, which could be somewhat conservative, the per acre value of the nitrogen credit ranged from \$1.20/ac to \$2.50/ac for dry peas and lentils in North Dakota and Montana. In 2005, for example, the use of dry peas as a rotation crop results in an extra value of about \$15 per acre in North Dakota. This additional benefit includes

a value of about \$12.10 from the 10-percent wheat yield advantage for the wheat-dry pea rotation over the wheat-wheat rotation and a “nitrogen credit” worth \$2.54 per acre.

The estimation of aggregate acreage response equations involves the use of cross-section data, raising an issue regarding the fixed effects of individual States. In our analysis, Idaho is chosen as the base or benchmark State for comparison, which is captured in the intercept term.¹³ Differentials across individual States, relative to Idaho, are reflected in State dummies, which are part of the estimated results.

¹³The choice of the benchmark State does not affect relative differentials among major producing States.

Estimated Model Results

The expected net return variables for dry peas and lentils have the expected positive signs and are both statistically significant at the 5-percent significance level in the dry pea and lentil acreage share equations (table 8). Estimated results confirm that spring wheat (including durum) is the primary competing crop for dry peas and lentils, and the cross effects, to the extent that they are measurable, are statistically significant. This finding confirms the hypothesis that most of the acreage expansion for dry peas and lentils in North Dakota and Montana in recent years, starting in 2003, took place at the expense of spring wheat acreage. Some theoretical constraints, such as the symmetry between the beta coefficient of the expected net return for barley in the lentil share equation (b_{23}) and the coefficient of the expected net return for

Table 8

Estimated regression coefficients in the acreage share equations¹

Item	Acreage share planted to--			
	Dry peas	Lentils	Spring wheat	Barley
Intercept	3.1299 (0.8069)***	1.0607 (0.5116)**	19.2341 (3.6606)***	21.5967 (3.3378)***
NRT ₁	0.0143 (0.0069)**	--	--	-0.0008 (0.0069)
NRT ₂	--	0.0140 (0.0049)**	-0.0861 (0.0210)***	0.0388 (0.0258)
NRT ₃	-0.0135 (n.a.) ²	-0.0140 (0.0053)**	0.1750 (n.a.) ³	-0.0889 (0.0210)***
NRT ₄	-0.0008 (0.0069)	--	-0.0889 (0.0210)***	0.0509 (0.0412)
S _{i, t-1}	0.4240 (0.0974)***	0.8799 (0.1035)***	0.4757 (0.0697)***	0.5974 (0.0757)***
D ¹	-1.9462 (0.8379)**	-1.3120 (0.6278)**	21.1670 (2.8620)***	-18.0232 (2.9094)***
D ₂	-2.3631 (0.6723)***	-1.1804 (0.5941)*	24.9116 (2.7717)***	-14.2200 (2.4629)***
D ₃	1.8126 (0.8274)**	-0.6248 (0.6739)	13.9840 (2.6964)***	-12.3579 (2.9528)***

n.a. = Not applicable.

¹Figures in parentheses below the parameter estimates are standard errors. A single, double, or triple asterisk denotes significantly different from zero at 10%, 5%, or 1% significance level.

²A restricted coefficient that is consistent with a cross-price acreage elasticity of -0.501 for lentils with respect to spring wheat price obtained from this study, which is not subject to the test of null hypothesis.

³A restricted coefficient that is consistent with a supply price elasticity of 0.291 for U.S. spring wheat (Lin), which is also not subject to the test of null hypothesis.

lentils in the spring wheat share equation (b_{32}), are not imposed in the estimation because of their statistical insignificance after testing.

Due to a very high degree of multicollinearity between the expected spring wheat and barley net returns (with a correlation coefficient of 0.929), the beta coefficient of the expected spring wheat net return in the dry pea acreage share equation is restricted at -0.0135, consistent with a cross-price acreage elasticity of -0.501 for lentil acreage with respect to the spring wheat price obtained from this study. This “extraneous estimation” approach assumes that the cross-price elasticity of -0.501 for lentil acreage response is applicable to that for dry peas, that is, the cross-price acreage elasticity for dry pea acreage with respect to the spring wheat price is also -0.501 (Maddala; Greene; Lin and Dismukes, p.77). Similarly, the beta coefficient of expected spring wheat net returns in the spring wheat acreage share equation is restricted at 0.175, consistent with a U.S. spring wheat supply price elasticity of 0.291 (Lin, p. 24; Lin et al., p.18). Based on the estimated results, lentils and barley are found to be important competing crops for spring wheat, while spring wheat is the most important competing crop for barley in these major dry pea and lentil producing areas.

Multicollinearity between the expected spring wheat and barley net returns causes the beta coefficient of the expected net return for barley to be statistically insignificant (prior to the imposition of the restriction) in the dry pea acreage share equation. Similarly, it also causes the beta coefficient of the expected net return for spring wheat to be insignificant in the spring wheat acreage share equation. The extraneous information used to restrict specific beta coefficients, either taken directly from this study or previous work, is based on pooled time-series and cross-section (individual States) data, consistent with the nature of pooled data employed in this study. As a result, comparability is maintained after imposing the restrictions. In cases where no relevant extraneous information is readily available, some expected net return variables (e.g., the expected net return for dry peas in the spring wheat share equation) are omitted to avoid a wrong sign or statistical insignificance problem.

