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WORLD FEED BARLEY TRADE UNDER ALTERNATIVE TRADE POLICY SCENARIOS

Weining Mao
Won W. Koo
Mark A. Krause

DEPARTMENT OF AGRICULTURAL ECONOMICS
AGRICULTURAL EXPERIMENT STATION
NORTH DAKOTA STATE UNIVERSITY
FARGO, ND 58105-5636

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Mark A. Krause

Department of Agricultural Economics
North Dakota State University
Fargo, ND 58105-5636

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Abstract

A spatial equilibrium model based on a quadratic programming algorithm was developed to analyze world feed barley trade and international competition among major exporters (Australia, Canada, the European Union, and the United States) under the current and alternative trade policy scenarios. The U.S. Export Enhancement Program (EEP) plays an important role to maintain U.S. market share in importing countries. Eliminating Canadian rail subsidy decreases Canadian offshore exports, but greatly increases its exports to the United States. The North American Free Trade Agreement (NAFTA) increases feed barley trade within North America, but has little impact on world trade flows for feed barley. Canada benefits most under the Uruguay Round Agreement of GATT and the world free trade through significantly higher exports to offshore markets and the United States. Australia also gains from free trade. The European Union is worse off under free trade.

Keywords: feed barley, international grain trade, trade policy, spatial equilibrium model.

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Highlights

Barley is one of most heavily traded crops in the world grain market. World trade for barley has been dominated by several large countries and also distorted by tariff and non-tariff barriers, export subsidies, and other export promotion programs. A spatial equilibrium model based on a quadratic programming algorithm was developed to analyze the world feed barley trade and international competition among Australia, Canada, the European Union (EU), and the United States under current and alternative trade policy scenarios.

With implementation of the North American Free Trade Agreement (NAFTA) and the Uruguay Round Agreement of GATT, export subsidies and trade barriers in world feed barley trade are soon to be eliminated or reduced. These include the EU Export Restitutions/Refunds Program (ERP), the U.S. Export Enhancement Program (EEP), Canadian rail subsidies, and the tariff and non-tariff barriers in importing countries. This study evaluates the impacts of these changes on trade flows for feed barley. The optimal domestic marketing and distribution of feed barley in Canada and the United States and the bilateral trade flows of feed barley between these two countries under alternative policies are also examined.

The U.S. EEP is very important for U.S. feed barley exports. The removal of the U.S. EEP decreases U.S. competitiveness in the world market and reduces U.S. exports by 26 percent. In addition, U.S. imports from Canada will decrease by 23 percent. Although the increases in other countries' exports are relatively small, eliminating U.S. EEP will cause significant shifts in trade flows of feed barley in the world market.

The Canadian rail subsidy is an indirect subsidy provided by the Canadian government under the Western Grain Transportation Act (WGTA) to farmers for shipments of grains from producing regions to export ports. Eliminating the Canadian rail subsidy decreases Canadian offshore exports and increases the other countries' exports. U.S. imports from Canada significantly increase mainly because removal of the Canadian rail subsidy increases transportation costs to offshore markets and makes the U.S. market more attractive. These results are similar to those of Johnson and Wilson's study on North American barley trade and competition.

After the Canadian rail subsidy and the U.S. EEP are eliminated, both Canadian and U.S. feed barley exports decline, and the EU and Australia increase their exports. Mexico reduces its imports from Canada. Canadian exports to the United States increase by 34 percent. However, the impacts on trade flows under this scenario are less than under elimination of the U.S. EEP or the Canadian rail subsidy.

NAFTA increases the trade volume of feed barley in North America. Both Mexico and the United States increase imports from Canada. The United States also increases its exports to Mexico. However, NAFTA has little impact on feed barley trade in other markets. Eliminating *tariffs in importing countries also increases imports in Eastern Asia and Latin America. But its effects on world total exports, trade flows, and social payoffs are not significant.*

Under the Uruguay Round Agreement of GATT, EU exports of feed barley drop by 14 percent. Canada increases its exports to the world market by 17 percent. Canada gains most from freer trade, followed by Australia with slight increase of its exports. The United States reduces its exports by a small amount. Most importing regions, except Eastern Asia and Latin America, reduce their imports because reducing the U.S. EEP under the Uruguay Round Agreement raises import prices. The Uruguay Round Agreement of GATT has a significant influence on world trade flows of feed barley.

World free trade reduces EU feed barley exports by 48 percent. U.S. exports decrease lightly The other two exporting countries increase their exports. Canada benefits most under free trade by increasing its exports by 27 percent. Australia also gains from the free trade. The total trade volume and social payoffs of feed barley decline under world free trade scenario because of the reduction of export subsidies and promotion programs in exporting countries. Without import tariffs, Eastern Asia and Latin America increase imports of feed barley, but imports in other importing regions drop because of higher import prices with the elimination of export subsidies.

Reducing exports in Canada and the United States lowers domestic prices and increases consumer surplus, and reduces producer revenue in these two countries. However, increasing exports raises domestic prices and increases producer revenue. Consumers in the U.S. and Canada are made worse off because of higher domestic price.

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Introduction

Barley is one of most heavily traded crops in the world grain market. Historically, the volume of world barley trade has ranked third among grains behind wheat and corn. World barley trade has tripled since 1960, but still trails the growth in both corn and sorghum. In 1992/93, world barley trade reached 17.78 million metric tons (MT).

Australia, Canada, European Economic Community, and the United States are four major barley exporting countries. The European Union (EU) is the leading barley exporter, accounting for a 44 percent market share in 1992/93. Australia ranked second with a 16 percent market share, followed by Canada and the United States with market shares of 15 and 10 percent, respectively, during this time period (Canadian Grains Statistical Handbook).

The major barley importers are Saudi Arabia, the former Soviet Union (FSU), and Japan. These three countries accounted for about 71 percent of world barley imports in 1992/93. The United States is another important barley importer with a market share of 7 percent. The other importing countries or regions include West Asia, North Africa, East Europe, and Latin America. Saudi Arabia has become the world's largest barley importer since 1982/83. In 1992/93, Saudi Arabia accounted for almost half of world barley trade (FAO Trade Yearbook).

Barley is mainly used in the livestock and malt industries. Based on the variety and quality, barley is classified as feed or malting barley. If a malting variety fails to meet malting standards, it can be sold as feed barley. Consequently, international trade of barley consists of three parts: feed barley, malting barley, and malt. The trade volume of feed barley accounts for about 80 percent of total world barley trade (Statistical Digest of Barley, Malt, Beer, and Whisky). Because of the relatively small trade volume of malting barley and malt and the difficulty of obtaining comprehensive data on trade in malting barley and malt, this study concentrates on the world feed barley trade.

The world feed barley trade has been dominated by several large countries. Exporting countries have used various farm programs and trade policies to protect the incomes of domestic barley producers and to increase their competitiveness in the world market.

The overall objective of this study is to determine how the policy changes in major trading countries will affect world feed barley trade and net social payoffs. The four specific objectives are as follows:

1. To analyze the impacts of export subsidies and promotion programs used by major exporting countries on world trade flows of feed barley.

2. To investigate the impacts of the North America Free Trade Agreement (NAFTA) on feed barley trade in North America.

3. To analyze the impacts of the Uruguay Round Agreement of GATT and a free trade environment on world trade flows of feed barley.

4. To examine the optimal domestic marketing and distribution of feed barley in Canada and the United States.

Most previous studies on world grain trade have concentrated on wheat and corn. Few studies have analyzed the effects of agricultural policies used by major trading countries on world barley trade. Haley *et al.* (1992) used a static world policy simulation model (SWOPSIM) to analyze the impacts of the U.S. EEP on world barley trade for 1986/87 and 1987/88. Results from the study indicated that the barley EEP was probably more effective than the wheat EEP in boosting U.S. exports. The study concluded that the EEP likely causes U.S. barley prices to increase and consequently benefits U.S. barley producers and harms U.S. consumers. But consumer losses were less than what producers gained. In addition, some EEP expenditures on feed barley were offset by government saving from lower deficiency payments to barley producers. The results implied that the EEP has made the United States more competitive with the EU in barley exports.

Several recent studies have focused on North American barley trade and competition under an assumption of a single North American barley market. Alberta Agriculture (1992) released a proposal to eliminate the control of the Canadian Wheat Board (CWB) on feed and malting barley sales to the United States and to establish a "North American Continental Market for Barley." The Canadian Wheat Board (1992) presented a report to defend its role as a "single-desk" in marketing barley in Canada and the United States. A study conducted by Carter (1993) suggested that the removal of CWB's monopoly power would lead to economic gains for farmers due to improved price signals and competitive discipline in grain handling. The creation of the single North American barley market may also have negative impacts on farmers, but the gains to farmers from the single North American market outweigh any associated losses. The CWB would no longer be the only exporter of barley to the United States under the continental marketing system. However, Gary *et al.* (1993) argued that even though the United States would increase malting barley imports, the historic price premium in both Canada and the United States would drop sufficiently to lower total revenue for malting barley producers. A continental barley market would adversely affect optimal trade flows and reduce revenue for feed barley producers. The potential to offset these losses in revenue by reducing freight and handling costs or by growing higher-yielding feed varieties appears to be very limited.

Johnson and Wilson (1994) used a quadratic programming model to analyze North American barley trade and competition. Results from that study indicated that Canada has considerable potential for exporting barley to the United States. This study found that eliminating Canadian rail subsidies may not benefit U.S. producers, and that increasing the U.S. EEP bonus would increase U.S. domestic feed barley price and induce a large flow of Canadian barley into the U.S. market. However, an increase in U.S. barley planted acreage would lower producer prices in both Canada and the United States and reduce U.S. barley imports from Canada.

