ECONOMICS OF WHEAT AND CANOLA

CROPPING SYSTEMS

FOR OKLAHOMA

By

ELISHA ANN HENDERSON

Bachelor of Science

Oklahoma State University

Stillwater, Oklahoma

2004

Submitted to the Faculty of the
Graduate College of
Oklahoma State University
in partial fulfillment
of the requirements
for the Degree of
MASTER OF SCIENCE
December, 2005

ECONOMICS OF WHEAT AND CANOLA

CROPPING SYSTEMS

FOR OKLAHOMA

Thesis Approved:

Francis Epplin

Thesis Advisor

R. Joe Schatzer

Thomas Peeper

Rodney Holcomb

A. Gordon Emslie

Dean of Graduate College

ACKNOWLEDGMENTS

I would like to take this opportunity to recognize the important individuals that helped me to get where I am today in the master's program at Oklahoma State University. First of all, I would like to thank the Department of Agricultural Economics at Oklahoma State University. After completing my undergraduate degree and master's degree at this land grant university surrounded by such supportive and helpful faculty and staff in the Agricultural Economics department, I appreciate the hard work of both the university and department to maintain student success.

I would also like to thank the Oklahoma Wheat Commission for their participation in this project. Without this involvement the current project would not be possible. The Oklahoma Wheat Commission is to be commended for their support and hard work in the agricultural industry.

There are a few individuals that I would like to personally thank for their continuous guidance and support. I would like to thank Dr. Epplin for his unremitting encouragement on my thesis. Not a day went by that you didn't have a positive attitude to help me look on the bright side of things. Just when I would think it was not possible, you would give me other theories and models to look at to help me understand. I would also like to thank Dr. Peeper for his continuous cooperation with Dr. Epplin and I. Without your cooperation from the Plant and Soil Sciences Department, my thesis would not be complete. Thank you for working with us to look at all avenues possible to complete the project efficiently. Another special thanks to Deena Morley. Deena is a graduate student in the Plant and Soil Sciences Department, and is responsible for the construction of this research project. She provided all data available for this project. Thank you Deena for all of your hard work and cooperation on this project.

Thank you to Gracie and Norma for your positive encouragement and for making my experience in this department a fun and enjoying one. Also, a special thank you to Gracie for helping with all of my computer problems and formatting my thesis.

I would also like to thank my fellow graduate students who touched my life and are now great friends. Thank you for the great laughs and supportive comments to brighten each day. I will continue to cherish the many great memories for years to come. You truly are friends for a lifetime.

Most importantly, I would like to thank my husband and family for their longing love, compassion, and devotion to help me get through college. Without this sincere dedication from my husband and family, my master's program would not be possible. Thank you for your continuous encouragement to achieve this great accomplishment in my life.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

PAPER I

ECONOMICS OF WINTER WHEAT CROPPING SYSTEMS

ECONOMICS OF WINTER WHEAT

CROPPING SYSTEMS

ABSTRACT

Cropping alternatives in the Northwestern Oklahoma plains are limited as a result of climate and soil type. Continuous monoculture hard red winter wheat is the predominate crop. Continuous monoculture wheat produced with conventional-tillage methods has not been very profitable for farmers in this region. The USDA reported that the estimated cost of producing wheat in the Prairie Gateway region, which includes most of the southern Great Plains, exceeded the estimated returns by $74 per acre in 2001. Even after removing the $30 per acre opportunity cost of land and $17 per acre opportunity cost of unpaid labor, the estimated costs exceeded returns by $27 (U.S. Department of Agriculture). These data do not include government subsidies, but the problem of low returns from continuous monoculture wheat is evident. To generate positive economic returns, wheat producers in the region must employ economically efficient production methods.

In the southern Great Plains, wheat is a multiple use crop. It may be produced either for grain-only, forage-only, or as a dual-purpose crop for both forage and grain. Additionally, wheat can be produced with alternative production methods, such as no-till or direct seeding. The overall objective of the research reported in this paper is to

determine the most economical tillage system (conventional till, no-till) for continuous monoculture wheat production in Oklahoma for a 640-acre farm. The specific objective is to determine the costs and net returns of conventional tillage and no-till management farm practices for ten production systems using an enterprise budgeting procedure.

ECONOMICS OF WINTER WHEAT TILLAGE SYSTEMS

INTRODUCTION

The vast majority of Oklahoma cropland is seeded to continuous monoculture hard red winter wheat. In typical years, Oklahoma cropland does not receive enough rainfall for dryland summer crops such as corn and soybeans to be competitive with wheat.

Farmers have found that often the most effective and economical method to manage weeds and diseases in a monoculture system is to use conventional tillage (Epplin, Al-Sakkaf, and Peeper). However, on some soils, under some weather conditions, conventional tillage may result in excessive soil erosion, violate the farm's conservation compliance plan, and jeopardize government subsidies.

Previous comparisons of conventional tillage and no-till in monoculture continuous wheat production found that no-till is more expensive and results in lower yields (Epplin et al.). No-till wheat was not as economical as wheat produced with conventional tillage. Comparisons of conventional tillage to no-till for monoculture continuous corn production in the Midwest have also found that no-till results in lower yields (Al-Kaisi et al.; Vyn).

In a theoretical structure, producers are assumed to attempt to maximize expected profit, defined as expected returns less expected costs of production. Expected returns are estimated on a dollar per acre basis as expected price times expected yield. Expected costs include the estimated costs associated with production of the crop. For example, expected costs of wheat production include the cost of seed, fertilizer, herbicide, machinery operating and fixed costs, and any other costs that might be incurred during the production process.

A limited number of studies have been conducted to compare yield response to tillage for crops grown in a continuous monoculture (Ribera, Hons, and Richardson; DeVuysta and Halvorson). Most long-term studies of no-till and conventional tillage for continuous monoculture wheat have found that average wheat grain yields are lower in the no-till treatments (Vyn; Epplin et al.; Epplin, Al-Sakkaf, and Peeper; Williams, Roth, and Claassen). Similarly, most long-term studies of no-till and conventional tillage for continuous monoculture corn have found lower average corn grain yields under no-till management (Al-Kaisi et al.; Vyn).

Several studies have been conducted to compare the economics of alternative tillage for crops grown in a continuous monoculture (Aase and Schaefer; Epplin, Al-Sakkaf, and Peeper; Williams, Roth, and Claassen). In these studies, machinery complements are usually prepared for each tillage and farm size (Aase and Schaefer; Epplin et al.; Williams, Roth, and Claassen). Machinery fixed and operating costs are estimated based upon equations published by the American Society of Agricultural Engineers. In general, no-till systems require an increased investment in planting equipment and additional chemicals, especially herbicide. However, no-till requires less machinery labor and less investment in tillage equipment, and lower machinery operating costs (Aase and Schaefer; Williams, Roth, and Claassen).

Harman and Martin found conventional continuous wheat yields to be slightly higher in the semiarid region of the Rolling Plains of Texas, but net return to land, management, and risk for no-till was $26 greater per acre. Variable costs for no-till were $9 per acre greater, but machinery fixed costs were $36 per acre less than the conventional-till treatment. Conventional-till treatments had six operations compared to no-till systems having two operations plus two custom herbicide applications.

Another study done in the southern Plains by Heer and Krenzer reported that in two out of three years, conventional-till wheat yields were significantly greater than those obtained with a no-till system. It was also stated that when yields were limited by rainfall, no-till had the potential to have higher yields than conventional-till.

In a Kansas study, Williams, Llewelyn, and Barnaby discovered continuous no-till wheat yielded slightly more than the conventional systems. This was due to there being more soil moisture for the no-till crops.

A five-year North Dakota study by Bauer and Black found that spring wheat yields from a moldboard plowed conventional system were as high or higher in seven of nine comparisons than from three other systems including one no-till system.

Texas researchers found that a sweep plowing treatment yielded significantly less (425 kg/ha) than the best no-till treatment in two of four years in a continuous winter wheat production system (Wiese et al.). No-till variable costs were two to three times higher than the sweep plowing treatments. In the long run, it was found that no treatments were profitable when considering machinery use and depreciation costs.

In another study, it was found that a no-till system resulted in higher total costs than other alternative systems and that the no-till system was the least economical alternative out of all the systems in Oklahoma (Epplin, Al-Sakkaf, and Peeper). Highest yields (34 bushels/acre) for a continuous wheat system were obtained from moldboard plow based clean tillage system, and the lowest yields (24 bushels/acre) resulted from the no-till system.

A ten-year Kansas study found that continuous conventional-till wheat produced higher yields than no-till wheat (Williams et al.). Positive net returns were determined for all systems except continuous no-till wheat (-$11.80 per acre). Continuous conventional-till wheat had a net return of $8.19 per acre.

OBJECTIVES

General Objective

The overall objective of the research reported in this paper is to determine the most economical tillage system (conventional till, no-till) for continuous monoculture wheat production in Oklahoma for a 640-acre farm.