The acreage own-price elasticity is estimated at 0.281 for dry peas and 0.624 for lentils, based on procedures described in Lin et al.¹⁴ There are no published estimates of supply elasticities for dry peas and lentils that can be compared with results of this study. The greater acreage price elasticity for lentils than for dry peas is probably due to several factors. First, lentils rely more on export markets, which have been subject to wider fluctuations in recent years, due, for instance, to bad lentil crops in Canada and drought-affected dry pea crops in Spain. In contrast, dry peas have a small feed outlet and can be more responsive to variation in export markets. Second, due to the small base of lentil acreage, its percent of increase in response to a 1-percent change in the expected grower price is likely higher than that for other crops.

The statistical significance of the coefficient of the expected spring wheat net return in the lentil (and possibly dry pea) acreage equation suggests strong competition between spring wheat (including durum) and these pulse crops. Based on procedures discussed in Lin et al., the cross-price acreage elasticity of lentils with respect to the spring wheat price is estimated at -0.501,

¹⁴Concerns have been raised about whether the supply response to expected market price will be different under the marketing loan program than with no program. In other words, did the introduction of the 2002 Farm Act cause structural change in farmers' supply response? Results from previous studies, such as Lin et al. and McDonald and Sumner, are that farmers' acreage response to market price under a planting flexibility policy environment (such as the one under the 1996 Farm Act) or a free market was greater than under farm programs with various planting restrictions (such as during 1991-95). However, this difference is likely to be much smaller in this study than in McDonald and Sumner, because farm programs during the study period of 1997/98 to 2005/06 virtually offered producers complete planting flexibility. The marketing loan program offers producers downside price risk protection through truncation (from below) of the commodity price distribution, which could alter the expected grower price but is unlikely to cause structural change in the supply relations. Also, an unconventional approach, such as the one in the McDonald and Sumner study, is not feasible because it requires detailed data on the total costs of production and marginal cost functions for dry peas and lentils State-by-State, which is only available every other year in the Pacific Northwest region.

meaning that a 1-percent decrease in the expected price of spring wheat would lead to an increase of 0.501 percent in lentil plantings.

The beta coefficients of the lagged dependent variable suggest that producers of dry peas and lentils in the major producing States showed lagged responses to market signals and marketing loan programs. Producers of dry peas responded to these production incentives faster than lentil producers. The slower acreage response for lentils might reflect a greater inertia among lentil producers because of the lack of a feed market and greater reliance on the export market (both commercial and food aid), which is subject to wider fluctuations.¹⁵

¹⁵Although both dry peas and lentils rely heavily on PL-480 purchases by the Federal Government, lentils are more dependent on this outlet.

The Role of Marketing Loans in Acreage Expansion

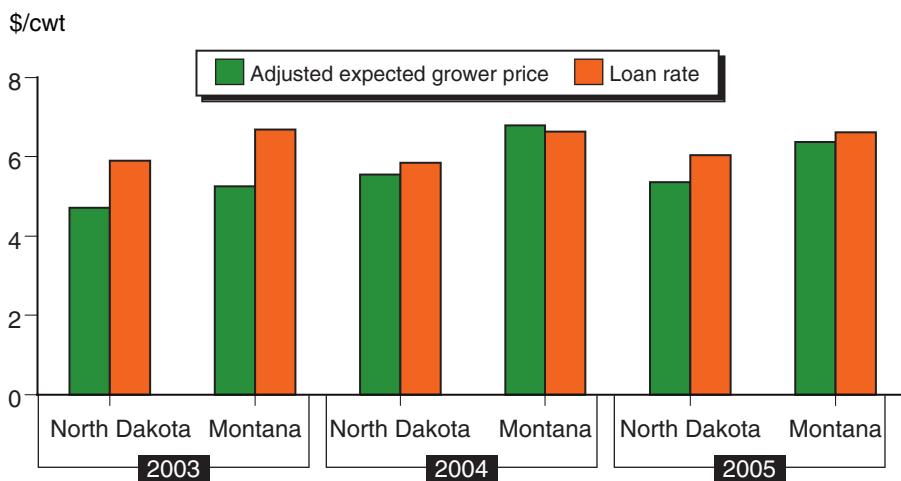
Dry pea and lentil producers benefit from marketing loans through loan deficiency payments (LDPs) or marketing loan gains (MLGs) when the weekly loan repayment rate is less than the loan rate. Since the LDP or MLG equals the difference between the loan rate and the loan repayment rate, the loan rate becomes the effective expected grower price when the expected price is low.

Marketing loans have an impact on acreage whenever the expected grower price is lower than the loan rate because farmers make their planting decisions, in part, based on the expected grower price, not the actual market price received by farmers. Marketing loans played an important role in acreage expansion for dry peas during 2003-05 and for lentils in 2003. In 2003, dry pea producers expected to receive marketing loan benefits of \$1.18 per cwt in North Dakota and \$0.63 in Montana—20 percent and 11 percent of the effective expected grower price (fig. 5). Growers in traditional pea-producing States—Washington and Idaho—were not expecting to directly receive an increase in the expected grower price attributed to marketing loans for the 2003-05 crops, even though marketing loans offered them downside price risk protection.