Trade Policies in Major Exporting and Importing Countries

The EU, the world's largest barley exporter, subsidizes 100 percent of its barley exports. The EU uses the Export Restitutions/Refunds Program (ERP) to compensate exporters for the difference between high internal market prices and world prices. The refunds are set on the basis of weekly tenders to the EU's Cereals Management Committee. The refunds are paid to exporting firms whose bids are accepted on the basis of the difference between internal EU prices and prices in importing regions and transport and marketing costs. According to *World Grains Statistics* (International Wheat Council), the average unit export refund for barley from 1990/91 to 1992/93 was $129 per metric ton.

The United States subsidizes its barley exports through the Export Enhancement Program (EEP). The objectives of the EEP are to offset the effects of trade-distorting subsidies of competing exporters, expand U.S. exports, and maintain or increase U.S. market shares in the world grain market. The United States first applied the EEP to barley in 1986 to compete with the EU in targeted importing countries. Since then, most U.S. barley exports have been subsidized under the EEP. In terms of value of sales, barley is the second most important commodity sold under the EEP after wheat. EEP bonuses vary by country as well as by time period. Saudi Arabia is the largest market for U.S. barley exports under the EEP. The other targeted countries include Israel, Cyprus, Jordan, Algeria, Morocco, Tunisia, Bulgaria, Hungary, Poland, and the FSU.

Canada and Australia do not have explicit government programs to subsidize their exports. However, the Canadian Wheat Board (CWB) and Australian Wheat Board (AWB) have monopoly power for barley procurement and distribution. They can target international markets through discriminatory pricing. In addition, the Canadian government provides an indirect rail subsidy for export shipments of barley under the Western Grain Transportation Act (WGTA). The WGTA rail subsidy reduces the transport and handling costs of barley shipments from producing regions to export ports. The Canadian rail subsidy was estimated at $21.31 per metric ton, which was equivalent to 70 percent of the estimated average freight rate in 1989-1990, according to the U.S. International Trade Commission.

Long-term Agreements (LTAs) and Credit Guarantees are other important export promotion programs used by major barley exporting countries. These programs help exporting countries to expand their exports, enter new markets, and stabilize exports to some targeted markets for a long period. Most barley exporting countries, except the EU, have long-term agreements with some major importing countries. Australia extends export credits through the AWB for up to 3 years. The Canadian government also guarantees loan repayment on credit extended no more than three years. The United States has two programs to provide export credit guarantees for barley exports: GSM-102 and GSM-103, operated by the Commodity Credit Corporation. GSM-102 provides short-term (less than 3 years) and GSM-103 provides medium-term (3-10 years) loan guarantees to targeted importing countries for U.S. barley exports.

The North American Free Trade Agreement (NAFTA) went into effect on January 1, 1994. The Uruguay Round of the General Agreement on Tariffs and Trade (GATT) negotiations also reached final agreement in 1994. These two agreements will reduce or eliminate tariff and non-tariff barriers and reduce export subsidies on agricultural products in the specified periods. Under NAFTA, both Mexico and the United States will eliminate tariffs on barley trade. Under the Uruguay Round Agreement of GATT, the major barley exporting countries will reduce their expenditures on export subsidies by 36 percent, and the subsidized quantity by 21 percent from their average levels in 1986-1988. Meanwhile, the barley importing countries will also reduce import tariffs and other trade restrictions by 15 percent for developed country and 25 to 33 percent for developing country (Premakumar *et al*., 1994).

Methodology

The model used for this study is a static spatial equilibrium model based on a quadratic programming algorithm. The model contains four major exporters (Australia, Canada, the EU, and the United States) and nine importing regions (East Asia, Saudi Arabia, West Asia, North Africa, East Europe, the FSU, Latin America, Mexico, and the United States). The United States is allowed to import and export feed barley. The composition and trade volume of each importing or exporting region/country are detailed in Table 1.

Barley production in the United States is concentrated in the midwest and western states. North Dakota is the leading producer (27%), followed by Idaho (17%), Montana (14%), and Minnesota (10%). Other important producers include California, Colorado, Oregon, South Dakota, Washington, and Wyoming. Barley production in Canada is concentrated in Alberta, Saskatchewan and Manitoba. These three provinces accounted for about 90% of Canadian planted acres in 1992. Feed barley demand is concentrated primarily in California, Washington, and other western states in the United States and western Canada, where barley is used as feed more than corn in these regions. However, corn is mainly used as feed in most eastern and southeastern states because of the large supply in those regions. In this study, Canada is divided into 7 producing regions and 6 consuming regions. The United States is divided into 18 producing regions and 13 consuming regions.

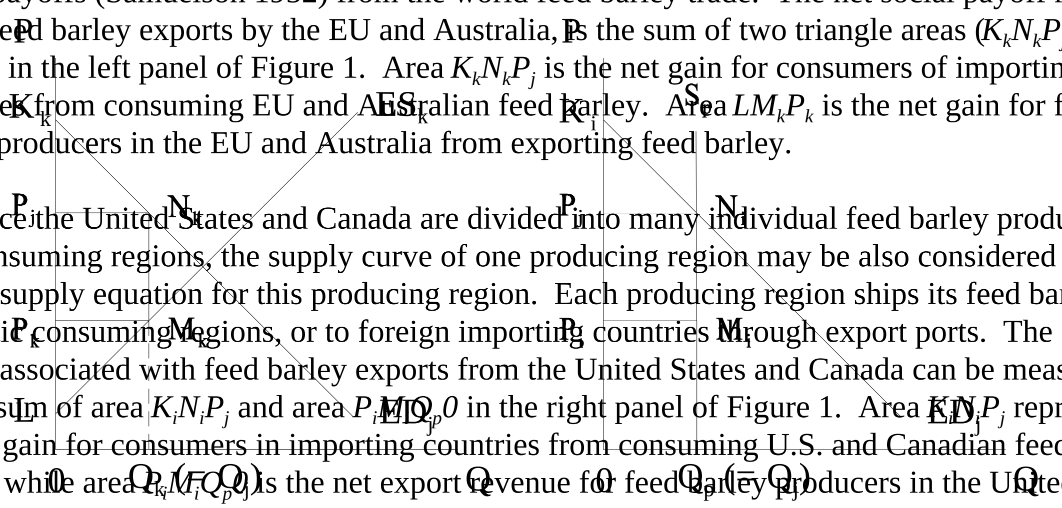
Table 1. World Feed Barley Importing and Exporting Regions and Composition

Country/Region	Composition	Trade Volume (1991-93 Average, MT)
	Exporting Country and Region	(Exports)
Australia	Australia	1,432,960[1]
Canada	Canada	3,761,100[2]
European Union	Former EC-12 Countries	7,835,500[3]
United States	United States	1,834,400[3]
	Importing Country and Region	(Imports)
Eastern Asia	Japan, South Korea	1,631,400[4]
Saudi Arabia	Saudi Arabia	4,648,500[4]
Western Asia	Cyprus, Iran, Iraq, Israel, Lebanon, Syria	1,324,000[4]
North Africa	Algeria, Morocco, Libya	1,161,700[4]
Eastern Europe	Czech Republic, Slovakia, Hungary, Poland, Romania	1,052,400[4]
FSU	Russia, Ukraine, Moldova, Belarus, Uzbekistan, Estonia	3,175,200[4]
Latin America	Brazil, Colombia, Peru	338,800[4]
United States	United States	463,800[2]
Mexico	Mexico	77,000[4]

Sources: [1] ABARE, "Commodity Statistical Bulletin."
[2] Canada Grains Councils, "Canadian Grains Industry Statistical Handbook."
[3] Gauger bvba/sprl, "Statistical Digest of Barley, Malt, Beer, and Whisky."
[4] FAO, "FAO Trade Yearbook."

For the United States and Canada, the model has transportation activities to ship feed barley from producing regions to domestic consuming regions and to foreign importing regions. The model also allows Canadian producing regions to directly ship their feed barley to U.S. consuming regions. For the other exporting countries, including the EU and Australia, this study considers only offshore shipments of feed barley. The model includes two export ports (Vancouver and Thunder Bay) in Canada and three export ports (Portland, Duluth, and Baltimore) in the United States. Export supply equations at export ports and import demand equations in importing regions are incorporated into the model. Domestic producing regions are linked to export ports through rail transportation activities. Import demand equations in importing regions are linked to exporting countries through ocean transportation activities. The mode of transportation from producing regions to domestic consuming regions and export ports is rail. Feed barley shipments from exporting countries to importing regions are by ocean vessels. However, exports within North America (i.e., from Canada to the U.S.) are assumed to be shipped by rail.

The feed barley supply in each producing region is assumed to be fixed in the study. The fixed supply of feed barley in each producing region represents its physical capacity to meet domestic and foreign import demand for feed barley. Feed barley demand in each Canadian consuming region is met by its the domestic supply, while demand in each U.S. demand region is met by domestic supply and imports from Canadian producing regions. There are no storage activities at export ports. Storage is allowed in producing regions. However, the quantity of storage in each producing region cannot exceed 60 percent of its total production of feed barley. Each producing region has to ship out a minimum amount of feed barley to domestic consuming regions and foreign markets.



The objective function of the specified quadratic programming model is to maximize the net social payoffs (Samuelson 1952) from the world feed barley trade. The net social payoff related to the feed barley exports by the EU and Australia, is the sum of two triangle areas ($K_kN_kP_j$ and LM_kP_k) in the left panel of Figure 1. Area $K_kN_kP_j$ is the net gain for consumers of importing countries from consuming EU and Australian feed barley. Area LM_kP_k is the net gain for feed barley producers in the EU and Australia from exporting feed barley.

Since the United States and Canada are divided into many individual feed barley producing and consuming regions, the supply curve of one producing region may be also considered as the excess supply equation for this producing region. Each producing region ships its feed barley to domestic consuming regions, or to foreign importing countries through export ports. The social payoff associated with feed barley exports from the United States and Canada can be measured by the sum of area $K_iN_iP_j$ and area $P_iM_iQ_p0$ in the right panel of Figure 1. Area $K_iN_iP_j$ represents the net gain for consumers in importing countries from consuming U.S. and Canadian feed barley, while area $P_iM_iQ_p0$ is the net export revenue for feed barley producers in the United States and Canada.