Specific Objective

The specific objective is to determine the costs and net returns of conventional till and no-till management farm practices for:

1. Wheat seeded in early September for forage-only,
2. Wheat seeded in early September for forage-only with foxtail millet seeded as a summer forage double crop,

3. Wheat seeded in early September for dual-purpose (forage plus grain),
4. Wheat seeded in late September for dual-purpose (forage plus grain), and
5. Wheat seeded in mid October for grain-only.

PROCEDURES

Agronomics

The field experiments examined for this research project were conducted on farms located near Loyal (Kingfisher County) and Hunter (Garfield County), Oklahoma. Deena Morley from the Plant and Soil Sciences Department at Oklahoma State University conducted this experiment. Conventional-till and no-till management practices were examined for alternative planting dates, and different wheat uses including grain-only, forage-only and dual-purpose (forage plus grain).

These experiments were conducted using the recommended procedure of wheat seeding as reported by Krenzer. Krenzer reported that seeding in early September for a dual-purpose system would result in more forage but less grain than wheat planted in early October. Therefore, if farmers want to have fall-winter grazing for their livestock, planting in early September is recommended, but if wheat is produced for grain-only production, an October planting date is recommended.

Acronyms were defined to describe the alternative production systems. ES, LS, and O are used to denote early September, late September, and October wheat planting dates, respectively. F, FM, D, and G are used to differentiate among forage-only, forage plus German foxtail millet, dual-purpose, and grain-only. Finally, C is used to refer to conventional-till and N to no-till.

Acronyms for the conventional-tillage systems are ESFC for wheat seeded in early September for forage-only, ESFMC for wheat seeded in early September for forage-only with German foxtail millet seeded as a summer forage double crop, ESDC for wheat seeded in early September for dual-purpose (forage plus grain), LSDC for wheat seeded in late September for dual-purpose (forage plus grain), and OGC for wheat seeded in mid October for grain-only.

A key assumption for both tillage systems is that the 640-acre farm is assumed to have custom application of fertilizer, insecticide, and herbicide. Table I-1 includes a list of the field operations used for each treatment.

Conventional Till Field Operations

Machinery complements for the conventional-tillage treatments include a tractor, moldboard plow, chisel, disk, and drill. The ESFMC system did not however include a moldboard plow. After wheat hay harvest in May, a chisel, disk, and moldboard plow operation were performed for the ESFC system. A moldboard plow was used on 20 percent of the acres and a chisel on the other 80 percent. A disk operation in June was then used, followed by another disk operation in August and early September. Urea (46-0-0) was broadcast in August at the rate of 196 pounds per acre. OK 101 wheat was planted around September 5th at a rate of 90 pounds per acre and diammonium phosphate (18-46-0) was banded with the wheat seed at 50 pounds per acre. Dimethoate was applied in April at a rate of 0.75 pints per acre to control bird cherry-oat aphids.

A chisel and a disk operation were performed after wheat hay harvest in May for the ESFMC system. Urea was broadcast in May at 170 pounds per acre, followed by foxtail millet being planted at a rate of 17 pounds per acre with diammonium phosphate banded at 50 pounds per acre. In August, millet hay was harvested from the plots. Following harvest the plots were disked and fertilized with urea at 196 pounds per acre. The plots were disked once more and planted to OK 101 wheat with a seeding rate of 90 pounds per acre. Fifty pounds of diammonium phosphate was banded with the wheat seed. In April, Dimethoate was applied to control bird cherry-oat aphids. This system did not have a moldboard plow since there is insufficient time to use a plow between wheat hay harvest in May and planting foxtail millet also in May.

The ESDC, LSDC, and OGC systems have the same field operations but different planting dates. After grain harvest in June, a moldboard plow operation was performed on 20 percent of the acres and a chisel on the other 80 percent. This was followed by disk operations in August and September. Wheat seed was drilled at a rate of 90 pounds per acre with diammonium phosphate banded with the seed following urea broadcast in August. LSDC and OGC systems had another disk operation before they were planted to wheat and banded with diammonium phosphate fertilizer around September 20th and October 15th, respectively. In April, Dimethoate was applied to the three systems.

<u>No-Till Field Operations</u>

ESFN is wheat seeded in early September for forage-only, ESFMN is wheat seeded in early September for forage-only with German foxtail millet seeded as a summer forage double crop, ESDN is wheat seeded in early September for dual-purpose (forage plus grain), LSDN is wheat seeded in late September for dual-purpose (forage plus grain), and OGN is wheat seeded in mid October for grain-only. After wheat hay harvest in May, the ESFN treatment was sprayed with glyphosate at a rate of 1.5 pints per acre. Another glyphosate application at 1.5 pints per acre in June, followed by a glyphosate application of 1.0 pint per acre in August, and a glyphosate plus Lorsban application at a rate of 1.0 pint per acre each in August followed this. Lorsban was used to control grasshoppers. In September, wheat was drilled at 90 pounds per acre with diammonium phosphate banded at 50 pounds per acre. Urea was broadcast in August at 196 pounds per acre and Dimethoate was applied in April at 0.75 pints per acre due to a bird cherry-oat aphid breakout.

After wheat hay harvest in May, Urea was broadcast at 170 pounds per acre and German foxtail millet was planted at 17 pounds per acre with diammonium phosphate banded at 50 pounds per acre. The ESFMN treatment was then sprayed with glyphosate at a rate of 1.5 pints per acre. Glyphosate and Lorsban were applied at a rate of 1.0 pint per acre each following the millet hay harvest in August. Wheat was then planted in September with diammonium phosphate banded with the seed after urea was broadcast in August. In April, Dimethoate was applied to control bird cherry-oat aphids.

The ESDN, LSDN, and OGN treatments were sprayed with glyphosate at a rate of 1.5 pints per acre after the harvest of wheat grain in June. This treatment was followed by a glyphosate application of 1.0 pint per acre and urea broadcast at 196 pounds per acre in August. The ESDN treatment was sprayed with glyphosate and Lorsban in August and then planted to wheat and banded with diammonium phosphate around September 5th. The LSDN and OGN treatments each had a glyphosate application of 1.0 pint per acre before they were planted around September 20th and October 15th, respectively. All three were then sprayed in April with Dimethoate.

Table I-1. Field Operations for Alternative Wheat Production Systems

Field Operations	Month	Systems									
		ESFC	ESFMC	ESDC	LSDC	OGC	ESFN	ESFMN	ESDN	LSDN	OGN
Chisel	May		X								
Disk	May		X								
Broadcast Fertilizer (46-0-0)	May		X					X			
Band Fertilizer (18-46-0)	May		X					X			
Apply Herbicide (Glyphosate)	May						X	X			
Plant German Foxtail Millet (Conventional Till)	May		X								
Plant German Foxtail Millet (No-Till)	May							X			
Moldboard Plow (Used on 20% of Acres)	June	X		X	X	X					
Chisel (Used on 80% of Acres)	June	X		X	X	X					
Disk	June	X									
Apply Herbicide (Glyphosate)	June						X		X	X	X
Harvest Millet Forage	August		X					X			
Apply Herbicide (Glyphosate)	August						X		X	X	X
Disk	August	X	X	X	X	X					
Broadcast Fertilizer (46-0-0)	August	X	X	X	X	X	X	X	X	X	X
Apply Herbicide and Insecticide (Glyphosate and Lorsban)	August						X	X	X		
Disk	Early September	X	X	X	X	X					
Band Fertilizer (18-46-0)	Early September	X	X	X			X	X	X		
Plant Wheat (Conventional Till Drill)	Early September	X	X	X							
Plant Wheat (No-Till Drill)	Early September						X	X	X		
Apply Herbicide (Glyphosate)	Late September									X	
Disk	Late September				X						
Band Fertilizer (18-46-0)	Late September				X					X	
Plant Wheat (Conventional-Till Drill)	Late September				X						
Plant Wheat (No-Till Drill)	Late September									X	
Apply Herbicide (Glyphosate)	October										X

Field Operations	Month	Systems									
		ESFC	ESFMC	ESDC	LSDC	OGC	ESFN	ESFMN	ESDN	LSDN	OGN
Disk	October					X					
Band Fertilizer (18-46-0)	October					X					X
Plant Wheat (Conventional Till Drill)	October					X					
Plant Wheat (No-Till Drill)	October										X
Apply Insecticide (Dimethoate)	April	X	X	X	X	X	X	X	X	X	X
Harvest Wheat Hay	May	X	X				X	X			
Harvest Wheat Grain	June			X	X	X			X	X	X

ESFC = Conventional-till wheat seeded in early September for forage-only
ESFMC = Conventional-till wheat seeded in early September for forage-only with German foxtail millet seeded as a summer forage double crop
ESDC = Conventional-till wheat seeded in early September for dual-purpose (forage plus grain)
LSDC = Conventional-till wheat seeded in late September for dual-purpose (forage plus grain)
OGC = Conventional-till wheat seeded in mid October for grain-only
ESFN = No-till wheat seeded in early September for forage-only
ESFMN = No-till wheat seeded in early September for forage-only with German foxtail millet seeded as a summer forage double crop
ESDN = No-till wheat seeded in early September for dual-purpose (forage plus grain)
LSDN = No-till wheat seeded in late September for dual-purpose (forage plus grain)
OGN = No-till wheat seeded in mid October for grain-only
Modified from Stock, pg. 22-23

Wheat Production Costs

Table I-2 includes a list of the operating input prices and application rates per acre for each production system. A glyphosate price of $2.50 per pint was provided by Michael Marlow (Monsanto Retail Sales Manager). Application rates were based on labeled rates used in the field trials. A custom rate charge of $3.66 per acre per application was assessed. This rate is based upon average custom rates used across east, central and western Oklahoma (Kletke and Doye).