However, the marketing loan benefit was lowered to \$0.29 per cwt for North Dakota producers in 2004 and to \$0.68 in 2005. The expected grower prices for peas in North Dakota in those 2 years were considerably higher than for 2003 and were below the loan rates by a smaller amount. Thus, no direct increase in the expected grower price was expected by Montana pea producers for 2004 and 2005 because the expected grower prices—\$6.79 and \$6.37 per cwt—were greater than the loan rates. In the case of lentils in 2003, growers expected to receive a marketing loan benefit of \$2.58 per cwt in North Dakota and \$0.36 in Montana—accounting for 22 percent and 3 percent of the effective expected grower price, respectively (fig. 6). Lentil

Figure 5

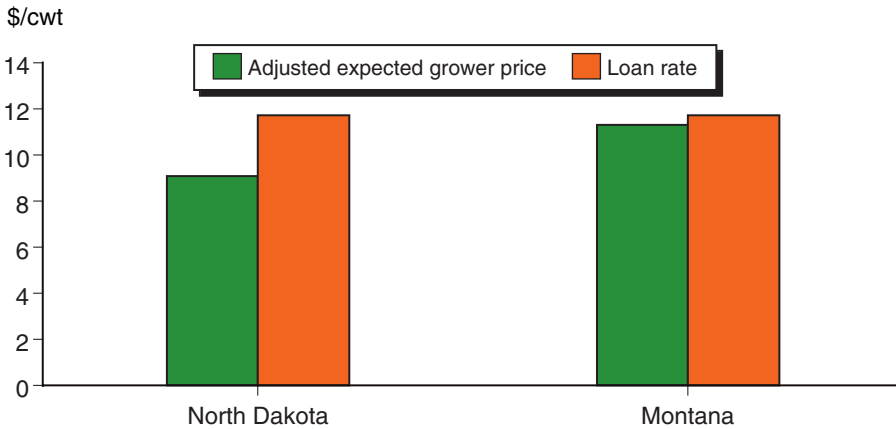
Dry peas: Adjusted expected grower price and loan rate, 2003-05



Sources: Adjusted expected grower prices estimated by USDA, ERS; loan rates as reported by USDA, Farm Service Agency.

Figure 6

Lentils: Adjusted expected grower price and loan rate, 2003



Sources: Adjusted expected grower prices estimated by USDA, ERS; loan rates as reported by USDA, Farm Service Agency.

growers in these two States were not expecting to receive direct marketing loan benefits for 2004 and 2005, nor were lentil producers in Washington and Idaho for 2003-05.

Table 9 shows simulated impacts of marketing loans on acreage expansion for dry peas during 2003-05 and lentils in 2003. In the case of dry peas, marketing loans contributed to acreage expansion in North Dakota, above and beyond market forces, by 40,000 acres in 2003, 9,000 acres in 2004, and 23,900 acres in 2005, and in Montana by 5,700 acres in 2003. Acreage expansion due to marketing loans was largest in 2003 because the marketing loan benefit reached \$1.18 per cwt that year, compared with \$0.68 in 2005. In percentage terms, marketing loans contributed to the acreage expansion of the 2003 crop, beyond that due to market forces, by 33.3 percent in North Dakota and 20.8 percent in Montana.

These impacts of marketing loans on acreage expansion are fairly significant. The impacts were more pronounced in 2003 due to considerably lower expected grower prices relative to the loan rates. Lower season-average prices over the previous few years prior to the planting decision time contributed to the lower expected grower prices for the 2003 crops. The impact of marketing loans would have been greater for the 2003 dry pea crop in North Dakota if the grower price had not reached as high as \$6.70/cwt in 2002 due to weather problems—dry weather in both the Pacific Northwest and the upper Midwest reduced dry pea yields to well below trend. A higher price in 2002 resulted in a greater expected grower price for the 2003 crop, reducing the impact of the marketing loan.

The role of marketing loans in dry pea acreage expansion in North Dakota was substantially reduced, from 33.3 percent in 2003 to 3.0 percent in 2004 and 4.6 percent in 2005, due partly to a large base of planted acreage in these 2 years. In addition, higher grower prices—\$6.70/cwt in 2002 and 6.54/cwt in 2003—contributed to higher expected grower prices for 2004 (\$5.55/cwt) and 2005 (\$5.35/cwt). Low yields of dry peas stemming from dry weather in 2002 and heat and drought in the Pacific Northwest in 2003, as well as

Table 9

Simulated impacts of marketing loan on acreage expansion of peas and lentils

Year	State	Actual planted acreage	Acreage expansion due to marketing loans	Planted acreage without marketing loans	Gain in acreage from marketing loans relative to acreage without marketing loans
<i>————— Dry peas (1,000 acres) —————</i>					<i>Percent</i>
2003	North Dakota	160	+40.0	120.0	33.3
	Montana	33	+ 5.7	27.3	20.8
2004	North Dakota	310	+ 9.0	301.0	3.0
2005	North Dakota	540	+23.9	516.1	4.6
<i>————— Lentils (1,000 acres) —————</i>					<i>Percent</i>
2003	North Dakota	55	+32.9 ¹	22.1	148.9
	Montana	30	+ 5.7	24.4	23.2

¹This acreage expansion is assumed to be half of that simulated using the beta coefficient of the expected net return for lentils in the acreage response model, reflecting the fact that the difference between the expected net returns for lentils calculated from the loan rate and expected grower price greatly exceeds the normal range during 1997-2005, the sample period in this study.

Source: Actual acreage from USDA, National Agricultural Statistics Service; other data computed by USDA, ERS.

strong demand in 2004, contributed to higher expected grower prices in 2004 and 2005. Hence, the impact of marketing loans would have been greater if weather in 2002-03 and market demand in 2004/05 had been in a more normal range.

Marketing loans contributed proportionately more to the acreage expansion of lentils in North Dakota (148.9 percent) and Montana in 2003 (23.2 percent) than to expansion of dry peas. A small base of planted acreage and an effective grower price lower than the loan rate were the main reasons.