Figure 1. Excess demand and supply of world feed barley trade

Since domestic supply is assumed to be perfectly inelastic, the social payoff related to the domestic regional demand and supply for the United States and Canada is measured by the summation of area $K_f N_f P_f$ (consumer surplus) and area $P_p M_f Q_p 0$ (producer revenue) in Figure 2.

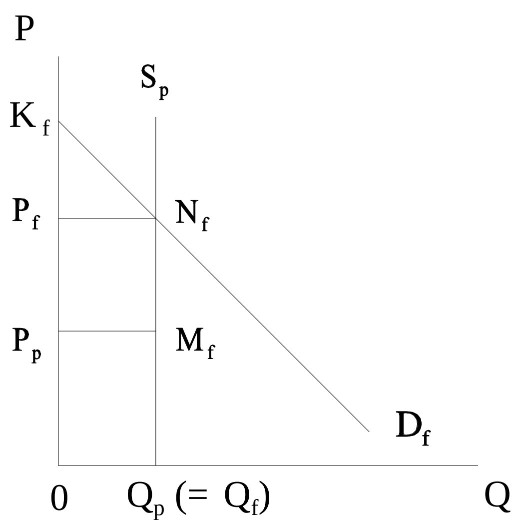


Figure 2. Domestic demand and supply of feed barley in the United States and Canada

The objective function in mathematical form is expressed as follows:

$$
\begin{aligned}
\max W = & \sum_{j=1}^{J} \int_{0}^{Q_j} ED_j(Q_j)\,dQ_j - \sum_{k=1}^{K} \int_{0}^{Q_k} ES_k(Q_k)\,dQ_k \\
& - \sum_{k=1}^{K}\sum_{j=1}^{J} t_{kj}Q_{kj} - \sum_{p=1}^{P}\sum_{i=1}^{I} t_{pi}Q_{pi} - \sum_{i=1}^{I}\sum_{j=1}^{J} t_{ij}Q_{ij} \\
& + \sum_{f=1}^{F} \int_{0}^{Q_f} D_f(Q_f)\,dQ_f - \sum_{p=1}^{P}\sum_{f=1}^{F} t_{pf}Q_{pf}
\end{aligned}
\qquad \textbf{(1)}
$$

where

W	=	net social payoffs of world feed barley trade
i	=	index denoted for export ports in the U.S. and Canada
k	=	index denoted for the EU and Australia
j	=	index denoted for importing countries or regions
p	=	index denoted for producing regions in the U.S. and Canada
f	=	index denoted for feed demand regions in the U.S. and Canada
Q_i	=	total feed barley export supply at port i in the U.S. and Canada
Q_k	=	total feed barley export supply in the EU and Australia
Q_j	=	total feed barley import demand in importing country j
Q_f	=	total feed barley demand at consuming region f in the U.S. and Canada
Q_{ij}	=	quantity shipped from export port i to importing country j
Q_{kj}	=	quantity shipped from exporting country k to importing country j
Q_{pi}	=	quantity shipped from producing region p to export port i
Q_{pf}	=	quantity shipped from producing region p to consumption region f
t_{ij}	=	unit transportation cost from export port i to importing country j
t_{kj}	=	unit transportation cost from exporting country k to importing country j
t_{pf}	=	unit transportation cost from producing region p to demand region f
t_{pi}	=	unit transportation cost from producing region p to export port i.
D_f	=	$P_f = \theta_{f0} - \theta_{f1}Q_f$ = demand equation for region f in the U.S. and Canada
ES_k	=	$P_k = \beta_{k0} + \beta_{k1}Q_k$ = export supply equation for the EU and Australia
ED_j	=	$P_j = \gamma_{j0} - \gamma_{j1}Q_j$ = import demand equation at importing country j
P_f	=	equilibrium price at domestic consuming region f in the U.S. and Canada
P_k	=	equilibrium price at export port in the EU and Australia
P_j	=	equilibrium price in importing country j.

The first term in Equation (1) represents area $K_kN_kQ_k0$ in Figure 1 and the second term represents area LM_kQ_k0. Subtracting the second term from the first term gives area $K_kN_kM_kL$. The net social payoff from feed barley trade between importing countries and exporting countries (the EU and Australia) is calculated by subtracting the total transportation costs (the third term, area $P_jN_kM_kP_k$) from area $K_kN_kM_kL$. The fourth and fifth terms represent the transportation costs from producing regions to export ports in the United States and Canada and those from export ports to importing countries, respectively. The social payoff associated with feed barley trade between importing countries and exporting countries in North America (the United States and Canada), denoted by two areas $K_iN_iP_j$ and $P_iM_iQ_p0$ in Figure 1, is calculated by subtracting the fourth and fifth terms from the first term. The social payoff associated with domestic demand and supply of feed barley in the United States and Canada, denoted by the two areas $K_fN_fP_f$ and $P_pM_fQ_p0$ in Figure 2, is calculated by subtracting the seventh term (transportation costs from producing regions to consuming regions, area $P_fN_fM_fP_p$) from the sixth term (area $K_fN_fQ_p0$).

The objective function is subject to the following constraints:

$$\sum_{j=1}^{J} Q_{ij} = Q_i \tag{2}$$

$$\sum_{k=1}^{K} Q_{kj} = Q_k \tag{3}$$

$$\sum_{i=1}^{I} Q_{ij} + \sum_{k=1}^{K} Q_{kj} = Q_j \tag{4}$$

$$\sum_{f=1}^{F} Q_{pf} + \sum_{i=1}^{I} Q_{pi} \leq SF_p \tag{5}$$

$$\sum_{f=1}^{F} Q_{pf} + \sum_{i=1}^{I} Q_{pi} \geq SF_p^{\min} \tag{6}$$

$$\sum_{f=1}^{F} Q_{pf} = Q_f \tag{7}$$

$$\sum_{p=1}^{P} Q_{pi} = \sum_{j=1}^{J} Q_{ij} = Q_i \tag{8}$$

$$ES_i(Q_i) = P_i = \alpha_{i0} + \alpha_{i1}Q_i \tag{9}$$

$$ES_k(Q_k) = P_k = \beta_{k0} + \beta_{k1}Q_k \tag{10}$$

$$ED_j(Q_j) = P_j = \gamma_{j0} - \gamma_{j1}Q_j \quad \textbf{(11)}$$

$$D_f(Q_f) = P_f = \theta_{f0} - \theta_{f1}Q_f \quad \textbf{(12)}$$

$$P_j - P_i \geq t_{ij} \quad \textbf{(13)}$$

$$P_j - P_k \geq t_{kj} \quad \textbf{(14)}$$

where

SF_p = total feed barley supply at producing region *p* in the U.S. and Canada
SF_p^{min} = minimum feed barley supply at producing region *p* in the U.S. and Canada
P_i = equilibrium price at export port *i* in the U.S. and Canada
ES_i = export supply equation for export port *i* in the U.S. and Canada.

There are 15 linear constraints for the objective function. Equations (2) and (3) are the supply constraints for export ports in North America and other exporting countries, respectively. Equation (4) is the demand constraint for importing countries. Equations (5) and (6) are the supply constraints for each producing region. Equation (5) indicates that the total feed barley shipment from one producing region to the domestic demand regions and exporting ports must be less than or equal to the total amount available in that region. Equation (6) indicates that a minimum amount of barley must be shipped out to domestic consuming regions and export markets. Equation (7) indicates that the quantity of feed barley shipped from producing regions should meet the demand in each consuming region. Equation (8) is the inventory clearing condition at exporting ports in North America. The total quantity of barley shipped from domestic producing regions to each port must be equal to the quantity of barley destined to importing countries from the same port. Equation (9) denotes the excess supply equation for export port in the United States and Canada and is not included in the objective functions. However, it is used as one constraint to determine the spatial equilibrium prices at export ports in the United States and Canada. The spatial equilibrium prices in other countries are determined by Equations (10), (11), and (12), respectively. The Kuhn-Tucker conditions for optimality are implied by Equations (13) and (14), under which no trade activity will exist if the price differences between exporting countries and importing countries are less than the transportation costs. Tariffs of importing countries and subsidies of exporting countries are incorporated in transportation cost parameters. Long-term agreements and Credit Guarantees of exporting countries are also included as constraints in the model.

The Base and Alternative Models

The base model of this study reflects the current trade activities in world feed barley trade. Existing trade policies of importing and exporting countries are incorporated in the base model. These trade polices include import tariffs of importing countries, Canadian rail subsidies under WGTA, U.S. EEP, EU ERP, credit sale, and long term agreements. To analyze the impacts of these trade policies on world feed barley trade, the following seven models are identified:

Model 1: the base model reflecting world feed barley trade under current trade policies in major trading countries.
Model 2: the base model with the removal of U.S. EEP.
Model 3: the base model with the removal of Canadian rail subsidies.
Model 4: the base model with the removal of U.S. EEP and Canadian rail subsidies.
Model 5: the base model with the removal of tariffs within North America under the North American Free Trade Agreement.
Model 6: the base model with the reduction of trade subsidies and restrictions under the Uruguay Round Agreement of GATT.
Model 7: the base model with the removal of all trade subsidies and restrictions under world free trade.

Data Sources and Development

Data used for the model are the supply of feed barley in producing regions, demand for feed barley in domestic consuming regions in North America, transportation costs in shipping feed barley from producing regions to domestic consuming regions in North America, and transportation costs from exporting countries to importing regions. The export supply equations at ports of exporting countries and the import demand equations in import regions are also incorporated into the model.