Insecticides, Dimethoate and Lorsban, prices were obtained from Helena Chemical Company, El Reno, Oklahoma. Dimethoate is priced at $32 per gallon and Lorsban at $34 per gallon. Application rates were based on labeled rates. A custom rate charge of $3.04 per acre was assessed for applying insecticide (Kletke and Doye).

Fertilizers, diammonium phosphate and urea, prices were obtained from the Oklahoma State University (OSU) Enterprise Budgets. Urea was broadcast once for all treatments at 196 pounds per acre at $176 per ton in August. The ESFMC and ESFMN systems had an additional application in May at 170 pounds per acre. Custom application for the 640-acre farm was budgeted at $2.60 per acre (Kletke and Doye). Diammonium phosphate was banded with the millet and wheat seed in each drilling application at a 50-pound per acre rate. The budgeted price is $212 per ton.

A millet seed price of $940 per ton or $0.47 per pound was obtained from Stillwater Milling Company. Millet was seeded at 17 pounds per acre at a cost of $7.99 per acre (Stock, p. 35). A wheat seed price of $7.00 per bushel or $0.12 per pound is from the OSU Enterprise Budgets. Wheat seeding rate was at 90 pounds per acre at a cost of $10.50 per acre.

Custom wheat grain harvest was budgeted at \$13.00 per acre; with a \$0.13 per bushel charge for each additional bushel over 20 bushels per acre. Transportation costs are set at \$0.13 per bushel (OSU Enterprise Budgets).

Table I-2. Operating Inputs for Alternative Wheat Production Systems.

Operating Inputs	Date	Unit	Price ($)	Systems									
				ESFC	ESFMC	ESDC	LSDC	OGC	ESFN	ESFMN	ESDN	LSDN	OGN
Urea (46-0-0)	May	Lbs.	0.09		170					170			
Custom Application		Acre	2.60		1					1			
Diammonium Phosphate (18-46-0)	May	Lbs.	0.11		50					50			
Glyphosate	May	Pt.	2.50						1.5	1.5			
Custom Application		Acre	3.66						1	1			
Glyphosate	June	Pt.	2.50						1.5		1.5	1.5	1.5
Custom Application		Acre	3.66						1		1	1	1
Glyphosate	August	Pt.	2.50						1.0		1.0	1.0	1.0
Custom Application		Acre	3.66						1		1	1	1
Urea (46-0-0)	August	Lbs.	0.09	196	196	196	196	196	196	196	196	196	196
Custom Application		Acre	2.60	1	1	1	1	1	1	1	1	1	1
Glyphosate	August	Pt.	2.50						1.0	1.0	1.0		
Lorsban		Pt.	4.25						1.0	1.0	1.0		
Custom Application		Acre	3.66						1	1	1		
Diammonium Phosphate (18-46-0)	Early September	Lbs.	0.11	50	50	50			50	50	50		
Glyphosate	Late September	Pt.	2.50									1.0	
Custom Application		Acre	3.66									1	
Diammonium Phosphate (18-46-0)	Late September	Lbs.	0.11				50					50	
Glyphosate	October	Pt.	2.50										1.0
Custom Application		Acre	3.66										1
Diammonium Phosphate (18-46-0)	October	Lbs.	0.11					50					50
Dimethoate	April	Pt.	4.00	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
Custom Application		Acre	3.04	1	1	1	1	1	1	1	1	1	1
Millet Seed		Acre	7.99		1.0					1.0			
Wheat Seed		Acre	7.00	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5

Modified from Stock, pg 37

Economics

The procedures of this research focus on determining the costs and returns of both tillage treatments for five production systems (wheat seeded in early September for forage-only; wheat seeded in early September for forage-only with German foxtail millet seeded as a summer forage double crop; wheat seeded in early September for dual-purpose (forage plus grain); wheat seeded in late September for dual-purpose (forage plus grain); and wheat seeded in mid October for grain-only).

A wheat enterprise budget was used to determine the returns to land, labor, and management for each system. The enterprise budgets include gross receipts minus operating costs and fixed costs. Gross receipts include revenue from millet hay, fall-winter wheat grazing, wheat hay, and wheat grain. The operating costs include millet and wheat seed, fertilizer, herbicide, insecticide, custom application, custom millet hay and wheat hay harvest, custom grain harvest and hauling, operating capital, and machinery fuel, lubrication, and repair costs. Fixed costs consist of machinery interest, taxes, insurance, and depreciation costs.

Machinery Ownership and Operating Costs

MACHSEL, a machinery complement selection software program developed by Kletke and Sestak, was used to determine the machinery ownership and operating costs for the 640-acre farm for (1) conventional-tillage and (2) no-till methods. The farm was assumed to have the fertilizer, herbicide and insecticide applications done by custom operators. When establishing candidate machines, machinery parameters were key components into determining which machines were appropriate matches with each farm size and production scheme. Diesel fuel price was set at $1.75 per gallon, interest rate at

$0.09 per dollar per year borrowed, insurance rate at 0.006 of average value, and a tax rate of 0.01 of purchase price was assumed. Tractor time equaled 1.10 multiplied by implement time and labor hours equaled 1.10 multiplied by tractor time. Dollars per labor hour were set to zero since producers have different values of labor, especially for family labor. It was also assumed that eighty-five percent of the time, work would get done in the amount of days available each month for a central clay loam soil.

Candidate Machines

After the required field operations and parameters were determined, candidate machines were selected with the assistance of the MACHSEL software. Machinery complement list prices were determined from new John Deere equipment through the products and equipment section on the www.deere.com website and from personal interviews with John Deere dealers. Parameters, including field efficiency, draft, speed, repair factors, and depreciation costs, were updated from the American Society of Agricultural Engineers (ASAE) Agricultural Machinery Management Data Standards.

Candidate machines were selected for each of the 10 production systems based upon a 640-acre farm size. For each of the conventional-tillage systems, except for the ESFMC system, a moldboard plow operation was assumed to be used on 20 percent of the acres. A chisel was used on the other 80 percent. The MACHSEL software was used to determine that field operations could be conducted in a timely manner on the conventional-tillage farm with a 155 horsepower tractor, a chisel, disk, moldboard plow, and a twenty-foot conventional drill. The ESFMC system does not have a moldboard plow. The no-till systems have a 155 horsepower tractor and a twenty-foot no-till drill.

Spray and fertilizer equipment are not included for the farm since it was assumed that chemicals and fertilizer were custom applied.

Annual hours of tractor use were calculated after the candidate machines were established through MACHSEL and then compared between conventional-till and no-till systems. Four thousand hours (one-third of total tractor life of 12,000) was divided into each of the systems annual hours of tractor use to determine an estimate of years of tractor life on the farm. Twelve years owned per tractor was then used for all conventional-tillage systems and 20 years owned for the no-till systems. By this method, for the 640-acre farm, tractor life on the farm exceeded 20 years owned, but it was assumed that farmers would not want to own tractors more then 20 years due to technology advances and depreciation. By extending the years owned, repair and fixed costs will be extended over more years resulting in a decrease in costs per year for no-till farms.

Table I-3. Tractor and Machinery Complements for a 640-Acre Farm

						Systems									
Type of Machinery	Machinery Width (Feet)	Field Speed (MPH)	Field Efficiency (%*100)	Draft / ft. of Implement (Lbs.)	Machinery Complement Used (%*100)	ESFC	ESFMC	ESDC	LSDC	OGC	ESFN	ESFMN	ESDN	LSDN	OGN
155 hp Tractor						X	X	X	X	X	X	X	X	X	X
Moldboard Plow	7.75	4.5	0.85	1250	1.00	X		X	X	X					
Chisel	18.60	5.0	0.85	625	1.00	X	X	X	X	X					
Disk	17.10	6.0	0.80	425	1.00	X	X	X	X	X					
Conventional-Till Drill	20.00	5.0	0.70	225	1.00	X	X	X	X	X					
No-Till Drill	20.00	5.0	0.70	400	1.00						X	X	X	X	X

Stock p.28.

Table I-4 lists the tractor and machinery list prices and widths.

Table I-4.Tractors and Machinery Complements Available for Field Operations

Type of Machinery	Machinery Width (Feet)	List Price ($)
155 hp Tractor		81,707
Chisel	18.60	9,673
Disk	17.10	20,231
Moldboard Plow	7.75	15,812
Fertilizer Spreader	40.00	11,200
Sprayer	60.00	7,372
Conventional-Till Drill	20.00	23,957
No-Till Drill	20.00	51,992

Modified from Stock p. 28.

Wheat and Millet Production Returns

A $2.93 June grain value was found by taking a five-year average of Oklahoma City market wheat grain prices. Table I-5 shows the Oklahoma City June wheat prices per bushel from 2000-2004.