Implications of Marketing Loans for World Trade in Dry Peas and Lentils

The United States ranks fourth among dry pea exporting nations, with 5 percent of the world export market in 2002-04. Canada, France, and Australia are the top three exporting countries and collectively account for 72 percent of world dry pea exports. For lentils, the United States is the fifth-largest exporter, behind Canada, Turkey, Australia, and India. During 2003-05, the United States held 8 percent of the world lentil export market.

The expansion in dry pea and lentil acreage induced by marketing loan benefits was greatest in 2003 and was limited to North Dakota and Montana. The impact of the loans on dry pea acreage was modest in 2004 and 2005 and virtually zero for lentils in these 2 years. These findings reflect the fact that the expected marketing loan benefit accounted for a larger share of the combined market and program benefit on a per cwt basis for both dry peas and lentils in 2003, particularly in North Dakota, where the share reached 20.0 percent for dry peas and 24.0 percent for lentils. In 2004 and 2005, however, the shares declined to 5.0 percent and 11.3 percent, respectively, for dry peas and to zero each year for lentils due to high prices in 2003 and 2004. In Montana, the shares of market loan benefits in combined market loan/program benefits were 10.7 percent for peas and 5.7 percent for lentils in 2003 and zero for each in 2004 and 2005.

How does the expected marketing loan benefit affect the world price and U.S. exports? The expansion in U.S. dry pea and lentil acreage attributed to marketing loan benefits clearly is an important factor in exports; however, the impact of expanded production on the world market also depends on whether sustainable feed markets can be developed in the United States to absorb the additional production. The growth experience of the Canadian feed market for dry peas suggests that developing a feed market is a slow process. Until a threshold production level of several million acres is reached, necessary to support a feed industry, the U.S. dry pea industry will primarily rely on export markets to absorb additional production induced by marketing loans. Given limited domestic demand, a similar situation applies to the U.S. lentil industry, because lentils are used almost exclusively as human food. A conceptual framework that illustrates how marketing loans induce acreage expansion and affect world prices and U.S. exports is presented in appendix B.

In addition to the lack of sustainable feed markets for dry peas in the United States, with consequent increases in U.S. exports, there are other important factors that affect the world price, discussed in connection with the simulation model in appendix B. These factors include the share of revenue derived from market price vs. marketing loan benefits, supply and demand price elasticities in the United States and world market, and the share of U.S. production and consumption in world markets. The simulation model, adapted from Sumner, shows that in 2003, when marketing loans for dry peas had the largest impact, marketing loans led to a decline in the world price of 0.33 percent to 0.55 percent, depending on the demand price elasticity. The lower figure assumes an inelastic demand elasticity of -0.7 (the base case), while the higher one assumes a lower elasticity of -0.3.

The share of revenue coming from marketing loan benefits in North Dakota in 2003—20 percent, as obtained from this study’s supply response analysis—is assumed here to reflect a likely upper-bound impact facing Canadian pulse growers and the fact that most acreage expansion came from this State. Also, results from this study’s simulation model are cast in an *ex ante* context, which differs from the *ex post* analysis in Sumner.¹⁶ Results from the simulation model based on the expected grower price and expected marketing loan benefits can more accurately reflect reality, because producers make their planting decisions on the expected market returns and program benefits, not on actual values.

The present study’s estimates of the impact of marketing loans on the world price assumes that all additional U.S. production of dry peas induced by marketing loans is channeled into export markets. An impact of similar magnitude applies to marketing loans for lentils in 2003 because of similarities in the share of U.S. lentil production in the world market and the share of lentil producers’ revenue from the marketing loan benefit.¹⁷ However, larger supply price elasticity for lentils (0.624) than for dry peas (0.281) might exert a greater impact on world prices. Smaller impacts on the world price were expected from dry pea and lentil marketing loans in 2004 and 2005.

The impact of marketing loans for dry peas and lentils on the volume of U.S. exports is more pronounced in 2003 than in 2004 and 2005, but limited to that caused by expanded acreage in North Dakota and Montana. In the case of dry peas, the expanded acreage in 2003 translated into a production expansion of 39,500 tons. Assuming all the additional production is channeled into export markets, the volume of exports would be up by 1.8 percent for the 2003 crop, which would be particularly felt by Canadian pulse growers. The impact of marketing loans on U.S. exports would be smaller in 2004 and 2005 due to stronger expected grower prices and would be limited to induced acreage expansion in North Dakota.

The estimated impact on export volume is consistent with steady increases in Canadian dry pea imports, from 24,000 tons in 2003/04 to 56,000 tons in 2004/05 and 90,000 tons in 2005/06 (Skrypetz, Feb. 3, 2006). However, these large increases can apparently be attributed more to factors other than U.S. marketing loans, such as a Canadian dollar that had been steadily strengthening against the U.S. dollar since 2002, making imports of U.S. dry peas cheaper, all else being equal. Thus, the impact of U.S. marketing loans on dry pea exports was negligible for the study period.

The impact of marketing loans for lentils on the volume of U.S. exports is limited to that caused by acreage expansion in North Dakota and Montana in 2003. No such impacts apply to the 2004 and 2005 crops. Marketing loans for lentils are estimated to have induced an acreage expansion of 32,900 acres in North Dakota and 5,700 in Montana (table 9), accounting for 2.2 percent of world trade for lentils in 2003.

¹⁶The Sumner study treated an average of recent years (2003-05) as though they were representative for expectations for future years.