Data on barley production in the United States were derived from area planted, area harvested, and yields, which were taken from the USDA/NASS. The final feed barley supply in each producing region was then calculated from the average percentage of acres for malting barley and the percentage graded as malting barley from 1987-91[5]. The same data for Canada were obtained from Agriculture Canada (Table 2). There are no direct sources for data on regional or state feed barley demand. However. Johnson and Varghese (1993) developed state and province-level demand functions for feed barley using an optimization model. This study used the regional feed barley demand functions for 13 individual states and 6 provinces estimated by Johnson and Wilson (1994). The demand schedules for regional feed barley consuming regions are shown in Table 3.

Table 2. Supply Parameters for Barley Production in North America

[5] See Johnson and Wilson, p. 36 for detail.

Producing Region	Code	Location	Total Acres ('000)	% of Acres for Malting Barley	% Graded as Malting Quality	Average Yield (Bu/Acre)
Central Alberta	P01	Edmonton	2,117	49	8	55
Northern Alberta	P02	Grande Prairie	1,152	37	7	51
Southern Alberta	P03	Lethbridge	1,752	63	55	52
Northern Manitoba	P04	Winnipeg	454	43	13	52
Southern Manitoba	P05	Kilarny	936	53	21	51
Northern Saskatchewan	P06	Saskatoon	2,720	87	31	43
Southern Saskatchewan	P07	Weyburn	562	84	42	38
California	P08	Fresno	220	0	0	60
Colorado	P09	Denver	147	51	90	75
Idaho	P10	Moscow	798	41	91	70
Minnesota, CRD-1	P11	Crookston	642	97	71	56
Minnesota, CRD-4	P12	Morris	123	95	71	48
Eastern Montana	P13	Culbertson	248	5	80	29
Western Montana	P14	Shelby	1,168	40	80	44
North Dakota, CRD-1&4	P15	Minot	390	69	67	37
North Dakota, CRD-2&3	P16	Larimore	1,064	97	67	51
North Dakota, CRD-5&6&9	P17	Jamestown	893	87	67	42
North Dakota, CRD-7&8	P18	Linton	198	21	67	34
Oregon	P19	Eugune	167	6	80	70
South Dakota, CRD-2	P20	Selby	162	68	45	42
South Dakota, CRD-3	P21	Bristol	118	87	45	35
South Dakota, other	P22	Wosley	188	45	45	29
Utah	P23	Salt Lake City	111	52	90	80
Washington	P24	Spokane	490	9	90	58
Wyoming	P25	Powell	123	67	90	73

Source: Johnson and Wilson, "North American Barley Trade and Competition."

Table 3. Regional Feed Barley Demand Parameters in North America[6]

Demand Region (Province / State)	Code	Location	Constant	Slope	Price Elasticity of Demand
Alberta	F01	Edmonton	86.9	-.00804	-4.4
British Columbia	F02	Fraz. Valley	99.7	-.06357	-5.3
Manitoba	F03	Winnipeg	70.2	-.01376	-9.2
Ontario	F04	Nakina	82.0	-.00984	-6.6
Quebec	F05	Montreal	87.6	-.00833	-12.1
Saskatchewan	F06	Saskatoon	73.1	-.01257	-4.8
Arizona	F07	Phoenix	119.2	-.02515	-13.0
California	F08	Fresno	128.5	-.00391	-9.2
Colorado	F09	Denver	98.9	-.00684	-9.7
Idaho	F10	Pocatello	114.7	-.03726	-3.6
Minnesota	F11	Staples	82.4	-.00318	-8.4
Montana	F12	Malta	108.1	-.04919	-3.6
North Dakota	F13	Jamestown	81.5	-.03983	-2.7
Nevada	F14	Winnemucca	128.7	-.15724	-3.7
Oregon	F15	Bend	122.1	-.02352	-9.7
South Dakota	F16	Selby	86.3	-.00622	-10.1
Utah	F17	Salt Lake City	110.4	-.02911	-12.8
Washington	F18	Pasco	124.4	-.04502	-2.9
Wyoming	F19	Casper	99.4	-.07780	-3.7

Source: Johnson and Wilson, "North American Barley Trade and Competition."

Import demand equations for feed barley in importing regions were estimated with time series data from 1965-92. The import demand of each country is specified as a function of import price, world price of corn, population, and GDP. The time series data on these variables were obtained from the *World Grains Statistics* (International Wheat Council), the *FAO Trade Yearbook* (Food and Agricultural Organizations of United Nations), *International Financial Statistics Yearbook* (International Monetary Fund), the *"PS&D View," Commodity Database* (USDA/ERS). The estimated import demand elasticities for feed barley are -0.30 in East Asia, -

[6] See Johnson and Varghese, 1993 for detailed derivation of regional feed barley demand.

0.94 in Saudi Arabia, -1.15 in West Asia, -1.84 in North Africa, -0.20 in Latin America, -0.216 in Mexico. The import demand elasticities in East Europe and FSU are -1.20, which were taken from Gray, Ulrich, and Schmitz's study. The import demand equations for the study were then derived using the 3-year (1991-93) average import quantity and unit value of imports in each importing country. Data on import quantity and value of feed barley were taken from the *FAO Trade Yearbook* (Food and Agricultural Organizations of United Nations). The derived import demand equations for the quadratic programming model are shown in Table 4.

Table 4. Estimated Short-Run Import Demand Functions in Importing Regions

Import Region	Code	Import Demand Elasticity	Quantity (MT)	Import Price (U.S.$/MT)	Intercept (MT)	Slope (MT)
East Asia	J01	-0.30	1,631,410	140.94	2,120,833	-3,473
Saudi Arabia	J02	-0.94	4,648,493	116.49	9,018,076	-37,510
West Asia	J03	-1.15	1,342,023	119.39	2,885,349	-12,927
North Africa	J04	-1.84	1,161,700	117.01	3,299,228	-18,268
East Europe	J05	-1.20	1,052,400	112.81	2,315,280	-11,195
Former Soviet Union	J06	-1.20	3,175,200	114.81	6,985,440	-33,187
Latin America	J07	-0.20	338,813	132.77	406,576	-510
Mexico	J08	-0.22	77,000	130.87	97,280	-132

The export supply elasticities at export ports are difficult to directly estimate. However, export supply elasticity (e_x) were obtained from price elasticities of domestic demand (e_d) and domestic supply (e_s) as follows:

$$e_x = \frac{Q_s}{Q_e} e_s + \frac{Q_d}{Q_e} \mid e_d \mid \quad \textbf{(15)}$$

where Q_s is the total quantity of feed barley domestic supply, Q_e is total quantity of feed barley exported, and Q_d is total quantity of feed barley domestically consumed. As in Gray, Ulrich, and Schmitz's study, domestic feed barley supply is assumed to be completely inelastic (e_s = 0) in all exporting countries.

Price elasticities of domestic demand for feed barley were obtained from the domestic demand functions empirically estimated from time series data from 1965-1992. Data on

Australian domestic consumption of feed barley, feed barley price, and other feed grains prices were taken from the *Commodity Statistical Bulletin* (ABARE). The same data for the EU were collected from the *Agriculture Statistical Yearbook* (EUROSTAT), and the *Statistical Digest of Barley, Malt, Beer, and Whisky* (H.M. Gauger bvba/sprl). Data on Canadian domestic demand and prices of grains were taken from the *Canadian Grains Industry Statistical Handbook* (Canada Grains Council). The same data for the United States were collected from the *Feed Situation and Outlook Yearbook* (USDA/ERS). The number of cattle and calves in exporting countries are taken from the *"PS&D View," Commodity Database* (USDA/ERS). Data on GDP and the GDP deflator are obtained from the *International Financial Statistics Yearbook* (International Monetary Fund).

The estimated price elasticities for domestic feed barley demand are -1.20 in Australia, -0.2661 in EU, -0.70 in Canada, and -1.30 in the United States. The export supply elasticities at export ports were then derived from 3-year averages (1991-93) of data on export quantity and price. The export quantities at Canadian export ports were taken from the *Canadian Grains Industry Statistical Handbook* (Canada Grains Council). The prices at Canadian export ports and U.S. ports (Portland and Duluth) were obtained from the *Weekly Market Price Comparison* (AAFC, Livestock Feed Bureau). The price data at port Baltimore and the quantities of exports at U.S. ports were collected from the *Grain and Feed Market News* (USDA, AMS). The estimated export supply elasticities and their corresponding export supply equations in exporting countries are shown in Table 5.

Table 5. Estimated Short-Run Export Supply Functions at Export Ports

Import Region	Code	Export Supply Elasticity	Quantity (MT)	Import Price (U.S.$/MT)	Intercept (MT)	Slope (MT)
Thunder Bay, Canada	I01	1.23	833,420	73.84	-188,383	13,838
Vancouver, Canada	I02	1.23	2,438,748	99.30	-551,157	30,110
Portland, USA	I03	1.51	564,966	115.11	-289,263	7,421
Duluth, USA	I04	1.51	928,382	97.68	-475,332	14,371
Baltimore, USA	I05	1.51	290,085	93.16	-148,524	4,708
Rouen, EU	I06	1.31	7,835,000	98.00	-2,407,695	104,517
Sydney, Australia	I07	1.36	1,431,960	95.00	-452,786	19,839
Canada to Mexico	I08	1.23	25,136	97.05	-5,681	318
U.S. to Mexico	I09	1.51	51,000	99.65	-26,112	774

Transportation activities in the study include domestic transportation by rail and ocean transportation by vessels. Domestic transportation costs of shipping feed barley from producing regions to consuming regions and export ports within North America were calculated from the rail rate function estimated by Koo, Thompson, and Larson. Data on railway mileage between origins and destinations were obtained from the *Handy Railroad Atlas of the United States* (Rand McNally & Company). Ocean transportation costs of shipping feed barley from export ports to import regions were derived from the ocean freight rate function estimated by Golz and Koo. The nautical mileage between export ports and import ports were taken from the *Distances Between Ports* (U.S. Defense Mapping Agency).