Table I-5. **Oklahoma City June Wheat Prices ($/bu), 2000-2004.**

Year	Price
2000	2.50
2001	2.82
2002	2.91
2003	2.82
2004	3.59

Modified from Stock p. 38

The value of foxtail millet hay was calculated on a $50 per ton as fed basis. The per ton as fed basis was divided by the percentage of dry matter (87%) of hay sun-cured foxtail millet to establish a $57.47 per ton of dry matter (National Research Council). The per pound dry matter price of German foxtail millet hay (P_{MH}) was found by

(1) $$P_{MH} = (fedprice_{MH} / \%DM_{MH}) / 2000$$

where $fedprice_{MH}$ is the per ton as fed price for foxtail millet hay and $\%DM_{MH}$ is the percent of dry matter of foxtail millet hay as noted through the National Research Council. Dividing by 2000 converts the price from tons to pounds for a $0.029 per pound of dry matter.

A cutting, raking, and baling charge of large (800-1500 pounds) round bales was estimated to be $0.013 per pound dry matter. This harvest cost was determined from the average cost ($13.09) per bale in west, central, and eastern Oklahoma as reported by Kletke and Doye. The $13.09 (bale cost) was then divided by average pounds of dry matter per bale (1000.5 pounds) for a price of $0.013 per pound of dry matter. The average pounds of dry matter per bale were found by taking the average of the 800 and 1500 pounds of large round bales multiplied by the percent dry matter of foxtail millet. The equation to find harvest cost is as follows:

(2) $$hrvst\cos t = bale\cos t / DMbale$$

where *balecost* is the average harvest cost per bale and *DMbale* is the average pounds of dry matter per bale.

The value of wheat hay harvested in May was estimated in the same way as the foxtail millet hay except that wheat hay was valued at $40 per ton as fed instead of $50 per ton. This was assumed because foxtail millet hay is slightly more nutritious then sun-cured wheat hay (National Research Council). A net value of $0.023 per pound of dry matter of wheat hay was found. The per pound dry matter price of wheat hay (P_{WH}) was found by

(3) $$P_{WH} = (fedprice_{WH} / \%DM_{WH}) / 2000$$

where $fedprice_{WH}$ is the per ton as fed price for wheat hay and $\%DM_{WH}$ is the percent of dry matter of wheat hay as noted through the National Research Council.

The value of standing forage was calculated on a $40 per ton as fed basis. The per pound dry matter price of standing forage (P_{SF}) was found by

(4) $$P_{SF} = (DM / ton_{SF}) / 2000$$

where DM / ton_{SF} is the per ton as fed price for standing forage as noted through the National Research Council. Dividing by 2000 converts the price from tons to pounds for a $0.023 per pound of dry matter.

After the yield data were determined, a total of ten budgets were generated. One for each of the five wheat production systems times the two tillage systems. The net returns for each system were found by

(5) $$\pi = P_{WG}(Y_{WG}) + P_{MH}(Y_{MH}) + P_{WH}(Y_{WH}) + P_{SF}(Y_{SF}) - OC - FC .$$

where π is the net returns to land, labor, and management, P_{WG} is the price of wheat grain, Y_{WG} is the yield of grain, P_{MH} is the price of millet hay per pound of dry matter, Y_{MH} is the pound of dry matter of millet, P_{WH} is the price of wheat hay per pound of dry matter, Y_{WH} is the pound of dry matter of wheat, P_{SF} is the price of standing forage per pound of dry matter, Y_{SF} is the pound of dry matter of standing forage, OC is the operating costs, and FC is the machinery fixed costs.

RESULTS

Agronomics

The forage and grain yields produced at the two locations were averaged to acquire one average yield for each production system (Morley). The millet yields precede the forage yields for the following production year. For example, for wheat forage grown in 2003-2004, the corresponding millet yield was harvested in August of 2003.

Forage yields were available for both pre first hollow stem and post first hollow stem. Pre first hollow stem is defined as the stage at which hollow stem can first be identified above the crown where it occurs prior to the growing point reaching the soil surface (Redmon et al.).

Figure I-1 shows the millet forage yields per acre for the ESFMC and ESFMN systems across three years. An average of 3,820 pounds per acre of millet forage was produced in the no-till system, while the conventional tillage system yielded 47 pounds less.

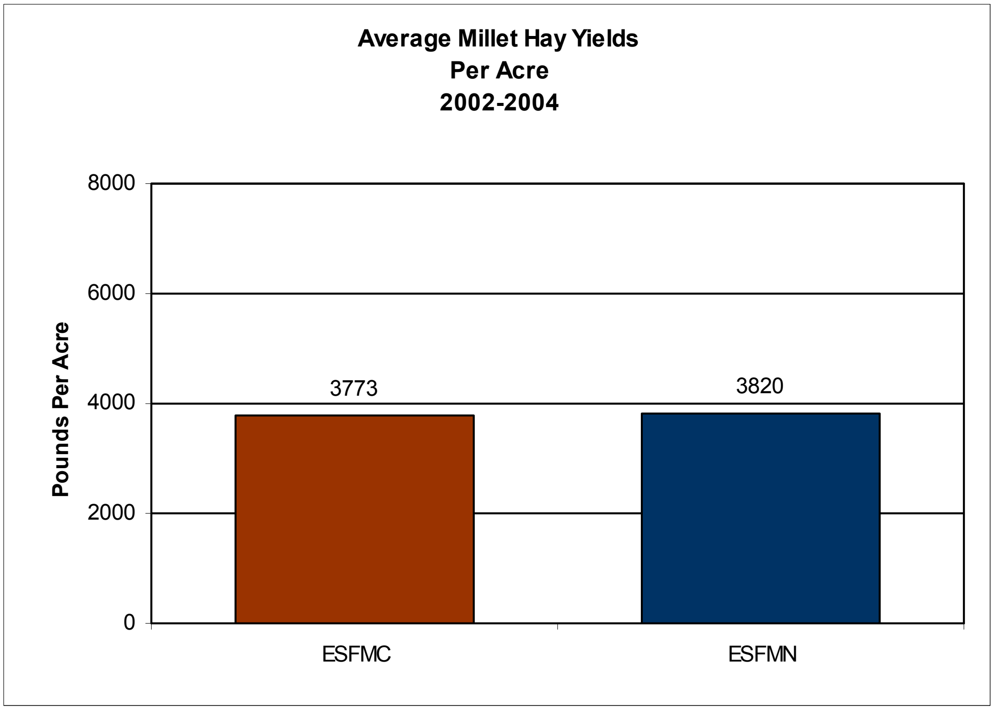

Figure I-1.**Average Millet Hay Yields Per Acre (Morley)**

Figure I-2 includes the average pre first hollow stem wheat forage yields per acre. The ESDC system had the highest fall-winter wheat forage yield of 2,540 pounds per acre while the ESDN system produced 2,518 pounds per acre. The ESFC system produced 2,370 pounds per acre of fall-winter forage compared to 2,257 pounds per acre from the ESFN system. The ESFMN and ESFMC systems produced 2,249 and 2,013 pounds per acre of fall-winter wheat forage, respectively. The LSDN and LSDC systems yielded 1,566 and 1,517 pounds per acre of pre first hollow stem wheat forage, respectively. The wheat forage yields are consistent with the pattern reported by Krenzer that expected fall-winter wheat forage yields are less for later planted wheat.

The post first hollow stem wheat forage yields are reported in Figure I-3. The ESFC system yielded the highest at 7,207 pounds per acre while the ESFN system followed at 7,080 pounds per acre. An average of 6,944 pounds per acre was produced in the ESFMN system. Following with the lowest yield in post first hollow stem wheat forage yields was the ESFMC system with 6,661 pounds per acre.

Average wheat grain yields per acre are displayed in Figure I-4. Conventional-till wheat grain yields were approximately six bushels per acre more than the no-till yields. The ESDN and ESDC systems yielded 36 and 42 bushels to the acre while the LSDN and LSDC systems produced 37 and 44 bushels per acre. The OGN system yielded only 32 bushels per acre as compared to the OGC system that had 37 bushels per acre. This finding is inconsistent with that reported by Krenzer that expected wheat grain yields are greater from early October planted wheat than from September planted wheat.