¹⁷In 2005/06, U.S. export share of production reached 61 percent for dry peas and 60 percent for lentils.

Conclusions

Marketing loans played an important role in acreage expansion for dry peas during 2003-05 and for lentils in 2003. In the case of dry peas, marketing loans contributed to an expansion in acreage for the 2003 crop by a third in North Dakota and about a fifth in Montana, above and beyond any increase due to market forces. The role of marketing loans in acreage expansion in North Dakota was substantially reduced in 2004 and 2005. No impact on dry pea acreage expansion from marketing loans was found in Montana for those 2 years, or in Idaho and Washington during 2003-05. On the other hand, marketing loans contributed proportionally more to the acreage expansion of lentils than of dry peas in North Dakota and Montana in 2003, but marketing loans had much less impact in any of the major producing States in 2004 and 2005.

The impacts of marketing loans on acreage expansion for dry peas and lentils were more pronounced in 2003 due to lower season-average prices over the few years prior to the planting decision time. The impact of marketing loans would have been greater for the 2003 dry pea crop in North Dakota if the grower price had not reached a high level due to dry weather. In contrast, considerably higher season-average prices in 2002/03 and 2003/04 caused by weather problems, and in 2004/05 by strong growth in demand, contributed to higher expected grower prices for dry peas in 2004/05 and 2005/06, lowering the impact of marketing loans on acreage expansion in 2004 and 2005.

Future acreage expansion of pulse crops will depend on whether a viable U.S. feed market develops to absorb the additional production of dry peas. The feed market in 2008 is largely undeveloped, and the growth experience of the feed market in Canada provides no historical basis for expecting that this will change soon. Until there is a consistent supply of dry peas to support a feed industry, the U.S. dry pea industry will continue to rely mostly on export markets for the sale of production induced by marketing loans. As for lentils, which are considered to be largely human food, any production increase that exceeds domestic demand will also go into exports.

Results of the simulation model used in the study (appendix B) suggest that marketing loans for dry peas and lentils had negligible impacts on market prices in the world market during 2003-05. For the 2003 crop, marketing loans contributed to an acreage expansion of U.S. dry peas and a reduction in the world price of 0.33 percent to 0.55 percent, depending on the demand price elasticity. Critical factors that lead to this negligible impact include: (1) the relatively small share held by U.S. production in the world market, (2) a modest share of revenues from marketing loan benefits, and (3) supply and demand price elasticities assumed in this study's analysis.

Thus, marketing loans for dry peas and lentils appear to have had minor impacts on the volume of world trade. The impact on U.S. exports was more pronounced in 2003 but limited to North Dakota and Montana. If all the additional production had been channeled into export markets, marketing loans would have increased the volume of exports by 1.8 percent for dry peas in 2003. The estimated impact was smaller in 2004-05. Similarly, marketing

loans are estimated to have led to an increase of 2.2 percent in U.S. lentil exports in 2003. However, no such impacts are found in 2004 and 2005.

This study abstracts from a formal treatment of risk about prices and yields, an analysis that would otherwise require the inclusion of a covariance term between crop yields and farm prices in expected net returns calculation. Also, truncation (from below) of the price distribution from the marketing loan program would have to be explicitly taken into consideration and incorporated into the calculation of expected net returns and expected variance of revenues. Finally, acreage response equations would include expected covariance of revenues if commodity prices are correlated.

The estimation of acreage response parameters in the study is constrained by a limited number of observations in the pooled time-series and cross-section data. This makes the estimated acreage response system more prone to the correlation issues between some explanatory variables and endogeneity concerns. While the use of extraneous information that was obtained from previous studies offers some remedy, future studies that include longer time-series data as they become available would be warranted.

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Appendix A—Expected Grower Prices and Expected Net Returns for Dry Peas and Lentils, 1997-2005

Appendix table A-1

Calculating the expected grower prices of dry peas in Montana: 1997-2005

Year	Grower price	Unadjusted expected	$P_t^1 - UEP_t^2$	Adjustment factor	Adjusted expected	Effective expected	
		grower price			grower price	grower price	grower price (incl. LDP or MLG)
		\$/cwt				\$/cwt	
1997	6.40	9.05	-2.65	0.00	9.05	9.05	
1998	4.90	7.71	-2.81	-2.65	5.06	5.06	
1999	6.00	6.31	-0.31	-2.73	3.58	3.58	
2000	5.00	5.75	-0.75	-1.92	3.83	3.83	
2001	4.90	5.28	-0.38	-1.63	3.65	3.65	
2002	7.20	5.15	2.05	-1.38	3.77	3.77	
2003	8.10	6.07	2.03	-0.81	5.26	5.89	
2004	6.00	7.19	-1.19	-0.40	6.79	6.79	
2005	n.a.	6.87	n.a.	-0.50	6.37	6.37	

n.a. = not available.

¹Actual observed grower price.

²Unadjusted expected grower price has the following weighting scheme: 0.5, t-1, 0.3, t-2; and 0.2, t-3 (P_t).

Source: Computed by USDA, ERS from prices reported by USDA, National Agricultural Statistics Service.