Tariff schedules in importing countries, U.S. EEP quantity and value by country, and U.S. export credit sales were obtained from the Foreign Agricultural Service of the USDA. U.S. EEP bonuses were calculated at 3-year average levels for individual importing countries (Table 6). Data on long-term agreements (LTAs), and EU Export Refunds Program (ERP) were taken from the *World Grains Statistics* (International Wheat Council) and are shown in Table 7. The import tariffs, U.S. EEP, and EU ERP are incorporated into the transportation cost in the model. The long-term agreements are included in the constraints of the model.

Table 6. Feed Barley Exports Under Credit Sale and Long-Term Agreement by Exporting Country (1991-93)

Exporting Country	East Asia	West Asia	North Africa	FSU
	--------------------------- Metric Tons		--------------------------	
Canada	800,000	0	0	913,020
United States	0	239,436	82,567	113,633
European Union	--	--	--	--
Australia	440,000	0	0	0

= not available.

Source: U.S. Department of Agriculture, Foreign Agricultural Service.

Table 7. U.S. EEP Bonus for Feed Barley by Importing Regions (1991-93)

Importing Region	U.S. EEP Bonus*

	------ U.S.$/MT ------
Saudi Arabia	34.48
West Asia	37.76
North Africa	34.82
East Europe	51.44
Former Soviet Union	31.01

Source: International Wheat Council, "World Grains Statistics."

Results

Results from the spatial equilibrium models under the base and alternative trade policy scenarios are discussed in this section. The base model reflects world feed barley trade under current trade policies of major trading countries. For the trade between Canada and the United States, Canadian producing regions are allowed to ship their feed barley directly to U.S consuming regions based on the transportation costs, price differences between Canadian and U.S. consuming regions, and the U.S. tariff. There are no quantitative restrictions on imports of feed barley into the U.S.. All inland shipments, including the shipments from Canadian producing regions to U.S. consuming regions, are assumed to be by rail. Since this study mainly focuses on the world feed barley trade, the optimal solutions of domestic trade flows of feed barley from producing regions to consuming regions and export ports are presented for the base model. The optimal solutions from alternative models are compared with the base model solution to evaluate the impacts of trade policy changes on international feed barley trade and net social payoffs.

Base Model Solution (*Model 1*)

Optimal trade flows, total imports of importing countries, and total exports at export ports in the base model are reported in Table 8. For comparison, the actual values of total imports and exports at the 3-year average (1991-93) are presented in the same table. Under the base model,

Table 8. Optimal Feed Barley Trade Flows From Exporting Countries to Importing Regions in Model 1 (The Base Model)

Region	Code	E. Asia (J01)	Saudi A. (J02)	W. Asia (J03)	N. Africa (J04)	E. Europe (J05)	FSU (J06)	L. America (J07)	Mexico (J08)	USA (J09)	Total Exports
		Metric Tons									
Thunder Bay	I01	--	--	--	--	--	913,020	--	--	--	913,020 (833,420)*
Vancouver	I02	800,000	935,320	--	--	--	--	335,030	--	--	2,070,400 (2,438,750)
All Canada		800,000	935,320	--	--	--	913,020	335,030	25,170 (25,140)	919,160 (463,800)	3,927,700 (3,761,110)
Portland	I03	--	544,520	--	--	--	--	--	--	--	544,520 (564,970)
Duluth	I04	--	475,940	458,520	--	--	--	--	--	--	934,460 (928,380)
Baltimore	I05	--	--	54,830	82,570	27,400	113,630	--	--	--	278,430 (290,090)
All USA		--	1,020,460	513,350	82,570	27,400	113,630	--	54,180 (52,650)	--	1,811,580 (1,834,430)
EU	I06	--	2,421,100	899,730	998,580	1,001,300	2,138,300	--	--	--	7,450,900 (7,835,000)
Australia	I07	831,280	477,610	--	--	--	--	--	--	--	1,308,900 (1,431,960)
Total Imports		1,626,300 (1,631,300)	4,798,000 (4,854,400)	1,413,000 (1,413,100)	1,141,900 (1,081,100)	1,064,900 (1,028,700)	3,272,300 (3,165,000)	336,080 (335,030)	79,350 (77,000)	919,160 (463,800)	14,507,160 (13,893,850)

* Actual values of feed barley trade volumes are enclosed within parentheses ( ).

Canada almost doubles its feed barley exports to the United States compared with its actual exports mainly because this study allows direct shipments from Canadian producing regions to the United States. Consequently, Canada reduces its offshore exports from Vancouver. The quantities of feed barley imported by the other importing countries and those exported by the European Union, Australia and the United States under the base model are fairly closed to the actual quantities.

Under the base model solution, the EU is the leading exporter of feed barley, followed by Canada and the United States. The EU is the major exporter in most importing regions, except Eastern Asia and Latin America. However, the EU faces strong competition from other exporting countries in Saudi Arabia, the world's largest importing market of feed barley. Canadian barley is mainly exported to Saudi Arabia, Eastern Asia, the former Soviet Union, and Latin America. Australia has a distance advantage to export feed barley to Eastern Asia and Saudi Arabia. Canada and Australia almost equally share the Eastern Asia market. Canada also dominates exports to Latin America and the United States. Saudi Arabia is the leading offshore market for U.S feed barley exports, followed by West Asia, the former Soviet Union, and North Africa. The United States competes with the EU in these markets with the Export Enhancement Program. The United States is also a primary exporter to Mexico.

The optimal shipments of feed barley from domestic producing regions to consuming regions and export ports in North America are shown in Tables 9-12. Under the base model solution, Vancouver is the major port for Canadian exports to Eastern Asia, Saudi Arabia, and Latin America; and Thunder Bay is the major port for the former Soviet Union. Portland is one of the major ports for U.S. exports to Saudi Arabia. About half of U.S. feed barley exports are shipped from Duluth to Saudi Arabia and Western Asia. U.S. exports through Baltimore are mainly destined to the former Soviet Union, North Africa, Western Asia, and Eastern Europe.

In Canada, feed barley from Northern Alberta is shipped to the feed markets in the province for domestic use. Central Alberta supplies its barley to feed markets in British Columbia, Alberta, Vancouver for offshore exports, and Oregon in the United States. Feed barley from Southern Alberta is sent to domestic feed markets in Alberta and to Mexico and the United States for exports. Feed barley from Southern Alberta is also exported to Nevada and Utah. Southern Manitoba supplies its barley to feed markets in Manitoba and Ontario. Northern Manitoba also ships its feed barley to Ontario. Feed barley produced in northern Saskatchewan is shipped to feed markets in Saskatchewan for domestic use and to Vancouver and Thunder Bay for exports. Southern Saskatchewan ships its feed barley to Thunder Bay for exports.

Table 9. Feed Barley Shipments From Producing Regions to Consuming Regions in Canada

Producing Region	Code	Alberta (F01)	B. Columbia (F02)	Manitoba (F03)	Ontario (F04)	Quebec (F05)	Saskatchewan (F06)
		----------------------------------	Metric Tons	----------------------------------			
Central Alberta	P01	359,000	454,370	0	0	0	0
Northern Alberta	P02	1,663,100	0	0	0	0	0
Southern Alberta	P03	1,209,700	0	0	0	0	0
Northern Manitoba	P04	0	0	0	641,370	0	0
Southern Manitoba	P05	0	0	1,199,600	990	0	0
N. Saskatchewan	P06	0	0	0	0	0	1,536,600
S. Saskatchewan	P07	0	0	0	0	0	0

Table 10. Feed Barley Shipments From Canadian Producing Regions to Export Ports and Mexico

Producing Region	Code	Thunder Bay (I01)	Vancouver (I02)	To Mexico (J08)
		---------------------------	Metric Tons	---------------------------
Central Alberta	P01	0	1,886,400	0
Northern Alberta	P02	0	0	0
Southern Alberta	P03	0	0	25,170
Northern Manitoba	P04	0	0	0
Southern Manitoba	P05	0	0	0
N. Saskatchewan	P06	543,200	183,920	0
S. Saskatchewan	P07	369,820	0	0

Table 11. Feed Barley Shipments From Producing Regions to U.S. Consuming Regions

Producing Region	Code	Arizona (F07)	California (F08)	Colorado (F09)	Idaho (F10)	Minnesota (F11)	Montana (F12)	N. Dakota (F13)	Nevada (F14)	Oregon (F15)	S. Dakota (F16)	Utah (F17)	Washington (F18)	Wyoming (F19)
		Metric Tons												
Central Alberta	P01	0	0	0	0	0	0	0	0	478,970	0	0	0	0
Northern Alberta	P02	0	0	0	0	0	0	0	0	0	0	0	0	0
Southern Alberta	P03	0	0	0	0	0	0	0	98,800	0	0	341,370	0	0
Northern Manitoba	P04	0	0	0	0	0	0	0	0	0	0	0	0	0
Southern Manitoba	P05	0	0	0	0	0	0	0	0	0	0	0	0	0
N. Saskatchewan	P06	0	0	0	0	0	0	0	0	0	0	0	0	0
S. Saskatchewan	P07	0	0	0	0	0	0	0	0	0	0	0	0	0
California	P08	0	210,980	0	0	0	0	0	0	0	0	0	0	0
Colorado	P09	0	0	175,180	0	0	0	0	0	0	0	0	0	0
Idaho	P10	0	0	0	661,040	0	0	0	0	0	0	0	0	0
Minnesota, CRD-1	P11	0	0	0	0	227,090	0	0	0	0	0	0	0	0
Minnesota, CRD-4	P12	0	0	0	0	50,440	0	0	0	0	0	0	0	0
E. Montana	P13	0	0	0	0	0	213,690	0	0	0	0	0	0	0
W. Montana	P14	0	909,040	0	0	0	125,980	0	0	0	0	0	0	0
N. Dakota, CRD-1&4	P15	0	0	0	0	0	0	0	0	0	0	0	0	0
N. Dakota, CRD-2&3	P16	0	0	0	0	0	0	0	0	0	0	0	0	0
N. Dakota, CRD-5&6&9	P17	0	0	0	0	0	0	174,000	0	0	399,740	0	0	0
N. Dakota, CRD-7&8	P18	0	0	0	0	0	0	0	0	0	7,260	0	0	0
Oregon	P19	0	0	0	0	0	0	0	0	344,040	0	0	0	0
S. Dakota, CRD-2	P20	0	0	0	0	0	0	0	0	0	130,910	0	0	0
S. Dakota, CRD-3	P21	0	0	0	0	0	0	0	0	0	66,840	0	0	0
S. Dakota, other	P22	0	0	0	0	0	0	0	0	0	138,570	0	0	0
Utah	P23	0	0	0	0	0	0	0	0	0	0	138,570	0	0
Washington	P24	0	0	0	0	0	0	0	0	0	0	0	660,820	0
Wyoming	P25	0	0	0	0	0	0	0	0	0	0	0	0	102,420