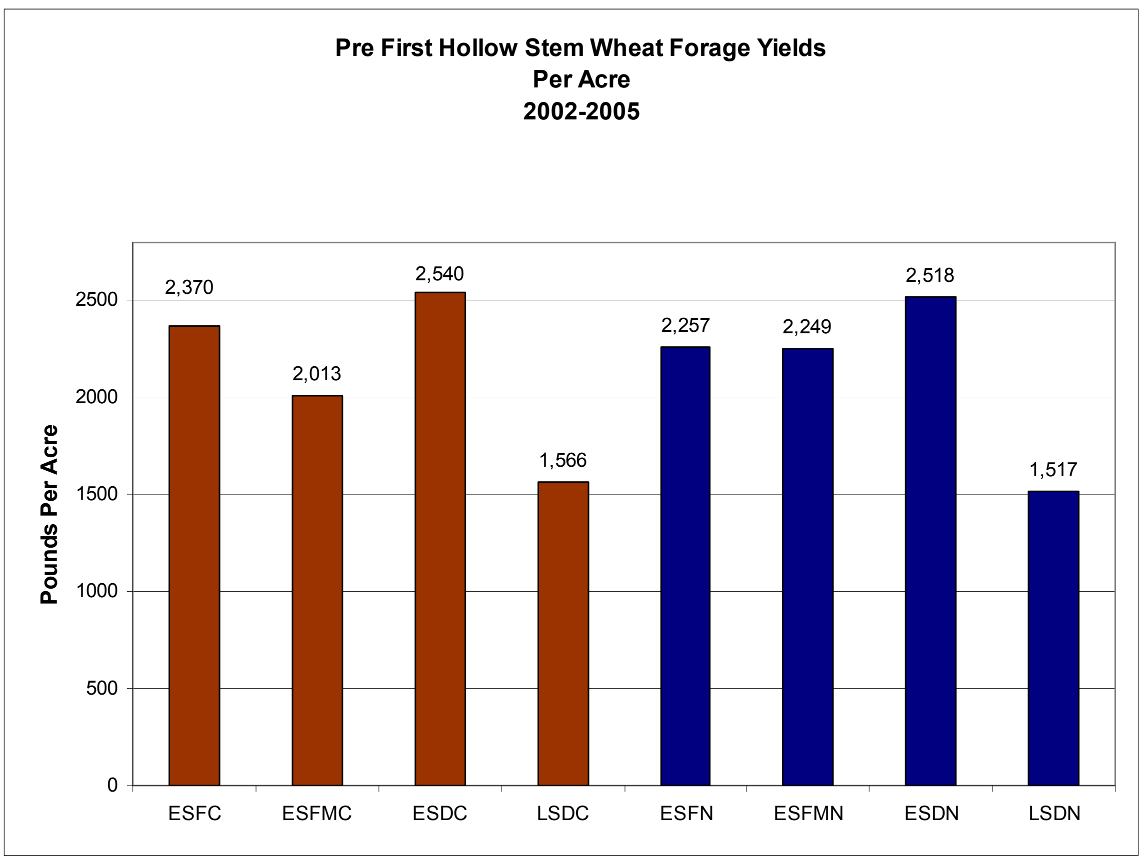

Figure I-2. Pre First Hollow Stem Wheat Forage Yields Per Acre (Morley)

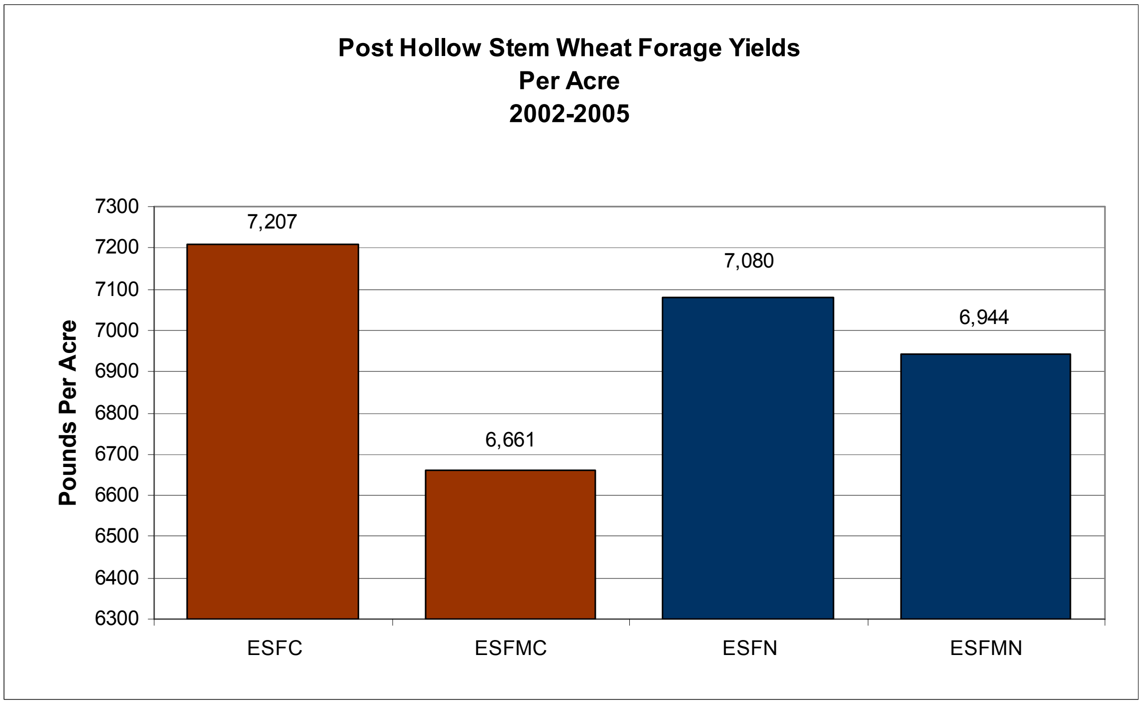

Figure I-3. Post Hollow Stem Wheat Forage Yields Per Acre (Morley)

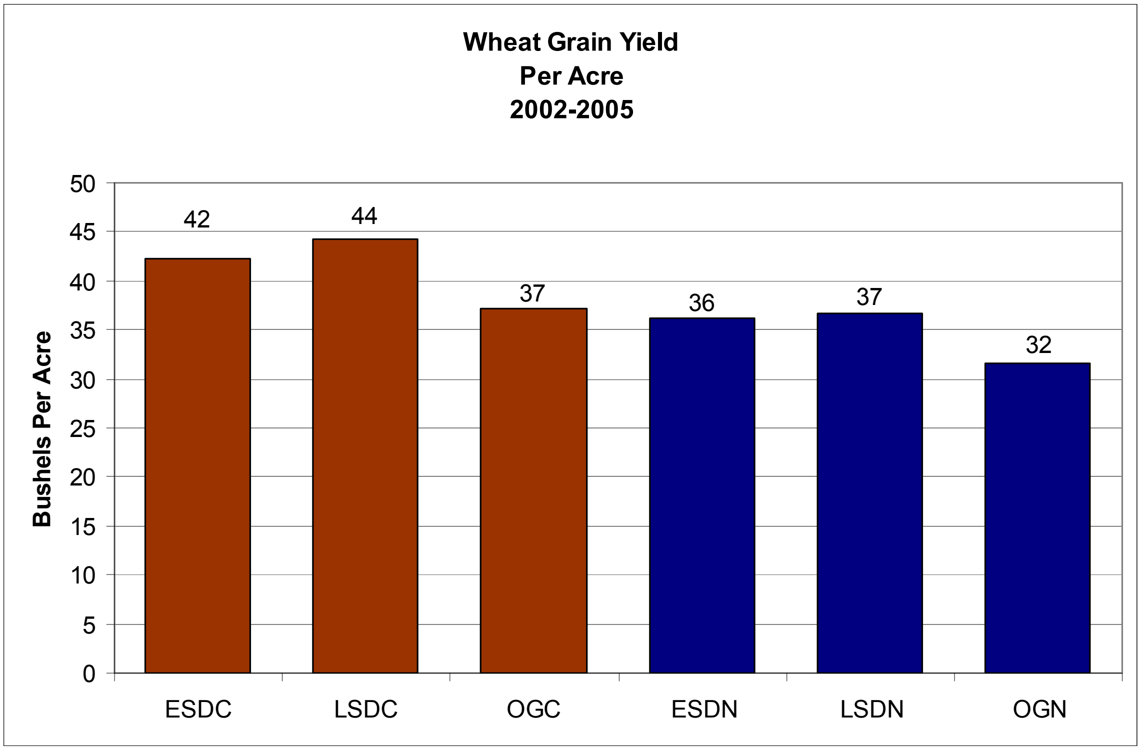

Figure I-4. Average Wheat Grain Yield Per Acre (Morley)

Economics

Operating Costs

Operating costs include the costs of millet and wheat seed, fertilizer, herbicide, insecticide, custom application, custom millet and wheat hay harvest, custom grain harvest and hauling, operating capital, and machinery fuel, lubricants, and repair costs. All five no-till systems had higher operating costs than their comparable conventional-tillage system. The average difference in operating costs over the five systems for the no-till farms was approximately $11.50 per acre higher than the conventional-till systems.

The major reasons for the high operating costs of no-till has to do with the increased herbicide use and custom application costs. Figure I-5 shows the herbicide and insecticide costs per acre for each system. The no-till systems ranged from $9 to $17 per acre higher than the conventional systems. The ESFN system herbicide and insecticide costs were the highest at $19.75 per acre due to an extra glyphosate application. The three no-till systems that were seeded in early September also had an extra insecticide application to control grasshoppers. All conventional-tillage systems had an insecticide cost of $3 per acre, which was dimethoate to control bird cherry-oat aphids.