Appendix table A-2

Calculating the expected grower prices of lentils in Montana: 1997-2005

Year	Grower price	Unadjusted expected	$P_t^1 - UEP_t^2$	Adjustment factor	Adjusted expected	Effective expected	
		grower price (UEP)			grower price	grower price (incl. loan rate)	
		\$/cwt				\$/cwt	
1997	13.20	15.49	-2.29	0.00	15.49	15.49	
1998	10.30	14.54	-4.24	-2.29	12.25	12.25	
1999	12.60	12.39	0.21	-3.27	9.13	9.13	
2000	10.00	12.03	-2.03	-2.11	9.92	9.92	
2001	11.00	10.84	0.16	-2.09	8.75	8.75	
2002	13.80	11.02	2.78	-1.64	9.38	9.38	
2003	15.40	12.20	3.20	-0.90	11.30	11.94	
2004	15.60	14.04	1.56	-0.32	13.72	13.72	
2005	n.a.	15.18		-0.08	15.10	15.10	

n.a. = not available.

¹Actual observed grower price.

²Unadjusted expected grower price has the following weighting scheme: 0.5, t-1, 0.3, t-2; and 0.2, t-3 (P_t).

Source: Computed by USDA, ERS from prices reported by USDA, National Agricultural Statistics Service.

Appendix table A-3

Expected net returns for dry peas in Montana: 1997-2005

Year	Expected yield	Expected price	Variable cost of production ¹	Uninflated expected net returns/acre	Value of yield loss reduction	Nitrogen credit for next crop	Augmented expected net returns/acre	Deflated (yr. 2000 \$) augmented net returns
	— Cwt/acre —				— \$/acre —			Constant \$/acre
1997	18.70	9.05	60.18	109.06	14.09	1.70	124.85	130.86
1998	18.90	5.06	60.80	34.83	12.81	1.70	49.34	51.15
1999	18.68	3.58	55.57	11.30	9.84	1.20	22.34	22.83
2000	17.74	3.83	53.77	14.17	9.26	1.25	24.69	24.69
2001	15.82	3.65	49.87	7.87	8.30	1.77	17.95	17.53
2002	15.26	3.77	53.06	4.47	9.26	1.50	15.23	14.62
2003	13.00	5.89	62.07	14.50	11.29	1.85	27.64	26.00
2004	12.30	6.79	62.73	20.79	11.98	2.30	35.07	32.14
2005	13.52	6.37	64.62	21.50	12.13	2.54	36.17	32.39

¹Uses data from North Dakota as a proxy.

Source: Compiled by USDA, ERS from data of North Dakota State University Extension Service and Northern Great Plains Research Laboratory.

Appendix table A-4

Expected net returns for dry peas in Montana: 1997-2005

Year	Expected yield	Expected price	Variable cost of production ¹	Uninflated expected net returns/acre	Value of yield loss reduction	Nitrogen credit for next crop	Augmented expected net returns/acre	Deflated (yr. 2000 \$) expected net returns
	— Cwt/acre —				— \$/acre —			Constant \$/acre
1997	9.00	15.49	50.96	88.45	14.09	1.70	104.24	109.26
1998	9.50	12.25	56.06	60.32	12.81	1.70	74.82	77.56
1999	10.23	9.13	55.21	38.19	9.84	1.20	49.23	50.31
2000	11.28	9.92	52.06	59.84	9.26	1.25	70.35	70.35
2001	12.32	8.75	53.50	54.30	8.30	1.77	64.37	62.86
2002	13.22	9.38	52.07	71.93	9.26	1.50	82.69	79.37
2003	13.22	11.94	60.43	97.42	11.29	1.85	110.56	104.00
2004	13.08	13.72	68.74	110.72	11.98	2.30	125.00	114.58
2005	12.72	15.10	70.87	121.20	12.13	2.54	135.87	121.67

¹Uses data from North Dakota as a proxy.

Source: Compiled by USDA, ERS from data of North Dakota State University Extension Service and Northern Great Plains Research Laboratory.

Appendix B—Conceptual Framework and Simulation Model

This analysis extends the estimated results from the supply response model developed for the study to draw out the implications of marketing loans for dry peas and lentils on world prices and trade volume, using a simulation model adapted from Sumner (2005).