Table 12. Feed Barley Shipments From U.S. Producing Regions to Export Ports and Mexico

Producing Region	Code	Portland (I03)	Duluth (I04)	Baltimore (I05)	To Mexico (J08)
		----------------------	Metric Tons	----------------------	
California	P08	0	0	0	0
Colorado	P09	0	0	0	0
Idaho	P10	126,540	0	0	54,180
Minnesota, CRD-1	P11	0	64,460	0	0
Minnesota, CRD-4	P12	0	0	0	0
E. Montana	P13	0	0	0	0
W. Montana	P14	0	0	0	0
N. Dakota, CRD-1&4	P15	273,580	178,360	0	0
N. Dakota, CRD-2&3	P16	0	493,980	0	0
N. Dakota, CRD-5&6&9	P17	0	0	0	0
N. Dakota, CRD-7&8	P18	0	197,660	278,430	0
Oregon	P19	0	0	0	0
S. Dakota, CRD-2	P20	0	0	0	0
S. Dakota, CRD-3	P21	0	0	0	0
S. Dakota, other	P22	0	0	0	0
Utah	P23	0	0	0	0
Washington	P24	144,390	0	0	0
Wyoming	P25		0	0	0

In the United States, North Dakota is the leading state in exporting feed barley. It ships its feed barley to its regional feed market and South Dakota for domestic use and to all three U.S. ports for exports. Idaho and Washington also export feed barley through Portland. Feed barley produced in Minnesota is shipped to its regional feed markets and Duluth for exports. All U.S. feed barley exported to Mexico originates from Idaho due to its relatively lower transportation costs to Mexico. Western Montana ships its feed barley to California. Feed barley imported from Canada is mainly shipped to U.S. feed deficit states such as Oregon, Nevada, and Utah.

Shadow price associated with production capacity of each producing region measures the change in the value of objective function as an additional unit of feed barley is produced in each producing region. Because production costs are not included in the model, these shadow prices may only reflect the proximity of each producing region to demand regions and export ports. Shadow prices of producing regions in the U.S. and Canada under the base model are shown in Table 13.

Two producing regions in Manitoba have the highest shadow prices in Canada, while three producing regions in Alberta have the lowest shadow prices. In the United States, California has the highest shadow prices, followed by Oregon, Utah, and Colorado. All those states are feed deficit states. Producing regions in South Dakota, North Dakota, and Minnesota have the lowest shadow prices among U.S. producing regions.

Removal of the U.S. EEP (*Model 2*)

Impacts of eliminating the U.S. EEP in barley exports are shown in Table 13. Compared to the base model solution, U.S. feed barley exports decrease 26 percent from 1.81 million MT to 1.35 million MT after the U.S. EEP is eliminated. This result is different from the study of Johnson and Wilson (1994). Their results show that if EEP is eliminated, U.S. exports of feed barley drop to zero. These differences are due to different model specifications and assumptions.

Under this scenario, the United States loses market share in Saudi Arabia and Eastern Europe and reduces its exports to Western Asia by 53 percent. Removal of the EEP reduces U.S. competitiveness in the EEP receiving countries. However, the United States almost doubles its exports to the Former Soviet Union, captures all market shares in Latin America, and increases its market share in Eastern Asia by 25 percent mainly due to the lowest transportation cost between the United States and these importing regions. Canadian exports to the United States fall by 23 percent with the removal of the U.S. EEP. Australia and the EU slightly increase their total exports. Canadian also increases offshore exports to Saudi Arabia by 46 percent and stops exporting feed barley to Latin America. However, Canadian total exports fall slightly because of the reductions in Canadian exports to the United States. The EU reduces its market share in the former Soviet Union, but increases exports to other importing regions. Australia increases its exports to Saudi Arabia by 90 percent and reduces exports to Japan by 47 percent. Eastern Asia, Latin America, and Mexico increase feed barley imports. However, the other importing regions slightly reduce their imports because removal of the U.S. EEP raised import prices in these regions.

Table 13. Shadow Price Associated with Production Capacity in Each Producing Region

Production Region	Code	Shadow Price (U.S.$/MT)
Central Alberta	P01	40.07
Northern Alberta	P02	40.07
Southern Alberta	P03	40.07
Northern Manitoba	P04	46.87
Southern Manitoba	P05	45.37
Northern Saskatchewan	P06	42.55
Southern Saskatchewan	P07	42.75
California	P08	101.49
Colorado	P09	92.32
Idaho	P10	88.33
Minnesota, CRD-1	P11	80.33
Minnesota, CRD-4	P12	80.44
Eastern Montana	P13	82.37
Western Montana	P14	86.73
North Dakota, CRD-1&4	P15	87.45
North Dakota, CRD-2&3	P16	80.17
North Dakota, CRD-5&6&9	P17	80.07
North Dakota, CRD-7&8	P18	80.46
Oregon	P19	92.84
South Dakota, CRD-2	P20	81.26
South Dakota, CRD-3	P21	80.17
South Dakota, Other	P22	79.83
Utah	P23	92.51
Washington	P24	85.33
Wyoming	P25	86.18

Removal of the Canadian Rail Subsidy (*Model 3*)

Effects of removing the Canadian rail subsidy are shown in Table 14. In this scenario, Canadian offshore exports decrease 15 percent and Canadian exports to the United States increase 62 percent. This is because eliminating the Canadian rail subsidy increases transportation costs from Canadian producing regions to the offshore exports, making transportation costs to the United States relatively cheaper. The U.S. market becomes more attractive to Canadian producers even though the shipments of feed barley from Canadian producing regions to U.S. consuming regions do not qualify for the WGTA's freight rate subsidy. This finding is similar to Johnson and Wilson's study. Meanwhile, Canadian exports to Saudi Arabia decrease 48 percent from 935 thousand MT to 485 thousand MT. Canada also slightly reduces exports to Latin America and Mexico. As a result, the total Canadian exports under this model increase slightly compared to the base model.

Feed barley exports of other exporting countries increase slightly. Australia and the EC capture the market shares given up by Canada in Saudi Arabia. The EU also slightly reduces its feed barley exports to the FSU. The United States increases its exports to Western Asia. Australia slightly decreases its exports to Japan and switches exports to Saudi Arabia. Among importing regions, Western Asia and the U.S. increase their imports, while imports of other regions decline by a small amount.

Removal of the Canadian Rail Subsidy and the U.S. EEP (*Model 4*)

Under this scenario, U.S. feed barley exports decline 12 percent. Canada reduces its offshore exports by 10 percent. Canadian exports to the United States increase 34 percent because of higher shipping costs for offshore exports and a higher price in U.S. feed barley markets. Canada also increases exports to Latin America, the closet offshore market. Canadian exports to Mexico decrease because of increased Mexican imports from the U.S.. The EU and Australia increase their exports to world feed barley markets. Canadian and U.S. market shares in Saudi Arabia are reduced by 31 and 55 percent, respectively. On the other hand, the EU increases its exports to Saudi Arabia by 28 percent. The United States decreases exports to Western Asia by 53 percent, but the United States significantly increases its market share to Eastern Europe from 3 percent to 81 percent. U.S. exports to Mexico also increase by a small amount. Australia slightly increases its exports to Saudi Arabia and Eastern Asia. The EU also increases exports to Western Asia by 30 percent, while its exports to Eastern Europe decrease by 63 percent. The elimination of the U.S. EEP and the Canadian rail subsidy significantly influence Canadian and U.S. exports and world trade flows of feed barley. However, the effects under this scenario are less than that under elimination of either the U.S. EEP or the Canadian rail subsidy alone (Table 15).