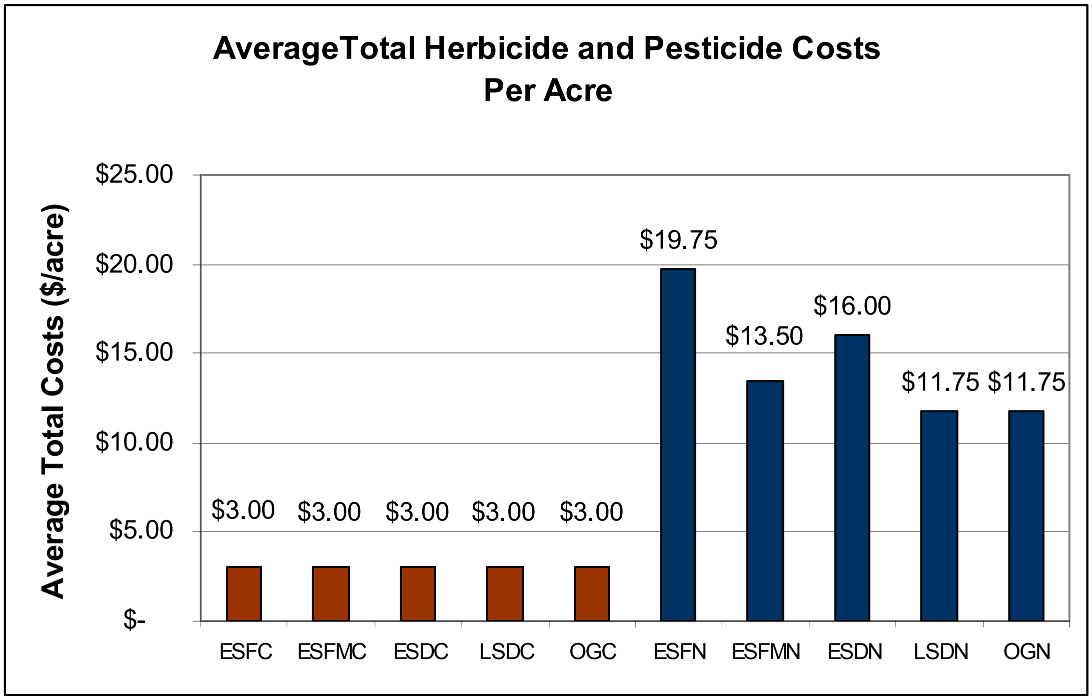

Figure I-5. Average Total Herbicide and Insecticide Costs per Acre

Machinery Variable Costs

Machinery variable costs (fuel, lubrication, and repair) were also another factor in determining total operating costs. Figure I-6 shows the machinery variable costs per acre. No-till machinery variable costs were lower than conventional-tillage costs for every system. Conventional tillage systems had higher machinery variable costs because they spend more time going over the field.

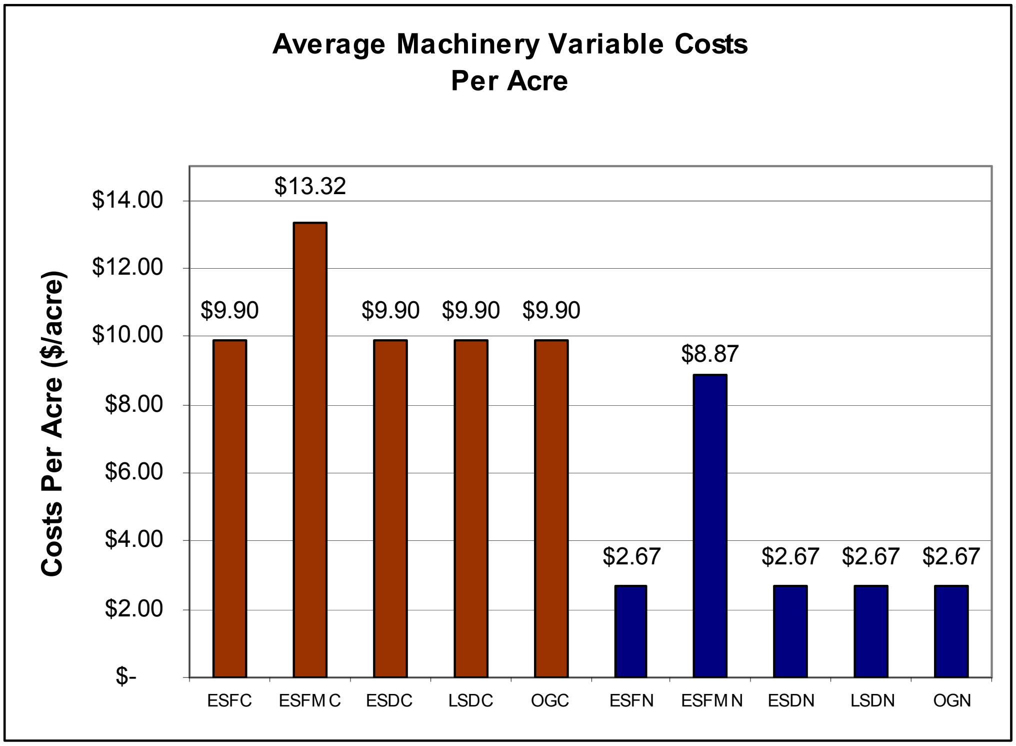

Figure I-6. Average Machinery Variable Costs per Acre.

For all systems except ESFMC and ESFMN, the no-till systems were approximately $7 per acre lower than the conventional tillage systems. The ESFMN system was $4 lower than the ESFMC system. The reason for the higher machinery variable cost for the systems that included millet was the two trips with the grain drill (once to seed millet and once to seed wheat).

<u>Machinery Fixed Costs</u>

Machinery fixed costs were lower for all no-till systems compared to the conventional tillage systems. No-till systems have fewer machines and the life of the tractor on the no-till farms was stretched out over more years. Machinery fixed costs was $28.09 per acre for the conventional till systems. All no-till farms had machinery fixed cost of $22.49 per acre.

Total Costs

Total costs excluding land, labor, and management were calculated. For all systems, ESFMN resulted in higher total costs then all the other systems with the ESFMC system having the second highest total cost. Figure I-7 shows the average total costs per acre.

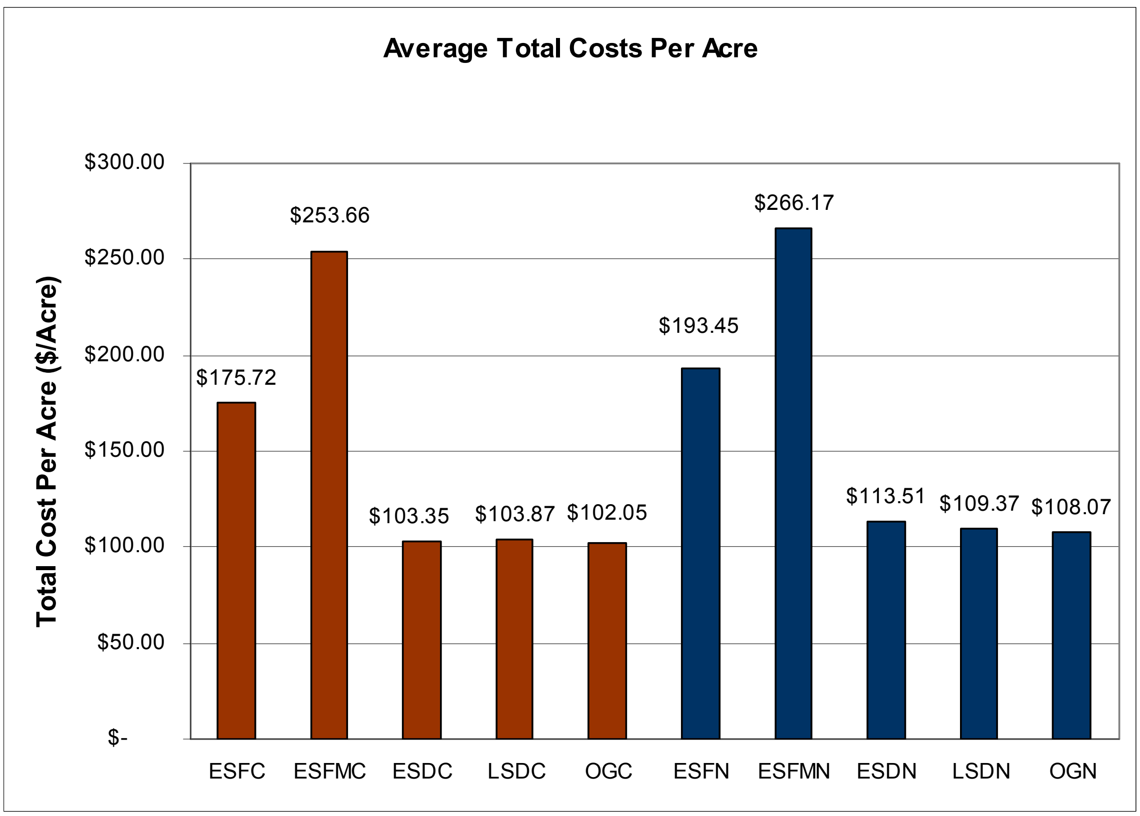

Figure I-7. Average Total Costs per acre

Machinery Labor Hours

Machinery labor hours are displayed in Figure I-8. The labor hours account for machinery labor for the budgeted machine operations and not labor associated with forage or grain harvest, taking care of livestock, fixing fences and water gaps, or any other management practices. It was assumed that hay and grain harvest costs including labor would not change across tillage systems. Costs for custom harvest of hay and grain were included in the budgets.