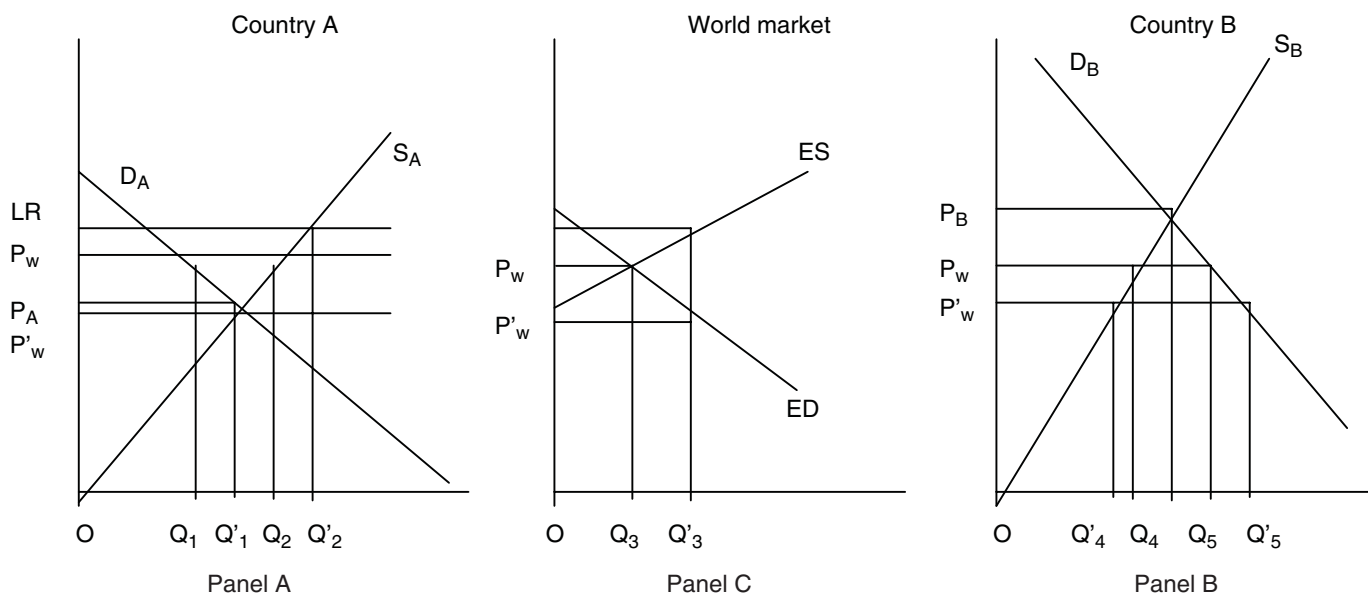
Conceptual Framework

The conceptual framework is a two-country, one-commodity trade mode (fig. B-1). Supply and demand functions for a particular commodity are represented in panel A for country A (the United States), in panel B for country B (the rest of the world (ROW)), and in panel C for the world market.¹ Let S_A and D_A be the supply and demand curves for dry peas or lentils in country A. Similarly, let S_B and D_B be the supply and demand curves in country B. In the absence of trade, the two markets clear prices at P_A and P_B , where the quantities supplied equals the quantities demanded. Trade of the commodity between the two countries without government intervention allows exportable supply of the commodity in country A to be shipped to country B, as the commodity price moves above P_A but below P_B . Excess supply in the world market is the horizontal difference between the supply and demand curves in country A as the commodity's price moves upward from P_A in country A. Similarly, excess demand is the horizontal difference between the demand and supply curves in country B as the price moves downward from P_B . The trading equilibrium is identified by the intersection of excess supply and excess demand curves, which yields the market clearing price of P_w . The volume of trade at this world price level equals the volume of export (Q_1Q_2), the difference between quantity supplied (OQ_2) and domestic use (OQ_1), in

¹In some trade applications the relevant market is not the "world market" but a smaller region (Sumner; Schnepf and Womach). An obvious question is whether North America should be treated as a region separate from the ROW, especially if this study focuses on the trade impact exclusively on the Canadian pulse industry.

Figure B-1

The conceptual framework of a two-country, one-commodity trade model



country A. This trade volume also equals the volume of import (Q_4Q_5), the difference between quantity demanded (OQ_5) and quantity supplied (OQ_4), in country B. In the world market panel, this volume of trade is denoted by quantity OQ_3 , where the export equals import.

Marketing loans for U.S. producers of dry peas and lentils have the potential to affect world prices and exports. The loan rate (LR) becomes the effective grower price when the expected grower price is below the loan rate, causing the supply curve in country A and the excess supply curve (ES) in the world market to become a kinked supply curve. A kink is also introduced in the excess supply curve at the loan rate level.

Under this market condition, where the expected grower price is below the loan rate, the quantity supplied in country A becomes OQ_2' up from the previous OQ_2 . In the case of dry peas or lentils, this conceptual framework assumes that additional production induced by marketing loans for either dry peas or lentils would be channeled into export markets. The feed market of the U.S. dry pea industry is largely undeveloped and is likely to remain so until the industry can provide a consistent, sustainable supply of dry peas for feed mills. Additional production of lentils would be channeled into export markets, because lentils are primarily used as human food. As a result, the volume of exports increases from Q_1Q_2 to Q_1Q_2' —the sum of Q_1Q_2 and Q_2Q_2' —in country A and imports by country B also increase from Q_4Q_5 to Q_4Q_5' —the sum of Q_4Q_5 , Q_4Q_4' , and Q_5Q_5' . The world market is cleared at a new world price level (P_w'), where the quantity of excess supply (OQ_3') intersects with the excess demand curve (ED), with a volume of trade at OQ_3' .

Simulation Model

The simulation model measures what the world price levels would have been if the marketing loan programs for dry peas and lentils, as they existed under the 2002 Farm Act, had been removed. While Sumner focuses on major grains and covers the whole array of government subsidies, the model in this study focuses on dry peas and lentils and is limited to marketing loans. Also, the impact of marketing loans on world price is derived from the expected grower price instead of from the realized market prices over recent years, which were treated in the Sumner study as though they were representative of future expectations. Finally, the supply price elasticity and the impact of marketing loans on U.S. exports, as obtained directly from results of the supply response model, are used to estimate the impacts on world prices and volume of trade on the world market.

Consider the supply and demand functions for dry peas or lentils in the United States and the rest of the world with the following general structure in logarithmic differential form:

$$(A-1) \quad d\ln S_u = \varepsilon_u (d\ln EFP)$$

$$(A-2) \quad d\ln D_u = \eta_u (d\ln P)$$

$$(A-3) \quad d\ln S_r = \varepsilon_r (d\ln EP)$$

$$(A-4) \quad d\ln D_r = \eta_r (d\ln P)$$

where S_u and S_r are the supply curves in the United States and the rest of the world, respectively, and D_u and D_r are the respective demand curves. EFP is the expected effective grower price facing U.S. growers of dry peas or lentils, which is the sum of the expected grower price and loan deficiency payment (LDP) or marketing loan gain (MLG) from the marketing loan when the expected grower price is lower than the loan rate. Otherwise, the expected grower price is EFP. Producers in the rest of the world respond only to the expected grower price (EPr) in the absence of a marketing loan program. Consumers (and buyers) in both the United States and the rest of the world respond to the market clearing price (P) in an otherwise largely free trade context.