Table 14.Optimal Feed Barley Trade Flows From Exporting Countries to Importing Regions in Model 2 (The Removal of the U.S. EEP)

Region	Code	E. Asia (J01)	Saudi A. (J02)	W. Asia (J03)	N. Africa (J04)	E. Europe (J05)	FSU (J06)	L. America (J07)	Mexico (J08)	USA (J09)	Total Exports
		Metric Tons									
Thunder Bay	I01	--	24,020	--	--	--	913,020	--	--	--	937,040
Vancouver	I02	800,000	1,341,500	--	--	--	--	--	--	--	2,141,150
All Canada		800,000	1,365,520	--	--	--	913,020	--	25,130	705,250	3,808,900
Portland	I03	412,550	--	--	--	--	--	--	--	--	412,550
Duluth	I04	--	--	239,440	82,570	--	220,020	147,220	--	--	689,250
Baltimore	I05	--	--	--	--	--	--	193,820	--	--	193,820
All USA		412,550	--	239,440	82,570	--	220,020	341,040	55,250	--	1,350,860
EU	I06	--	2,514,900	1,142,500	954,580	1,001,700	1,952,700	--	--	--	7,565,700
Australia	I07	440,000	905,270	--	--	--	--	--	--	--	1,345,300
Total Imports		1,652,500	4,785,700	1,381,900	1,037,100	1,001,700	3,085,100	341,040	80,380	705,250	14,070,730

Table 15.Optimal Feed Barley Trade Flows From Exporting Countries to Importing Regions in Model 3 (The Removal of the Canadian Rail Subsidy)

Region	Code	E. Asia (J01)	Saudi A. (J02)	W. Asia (J03)	N. Africa (J04)	E. Europe (J05)	FSU (J06)	L. America (J07)	Mexico (J08)	USA (J09)	Total Exports
		Metric Tons									
Thunder Bay	I01	--	--	--	--	--	913,020	--	--	--	913,020
Vancouver	I02	800,000	484,780	--	--	--	--	333,220	--	--	1,618,000
All Canada		800,000	484,780	--	--	--	913,020	333,220	25,080	1,488,640	4,044,770
Portland	I03	--	553,910	--	--	--	--	--	--	--	553,910
Duluth	I04	--	466,540	486,420	--	--	--	--	--	--	952,960
Baltimore	I05	--	--	59,810	82,570	27,400	113,630	--	--	--	283,410
All USA		--	1,020,460	546,230	82,570	27,400	113,630	--	54,030	--	1,844,320
EU	I06	--	2,722,100	871,060	1,021,500	1,015,400	2,180,000	--	--	--	7,810,100
Australia	I07	819,010	501,140	--	--	--	--	--	--	--	1,320,200
Total Imports		1,619,000	4,728,500	1,417,300	1,104,100	1,042,800	3,206,700	333,220	79,130	1,488,640	15,019,290

Under the North American Free Trade Agreement (*Model 5*)

Under the North American Free Trade Agreement (NAFTA), both Canada and the United States increase their feed barley exports. Canadian exports to the United States increase by 11 percent, but Canadian exports to Mexico increase only slightly. Under NAFTA, the United States increases its exports to Mexico by 7 percent. Total Mexican imports increase by 5 percent. Since the feed barley trade volume in North America is relatively small, NAFTA has very little impact on international feed barley trade (Table 16).

Under the Uruguay Round Agreement of GATT (*Model 6*)

According to the study on GATT by Premakumar *et al.*(1994), feed barley exporting countries reduce their export subsidies by 24 percent in unit value under the Uruguay Round Agreement of GATT. Meanwhile, tariffs are reduced by 15 percent and 25 percent in Eastern Asia and other importing regions, respectively. The simulation results under this scenario are shown in Table 17.

After full implementation of the Uruguay Round Agreement, EU feed barley exports decline by 14 percent from 7.45 million MT to 6.39 million MT. Australia ships all its feed barley exports to Eastern Asia and also increases its total exports by 3 percent. Canada increases its exports to both offshore markets and the United States by 6 and 50 percent, respectively. Total Canadian exports increase by 17 percent. U.S. feed barley exports slightly decline. The EU reduces exports to Saudi Arabia by 6 percent and loses market share in Eastern Europe. But the EU captures market share in North Africa and also increases exports to Western Asia by 20 percent. Canadian exports to Eastern Asia are reduced by 77 percent. However, Canada significantly increases its exports to Saudi Arabia with a market share of 38 percent.

The United States loses market share in North Africa and the former Soviet Union under the new GATT Agreement. The U.S. market share in Saudi Arabia also decreases from 21 percent to 12 percent. U.S. exports to Western Asia decline by 51 percent and U.S. exports to Mexico also increase by 5 percent. However, the United States captures market share in Eastern Europe. Since the Uruguay Round Agreement of GATT raises import prices, Saudi Arabia, Western Asia, North Africa, Eastern Europe, and the former Soviet Union reduce their feed barley imports by 6 percent, 6 percent, 12 percent, 10 percent, and 8 percent, respectively. However, Eastern Asia and Latin America increase their feed barley imports. The Uruguay Round Agreement benefits Canada and Australia, and has little effect on U.S. feed barley exports. The EU is a loser under this agreement.

Table 16.Optimal Feed Barley Trade Flows From Exporting Countries to Importing Regions in Model 4 (The Removal of the Canadian Rail Subsidy and the U.S. EEP)

Region	Code	E. Asia (J01)	Saudi A. (J02)	W. Asia (J03)	N. Africa (J04)	E. Europe (J05)	FSU (J06)	L. America (J07)	Mexico (J08)	USA (J09)	Total Exports
		Metric Tons									
Thunder Bay	I01	--	--	--	--	20,210	913,020	--	--	--	933,230
Vancouver	I02	800,000	647,230	--	--	--	--	339,780	--	--	1,787,000
All Canada		800,000	647,230	--	--	20,210	913,020	339,780	25,080	1,231,210	3,976,520
Portland	I03	--	463,140	--	--	--	--	--	--	--	463,140
Duluth	I04	--	--	239,440	82,570	408,980	113,630	--	--	--	844,620
Baltimore	I05	--	--	--	--	233,210	--	--	--	--	233,210
All USA		--	463,140	239,440	82,570	842,190	113,630	--	54,730	--	1,595,700
EU	I06	--	3,107,900	1,170,200	1,010,700	373,700	2,160,300	--	--	--	7,822,800
Australia	I07	844,010	487,930	--	--	--	--	--	--	--	1,331,900
Total Imports		1,644,010	4,706,200	1,409,600	1,093,200	1,036,100	3,187,000	339,780	79,800	1,231,210	14,726,930

Table 17.Optimal Feed Barley Trade Flows From Exporting Countries to Importing Regions in Model 5 (The North American Free Trade Agreement - NAFTA)

Region	Code	E. Asia (J01)	Saudi A. (J02)	W. Asia (J03)	N. Africa (J04)	E. Europe (J05)	FSU (J06)	L. America (J07)	Mexico (J08)	USA (J09)	Total Exports
		Metric Tons									
Thunder Bay	I01	--	--	--	--	--	913,020	--	--	--	913,020
Vancouver	I02	800,000	930,350	--	--	--	--	334,980	--	--	2,065,300
All Canada		800,000	930,350	--	--	--	913,020	334,980	25,300	1,023,160	4,026,810
Portland	I03	--	544,770	--	--	--	--	--	--	--	544,770
Duluth	I04	--	475,690	376,700	82,570	--	--	--	--	--	934,950
Baltimore	I05	--	--	137,520	--	27,400	113,630	--	--	--	278,550
All USA		--	1,020,460	514,220	82,570	27,400	113,630	--	58,040	--	1,816,320
EU	I06	--	2,409,000	878,100	1,061,800	1,039,000	2,250,100	--	--	--	7,469,700
Australia	I07	818,890	493,000	--	--	--	--	--	--	--	1,310,900
Total Imports		1,630,900	4,850,600	1,415,300	1,084,200	1,030,600	3,170,600	334,980	83,340	1,023,160	14,623,770

Under the World Free Trade (*Model 7*)

Under this scenario, all trade restrictions in importing regions and export subsidies and other export promotion programs in exporting countries are eliminated (Table 18). Free trade significantly shifts trade flows in the world feed barley market.

EU feed barley exports are projected to decline by 48 percent, but the EU still keeps a 61 percent market share in Western Asia and market share in North Africa and the FSU. The EU loses its market share in Saudi Arabia and Eastern Europe under world free trade. As EU exports decrease, Canada increases its exports by 27 percent. Canada ships 68 percent of its feed barley exports to Saudi Arabia. Canada increases its exports to the United States by 24 percent. Canadian exports to Latin America also slightly increase. U.S. exports to Saudi Arabia and Western Asia decline by 49 percent and 15 percent, respectively. The United States also loses market share in North Africa and the former Soviet Union. However, the United States captures all market share in Eastern Europe and increases exports to Mexico by 11 percent. U.S. total feed barley exports decrease slightly in Model 7. Australia also increases its exports by 3 percent and ships its feed barley exports to the nearest Eastern Asia market.

Under this scenario, Eastern Asia, Mexico, Latin America, and the United States increase their feed barley imports because of elimination of trade barriers. However, elimination of export subsidies reduces world feed barley exports and raises the world price. Imports of the former Soviet Union decline by 25 percent. Other importing regions also decrease imports under world free trade.

Canada benefits most among exporting countries under free trade, followed by Australia. The EU loses significant market share in the world market under free trade. World free trade has little impact on U.S. feed barley exports. Eastern Asia and Latin America also benefit from free trade, while the other importing regions are made worse off by the higher world price.

Impacts on Equilibrium Prices, Total World Exports, and Net Social Payoffs

Equilibrium prices at export ports and importing ports, and the total net social payoffs from feed barley trade under the base model and alternative scenarios are shown in Tables 19, 20, and 21, respectively. In general, removal of the U.S. EEP and the Canadian rail subsidy decreases the prices of feed barley at their export ports and increases the prices in other exporting countries. The prices of feed barley in most importing regions increase with the removal of export subsidies; but in some countries, import prices fall and import quantities increase. Removal of export subsidies and promotion programs in exporting countries decreases their exports and reduces total trade volume and net social payoffs. quantities increase. Removal of export subsidies and promotion programs in exporting countries decreases their exports and reduces total trade volume and net social payoffs.