No-till labor hours were 0.14 hours per acre for each system excluding the ESFMN system, which had 0.29 hours per acre. The ESFC system used 0.68 hours per acre, and the ESFMC system used 0.78 hours per acre. The ESDC system used 0.55 hours per acre and the LSDC and OGC systems used 0.68 hours per acre. By using the ESDN method for farm that has all of the herbicide, insecticide, and fertilizer applications done by custom work, a farmer could save 41 minutes an acre. Fifty-four minutes per acre are saved using the LSDN and OGN systems. If a farmer did the ESFN system instead of the ESFC practice, the farmer could save 54 minutes per acre. With this extra time, farmers could farm more land or spend more time with their families.

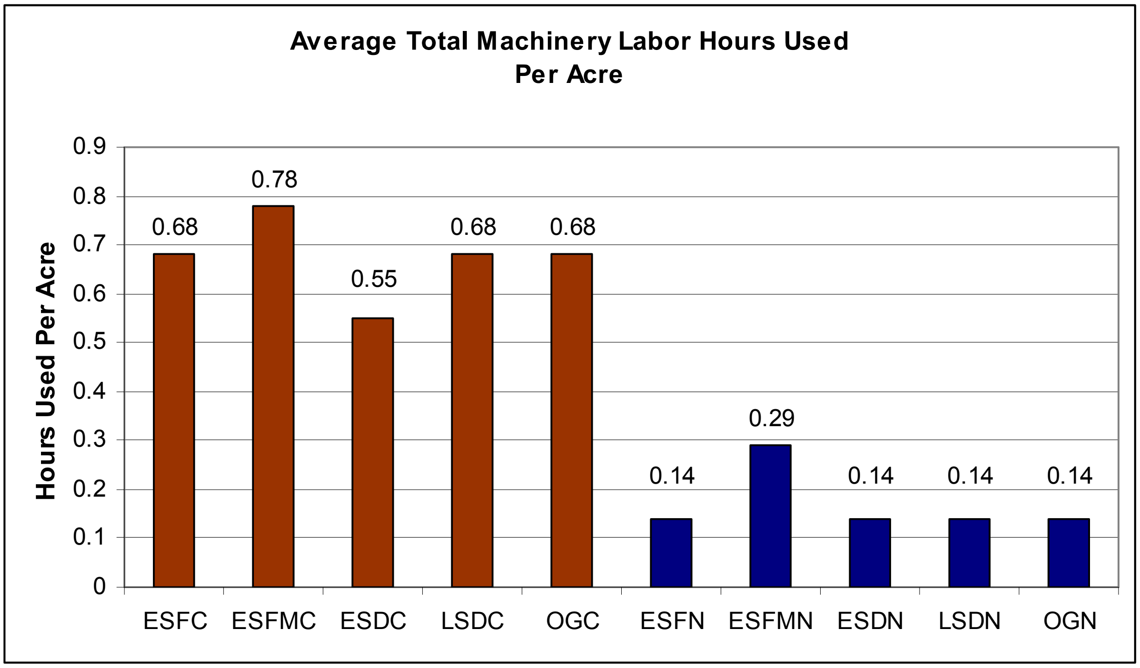

Figure I-8. Average Total Machinery Labor Hours Used per acre

Net Returns

The ESDC system had the highest average net returns. Net returns to land, labor, and management were $78.13 per acre for the ESDC system, while the LSDC method had a return of $61.07. The ESFMN and ESFMC practices had returns of $56.05 and $55.26. The OGN system had negative returns. The OGN system had returns of -$14.31 per acre, while the OGC practice had a net return of $6.36 per acre. The ESFC system had net returns of $43.44. The ESFC system was approximately $23 more than the no-till production method at $21.30. Table I-6 displays the average net returns per acre.

Table I-6. Average Net Returns Per Acre

System	Units	2002-2003		2003-2004		2004-2005		Average Net Return Per Acre[1]
		Hunter	Loyal	Hunter	Loyal	Hunter	Loyal	
ESFC	$/acre	65.16	7.51	93.16	43.69	70.00	(12.25)	44.55[bcd]
ESFMC	$/acre	130.45	(0.59)	101.01	22.02	59.05	19.59	55.26[b]
ESDC	$/acre	122.19	79.31	110.55	92.53	77.40	(13.19)	78.13[a]
LSDC	$/acre	89.58	98.52	60.34	77.35	54.24	(13.60)	61.07[a]
OGC	$/acre	4.89	14.21	2.15	31.79	18.38	(33.29)	6.36[e]
ESFN	$/acre	86.95	(5.88)	29.45	6.99	21.91	(11.65)	21.30[de]
ESFMN	$/acre	119.83	27.14	99.68	9.46	59.03	21.18	56.05[ab]
ESDN	$/acre	92.62	61.24	87.87	31.40	43.03	(16.80)	49.89[b]
LSDN	$/acre	58.71	41.15	56.50	51.13	35.24	(39.12)	33.93[cd]
OGN	$/acre	(4.18)	(45.22)	(4.56)	36.49	(14.74)	(53.63)	(14.31)[f]

[1] Means reported in the average column with the same letter are not significantly different at $\alpha=0.05$.

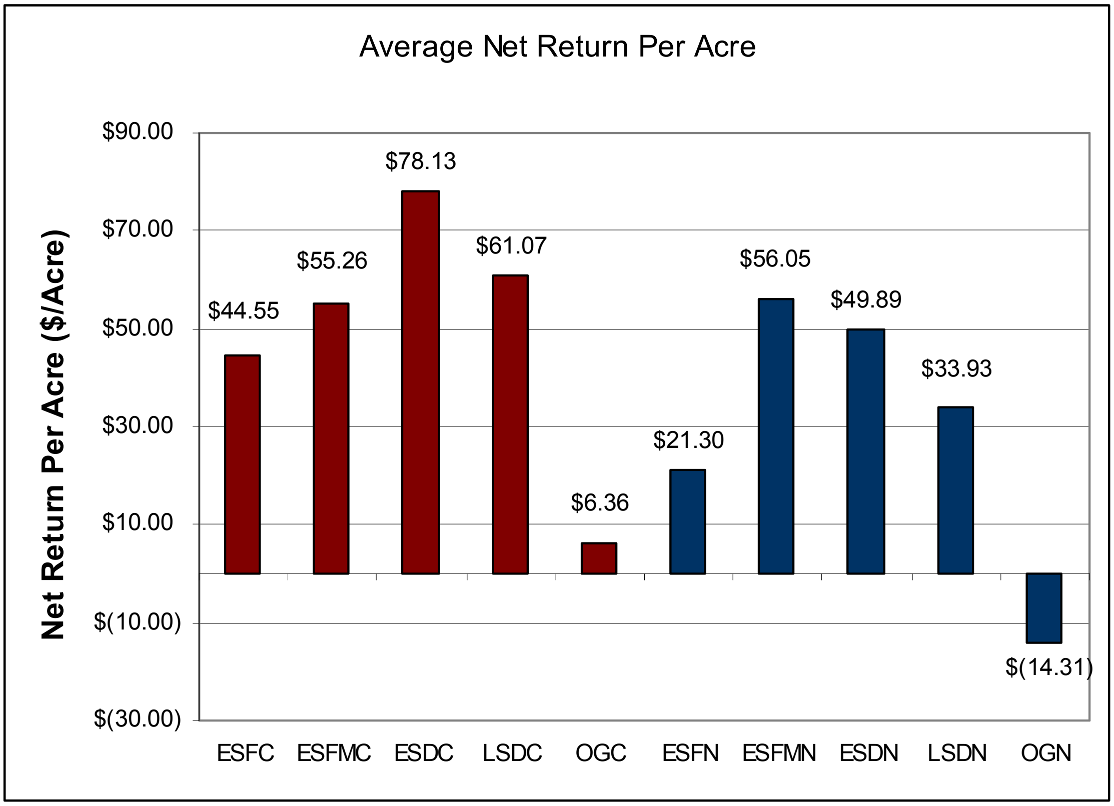

Figure I-9. Average Net Return Per Acre

Figure I-9 shows the average net returns for a 640-acre farm over three production years and two locations. For a 640-acre farm, ESFC, ESDC, LSDC, and OGC had higher net returns than the corresponding no-till systems. The OGN system resulted in negative returns to land, labor, and management. The ESDC system had the highest average net return across all systems. The ESFMN production method had the highest return for the no-till methods.

Tables I-7, I-8, I-9, I-10, and I-11 include the base budgets determined from the average yields, revenues and costs.