Since $EFP = EP_u + LDP$ when the expected grower price is below loan rate, this implies that:

$$(A-5) \quad d\ln EFP = \alpha d\ln EP_u + (1-\alpha) d\ln LDP$$

Where: $\alpha = EP_u / (EP_u + LDP)$, and
 $1-\alpha = LDP / (EP_u + LDP)$

The percentage change in the total supply of dry peas or lentils in the world market ($d\ln S_w$) is the weighted percentage change in the supply in the United States and the rest of the world, that is,

$$(A-6) \quad d\ln S_w = \delta_{su} d\ln S_u + (1 - \delta_{su}) d\ln S_r \\ = \delta_{su} \varepsilon_u (d\ln EFP) + (1 - \delta_{su}) \varepsilon_r (d\ln EP_r) \\ = \delta_{su} \varepsilon_u (d\ln EP_u) + \delta_{su} \varepsilon_u (d\ln LDP) + (1 - \delta_{su}) \varepsilon_r (d\ln EP_r)$$

where δ_u and $(1 - \delta_u)$ are the share of U.S. and the rest of the world production of dry peas or lentils in the world market, respectively. Similarly, the percentage change in the total demand in the world market ($d\ln D_w$) is the weighted percentage change in the demand in the United States and the rest of the world, that is,

$$(A-7) \quad d\ln D_w = \delta_{du} (d\ln D_u) + (1 - \delta_{du}) d\ln D_r$$

Substituting equations (A-2) and (A-4) into (A-7) yields:

$$(A-8) \quad d\ln D_w = \delta_{du} \eta_u d\ln P + (1 - \delta_{du}) \eta_r d\ln P$$

The percentage change in world price in the world market is determined by equating $d\ln S_w = d\ln D_w$, which is solved as:

$$(A-9) \quad d\ln P = [1 / (\delta_{du} \eta_u + (1 - \delta_{du}) \eta_r)] \cdot [\delta_{su} \varepsilon_u \alpha d\ln EP_u \\ + \delta_{su} \varepsilon_u (1 - \alpha) d\ln LDP + (1 - \delta_{su}) \varepsilon_r d\ln EP_r]$$

However, since the U.S. dry pea or lentil industry is likely a price taker, the percentage change in the expected grower price would follow that of the world price, implying that:

$$(A-10) \quad d\ln EP_u = d\ln EP_r = d\ln P$$

Setting $d\ln S_w = d\ln D_w$, the percentage change in the world price if marketing loan for dry peas or lentils in the United States is removed (that is, $d\ln LDP = -1$) becomes:

$$(A-11) \quad d\ln P = - \frac{[\delta_{su} \varepsilon_u (1-\alpha)]}{[\delta_{du} \eta_u + (1-\delta_{du})\eta_r - [(\delta_{su} \varepsilon_u \alpha) + (1-\delta_{su})\varepsilon_r]]}$$

Key parameter values assumed in deriving the percentage change in the world price resulting from the hypothetical removal of the marketing loan in the base scenario for the 2003 U.S. dry pea crop are:

$$\begin{aligned} \varepsilon_u &= 0.28 \\ \varepsilon_r &= 0.28 \\ \delta_{su} &= 5.7\% \\ \delta_{du} &= 1.0\% \\ \alpha &= 80\% \\ 1-\alpha &= 20\% \\ \eta_u &= -0.7 \\ \eta_r &= -0.7 \end{aligned}$$

Substituting these key parameter values into equation (A-11), the percentage change in the world price is estimated at 0.33 percent, meaning that world price of dry peas in the world market in 2003 would have increased by 0.33 percent if the U.S. marketing loan program had been removed. This finding suggests that the implementation of the dry pea marketing loan lowered the world price by 0.33 percent for the 2003 crop—a negligible impact. Critical factors behind this result include: (1) the small 5.7-percent share of U.S. dry pea production in the world market, (2) a modest 20-percent share of revenues from LDP, (3) an inelastic supply elasticity of 0.28, and (4) an inelastic demand price elasticity of -0.7.² Alternatively, marketing loans for dry peas are estimated to have lowered the world price by 0.55 percent if a smaller demand price elasticity (-0.3) is assumed. The impact of the marketing loan on the world price for lentils is of similar magnitude, although larger supply elasticity could exert a greater impact. However, the impacts are even smaller for the 2004 and 2005 dry pea crops and are virtually nil for the 2004 and 2005 lentil crops.

The future impact of the marketing loan program on the volume of exports depends on whether a U.S. feed market can be developed to absorb additional production of dry peas caused by marketing loans. The trade impact of increased U.S. exports would be particularly felt by Canadian pulse growers. Most of this volume would likely be transshipped through Canada from North Dakota and Montana due to transportation economics. The impact of marketing loans on the volume of U.S. exports would have been smaller in 2004 and 2005 and limited to a surplus induced by acreage expansion in North Dakota.

Additional production stimulated by marketing loans for lentils most likely would have been channeled to export markets because lentils are used primarily for food. However, the impact of marketing loans on exports was limited to that caused by acreage expansion in North Dakota and Montana in 2003. There were no such impacts from the 2004 and 2005 crops.

²If the appropriate U.S. supply elasticity turns out to be greater than that estimated over the study period, then the impact of marketing loans on the world price would be greater.