Table 18.Optimal Feed Barley Trade Flows From Exporting Countries to Importing Regions in Model 6 (The Uruguay Round Agreement of GATT)

Region	Code	E. Asia (J01)	Saudi A. (J02)	W. Asia (J03)	N. Africa (J04)	E. Europe (J05)	FSU (J06)	L. America (J07)	Mexico (J08)	USA (J09)	Total Exports
		Metric Tons									
Thunder Bay	I01	--	--	--	--	--	930,400	--	--	--	930,400
Vancouver	I02	184,500	1,731,900	--	--	--	--	340,650	--	--	2,257,700
All Canada		184,500	1,731,900	--	--	--	930,400	340,650	25,240	1,373,800	4,586,640
Portland	I03	--	531,860	--	--	--	--	--	--	--	531,860
Duluth	I04	--	--	252,920	--	686,150	--	--	--	--	939,080
Baltimore	I05	--	--	--	--	271,530	--	--	--	--	271,530
All USA		--	531,860	252,920	--	957,680	--	--	56,990	--	1,799,450
EU	I06	--	2,284,800	1,078,200	1,003,700	--	2,024,100	--	--	--	6,390,800
Australia	I07	1,470,600	--	--	--	--	--	--	--	--	1,470,600
Total Imports		1,655,100	4,548,600	1,331,100	1,003,700	957,690	2,954,500	340,650	82,230	1,373,800	14,247,460

Table 19.Optimal Feed Barley Trade Flows From Exporting Countries to Importing Regions in Model 7 (The World Free Trade)

Region	Code	E. Asia (J01)	Saudi A. (J02)	W. Asia (J03)	N. Africa (J04)	E. Europe (J05)	FSU (J06)	L. America (J07)	Mexico (J08)	USA (J09)	Total Exports
		Metric Tons									
Thunder Bay	I01	--	1,037,300	--	--	--	63,370	--	--	--	1,100,700
Vancouver	I02	--	2,374,600	--	--	--	--	341,250	--	--	2,715,200
All Canada		--	3,411,900	--	--	--	63,370	341,250	25,310	1,140,200	4,982,020
Portland	I03	--	524,760	--	--	--	--	--	--	--	524,760
Duluth	I04	--	--	436,700	--	521,710	--	--	--	--	1,130,800
Baltimore	I05	--	--	--	--	262,560	--	--	--	--	262,560
All USA		--	524,760	436,700	--	784,270	--	--	59,960	--	1,805,680
EU	I06	--	--	694,130	789,150	-	2,377,000	--	--	--	3,860,300
Australia	I07	1,661,400	86,960	--	--	--	--	--	--	--	1,748,300
Total Imports		1,661,400	4,023,600	1,130,800	789,150	784,270	2,440,400	341,250	85,270	1,140,200	12,396,310

Table 20. Equilibrium Prices at Exporting Ports in the Base and Alternative Models

Port	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
	----------	----------	----------	US$ per Metric Tons	----------	----------	----------
Thunder Bay, Canada	79.70	81.47	79.70	81.19	79.07	80.99	93.53
Vancouver, Canada	86.83	89.24	71.51	77.23	86.66	93.17	108.66
Portland, USA	109.42	79.79	112.95	83.82	109.52	104.66	101.99
Duluth, USA	98.84	72.03	102.37	86.69	98.94	99.72	103.41
Baltimore, USA	86.37	57.67	89.27	65.02	86.44	82.35	79.12
Rouen, EU	94.40	95.42	97.76	97.88	94.51	84.18	61.97
Sydney, Australia	88.80	90.63	89.36	89.96	88.90	96.95	110.95
Canadian Exports to Mexico	100.84	100.75	99.20	99.11	102.81	101.24	104.33
US Exports to Mexico	101.79	101.84	101.83	101.88	107.16	103.50	108.11

Eliminating tariffs in importing countries reduces their port prices and increases imports in these countries, while the port prices in exporting countries slightly increase. Total world exports and net social payoffs increase with the removal of tariffs in importing countries. This result is consistent with trade theory, indicating that freer trade increases world trade volume and social welfare of participating countries.

However, this study found that trade volume of feed barley and net social payoffs declined under the two freer trade scenarios (Models 6 and 7). This is mainly because eliminating export subsidies of the major exporting countries reduces exports and causes higher prices in world feed barley market. The impacts of export subsidies on world feed barley trade are more significant than those of tariffs.

The impacts of changing trade policy on consumer surplus, producer revenue, and average price in domestic demand regions of North America can also be examined from Tables 19 and 20. Eliminating the U.S. EEP reduces U.S. offshore exports and U.S. imports from Canada. Domestic feed barley prices decrease in both Canada and the United States. Lower domestic prices make consumers better off and reduce producer revenue in both countries. Removal of the Canadian rail subsidy boosts Canadian exports to the United States and reduces Canadian exports to offshore markets. It also increases the Canadian domestic price and depresses the U.S.

domestic price. Under this scenario, U.S. consumers benefit from a lower price and U.S producer also get better off because the United States increases exports under this scenario. Meanwhile, Canadian producers are hurt mainly because the loss from decreased offshore exports is greater than the gain from increased exports to the United States. Canadian consumer surplus also decreases because of higher domestic price. The impacts of removal of both the U.S. EEP and the Canadian rail subsidy (Model 4) are the similar to those under Model 3, but the magnitudes are slightly different. Under NAFTA, Mexico and the United States increase their imports from Canada. U.S. exports to Mexico also increase.

Canadian and U.S. producers revenue increases under NAFTA. U.S. consumer surplus also increases because of a lower domestic price. However, the higher domestic price in Canada, caused by increasing exports, reduces Canadian consumer surplus under NAFTA. Under the Uruguay Round Agreement and world free trade scenarios, the United States increases imports from Canada. The domestic price in the United States decreases while the domestic price in Canada increases under these two scenarios. The changes in price increase U.S. consumer surplus and reduce Canadian consumer surplus. Canadian producer revenue increases due to the increased exports to offshore markets and the United States. U.S. producer revenue decreases slightly under the Uruguay Round Agreement and world free trade scenarios because of lower domestic prices and slight reductions in exports.

Summary and Conclusions

A static spatial equilibrium model based on a quadratic programming algorithm is used to analyze world feed barley trade and international competition among Australia, Canada, the European Union, and the United States under the current and alternative trade policy scenarios. The optimal domestic marketing and distribution of feed barley in Canada and the United States and bilateral trade flows of feed barley between these two countries are also examined in the study.

The U.S. EEP is important for U.S. feed barley exports. Eliminating the U.S. EEP reduces U.S. exports by 26 percent and significantly affects world trade flows. Removal of the Canadian rail subsidy under the WGTA decreases Canadian offshore exports by 15 percent. However, eliminating the rail subsidy increases Canadian exports to the United States by 62 percent. Elimination of both the U.S. EEP and the Canadian rail subsidy reduce offshore exports for Canada and the United States. U.S. imports from Canada also increase by 34 percent. However, the effects under this scenario are less than that under elimination of either the U.S. EEP or the Canadian rail subsidy alone.

Under NAFTA, Canada increases feed barley exports to the United States and Mexico. The NAFTA also increases U.S. exports to Mexico. Eastern Asia and Latin America increase their imports of feed barley with the elimination of import tariffs, but the impacts on world trade volume, trade flows, and social payoffs are not substantial.

Under the Uruguay Round Agreement of GATT, EU feed barley exports are expected to decline by 14 percent. Australia and Canada increase exports by 3 and 17 percent, respectively. U.S. exports slightly decrease, while U.S. imports from Canada increase by 50 percent. The total world feed barley exports decrease because of the reduction in export subsidies under this scenario.

Under world free trade, EU feed barley exports decline by 48 percent. U.S. exports slightly decrease. Canada increases its exports by 27 percent. Australia also gains from the free trade. However, total world exports and social welfare decline; most importing regions, except Eastern Asia and Latin America, reduce their imports mainly because of the elimination of export subsidies.

U.S. total exports of feed barley decrease slightly under the Uruguay Round Agreement and world free trade scenarios. Canada benefits most from freer trade through significantly higher exports to offshore markets and the United States. Australia is also made better off through higher exports because of its locational distance advantage to major importing regions.

There are some limitations to this study. Due to the difficulty of obtaining trade data for malting barley by country, only feed barley is considered in the model. This study, therefore, does not reflect the entire world barley trade. The lack of data on some countries' exporting subsidies and promotion programs may also affect the reliability of optimal solutions from the model. A final limitation is that the model does not include annual stocks in the model and does not allow storage at export ports.

Further research on world barley trade may include malting barley and malt. Besides transportation costs, production costs, and handling cost may be included so that the model more accurately portrays the world barley economy.

Table 21. Equilibrium Prices in Importing Countries and Average Prices in Domestic Demand Regions of North America in the Base and Alternative Models

Region	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
	----------	----------	----------	US$ per Metric Tons	----------	----------	----------
Eastern Asia	140.98	134.85	144.51	137.31	141.07	134.11	132.31
Saudi Arabia	111.00	112.83	114.36	114.95	111.10	119.15	133.15
Western Asia	113.89	116.30	113.57	114.16	113.72	120.24	135.73
North Africa	121.42	123.82	120.16	120.76	121.25	125.66	137.40
Eastern Europe	114.93	117.34	113.67	114.27	114.76	121.27	136.76
FSU	115.12	117.53	113.86	114.46	114.95	121.46	136.95
Latin America	140.19	128.42	143.72	130.88	140.28	129.16	127.99
Mexico	136.37	136.28	136.42	136.32	125.25	132.85	123.17
CAN Domestic Price	67.08	66.08	67.69	67.24	67.31	68.58	69.48
US Domestic Price	96.22	95.82	95.06	95.48	95.93	95.67	95.94

Table 22. Total World Feed Barley Exports and Social Welfare in the Base and Alternative Models

Model	Total World Exports (1,000 MT)	Canadian Consumer Surplus	Canadian Producer Revenue	U.S. Consumer Surplus	U.S. Producer Revenue	Net Social Payoffs
		----------	----------	Million U.S.$ ----------	----------	----------
Model 1	14,507	75.32	596.87	39.35	549.24	2,560
Model 2	14,071	78.18	589.97	41.76	473.33	2,487
Model 3	15,019	72.71	593.69	43.58	551.75	2,575
Model 4	14,727	73.31	586.80	44.36	490.39	2,523
Model 5	14,624	72.97	600.90	41.12	549.82	2,565
Model 6	14,250	71.85	629.65	43.35	545.94	2,452
Model 7	12,396	70.42	704.20	41.15	548.52	2,255

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