Table I-7. Net Returns for ESFC and ESFN Production Systems

			ESFC		ESFN	
	Unit	Price or Cost/Unit	Quantity	Value	Quantity	Value
Gross Returns						
Millet Hay	Lbs.	$ 0.029				
Wheat						
Grain	Bu.	$ 2.93				
Pasture (February)	Lbs.	$ 0.023	2370	$ 54.51	2257	$ 51.91
Hay (May)	Lbs.	$ 0.023	7207	$ 165.76	7080	$ 162.84
Gross Returns				$ 220.27		$ 214.75
Cash Costs						
Millet Seed	Acre	$ 7.99				
Wheat Seed	Acre	$ 10.50	1	$ 10.50	1	$ 10.50
Fertilizers						
Urea	Lbs.	$ 0.09	196	$ 17.64	196	$ 17.64
Diammonium Phosphate	Lbs.	$ 0.11	50	$ 5.50	50	$ 5.50
Herbicides						
Glyphosate	Pint	$ 2.50			5	$ 12.50
Insecticides						
Lorsban	Pint	$ 4.25			1	$ 4.25
Dimethoate	Pint	$ 4.00	0.75	$ 3.00	0.75	$ 3.00
Custom Application Charge						
Urea	Acre	$ 2.60	1	$ 2.60	1	$ 2.60
Dimethoate	Acre	$ 3.04	1	$ 3.04	1	$ 3.04
Glyphosate	Acre	$ 3.66			4	$ 14.64
Custom Millet and Wheat Hay Harvest						
Cutting, Raking, and Baling	Lbs.	$ 0.013	7207	$ 93.69	7080	$ 92.04
Custom Grain Harvest and Hauling						
Base Charge	Bu.	$ 13.00				
Hauling	Bu.	$ 0.13				
Excess for >20	Bu.	$ 0.13				
Annual Operating Capital (6.75%)	$	$ 0.0675	26.09	$ 1.76	38.17	$ 2.58
Machinery Fuel, Lube, and Repair	Acre		1	$ 9.90	1	$ 2.67
Total Cash Costs	$/acre			$ 147.63		$ 170.96
Machinery Fixed Costs	$/acre			$ 28.09		$ 22.49
Total Operating Costs				$ 175.72		$ 193.45
Net Returns	$/acre			$ 44.55		$ 21.30

Table I-8. Net Returns for ESFMC and ESFMN Production Systems

			ESFMC		ESFMN	
	Unit	Price or Cost/Unit	Quantity	Value	Quantity	Value
Gross Returns						
Millet Hay	Lbs.	$ 0.029	3773	$ 109.42	3820	$ 110.78
Wheat						
Grain	Bu.	$ 2.93				
Pasture (February)	Lbs.	$ 0.023	2013	$ 46.30	2249	$ 51.73
Hay (May)	Lbs.	$ 0.023	6661	$ 153.20	6944	$ 159.71
Gross Returns				$ 308.92		$ 322.22
Cash Costs						
Millet Seed	Acre	$ 7.99	1	$ 7.99	1	$ 7.99
Wheat Seed	Acre	$ 10.50	1	$ 10.50	1	$ 10.50
Fertilizers						
Urea	Lbs.	$ 0.09	366	$ 32.94	366	$ 32.94
Diammonium Phosphate	Lbs.	$ 0.11	100	$ 11.00	100	$ 1.00
Herbicides						
Glyphosate	Pint	$ 2.50			2.5	$ 6.25
Insecticides						
Lorsban	Pint	$ 4.25			1	$ 4.25
Dimethoate	Pint	$ 4.00	0.75	$ 3.00	0.75	$ 3.00
Custom Application Charge						
Urea	Acre	$ 2.60	2	$ 5.20	2	$ 5.20
Dimethoate	Acre	$ 3.04	1	$ 3.04	1	$ 3.04
Glyphosate	Acre	$ 3.66			2	$ 7.32
Custom Millet and Wheat Hay Harvest						
Cutting, Raking, and Baling	Lbs.	$ 0.013	10434	$ 135.64	10764	$ 139.93
Custom Grain Harvest and Hauling						
Base Charge	Bu.	$ 13.00				
Hauling	Bu.	$ 0.13				
Excess for >20	Bu.	$ 0.13				
Annual Operating Capital (6.75%)	$	$ 0.0675	43.50	$ 2.94	50.18	$ 3.39
Machinery Fuel, Lube, and Repair	Acre		1	$ 13.32	1	$ 8.87
Total Cash Costs	$/acre			$ 225.57		$ 243.68
Machinery Fixed Costs	$/acre			$ 28.09		$ 22.49
Total Operating Costs				$ 253.66		$ 266.17
Net Returns	$/acre			$ 55.26		$ 56.05

Table I-9. Net Returns for ESDC and ESDN Production Systems

			ESDC		ESDN	
	Unit	Price or Cost/Unit	Quantity	Value	Quantity	Value
Gross Returns						
Millet Hay	Lbs.	$ 0.029				
Wheat						
Grain	Bu.	$ 2.93	42	$ 123.06	36	$ 105.48
Pasture (February)	Lbs.	$ 0.023	2540	$ 58.42	2518	$ 57.91
Hay (May)	Lbs.	$ 0.023				
Gross Returns				$ 181.48		$ 163.39
Cash Costs						
Millet Seed	Acre	$ 7.99				
Wheat Seed	Acre	$ 10.50	1	$ 10.50	1	$ 10.50
Fertilizers						
Urea	Lbs.	$ 0.09	196	$ 17.64	196	$ 17.64
Diammonium Phosphate	Lbs.	$ 0.11	50	$ 5.50	50	$ 5.50
Herbicides						
Glyphosate	Pint	$ 2.50			3.5	$ 8.75
Insecticides						
Lorsban	Pint	$ 4.25			1	$ 4.25
Dimethoate	Pint	$ 4.00	0.75	$ 3.00	0.75	$ 3.00
Custom Application Charge						
Urea	Acre	$ 2.60	1	$ 2.60	1	$ 2.60
Dimethoate	Acre	$ 3.04	1	$ 3.04	1	$ 3.04
Glyphosate	Acre	$ 3.66			3	$ 10.98
Custom Millet and Wheat Hay Harvest						
Cutting, Raking, and Baling	Lbs.	$ 0.013				
Custom Grain Harvest and Hauling						
Base Charge	Bu.	$ 13.00	1	$ 13.00	1	$ 13.00
Hauling	Bu.	$ 0.13	42	$ 5.46	36	$ 4.68
Excess for >20	Bu.	$ 0.13	22	$ 2.86	16	$ 2.08
Annual Operating Capital (6.75%)	$	$ 0.0675	26.09	$ 1.76	34.47	$ 2.33
Machinery Fuel, Lube, and Repair	Acre		1	$ 9.90	1	$ 2.67
Total Cash Costs	$/acre			$ 75.26		$ 91.02
Machinery Fixed Costs	$/acre			$ 28.09		$ 22.49
Total Operating Costs				$ 103.35		$ 113.51
Net Returns	$/acre			$ 78.13		$ 49.89

Table I-10. Net Returns for LSDC and LSDN Production Systems

	Unit	Price or Cost/Unit	LSDC Quantity	LSDC Value	LSDN Quantity	LSDN Value
Gross Returns						
Millet Hay	Lbs.	$ 0.029				
Wheat						
Grain	Bu.	$ 2.93	44	$ 128.92	37	$ 108.41
Pasture (February)	Lbs.	$ 0.023	1566	$ 36.02	1517	$ 34.89
Hay (May)	Lbs.	$ 0.023				
Gross Returns				$ 164.94		$ 143.30
Cash Costs						
Millet Seed	Acre	$ 7.99				
Wheat Seed	Acre	$ 10.50	1	$ 10.50	1	$ 10.50
Fertilizers						
Urea	Lbs.	$ 0.09	196	$ 17.64	196	$ 17.64
Diammonium Phosphate	Lbs.	$ 0.11	50	$ 5.50	50	$ 5.50
Herbicides						
Glyphosate	Pint	$ 2.50			3.5	$ 8.75
Insecticides						
Lorsban	Pint	$ 4.25				
Dimethoate	Pint	$ 4.00	0.75	$ 3.00	0.75	$ 3.00
Custom Application Charge						
Urea	Acre	$ 2.60	1	$ 2.60	1	$ 2.60
Dimethoate	Acre	$ 3.04	1	$ 3.04	1	$ 3.04
Glyphosate	Acre	$ 3.66			3	$ 10.98
Custom Millet and Wheat Hay Harvest						
Cutting, Raking, and Baling	Lbs.	$ 0.013				
Custom Grain Harvest and Hauling						
Base Charge	Bu.	$ 13.00	1	$ 13.00	1	$ 13.00
Hauling	Bu.	$ 0.13	44	$ 5.72	37	$ 4.81
Excess for >20	Bu.	$ 0.13	24	$ 3.12	17	$ 2.21
Annual Operating Capital (6.75%)	$	$ 0.0675	26.09	$ 1.76	32.34	$ 2.18
Machinery Fuel, Lube, and Repair	Acre		1	$ 9.90	1	$ 2.67
Total Cash Costs	$/acre			$ 75.78		$ 86.88
Machinery Fixed Costs	$/acre			$ 28.09		$ 22.49
Total Operating Costs				$ 103.87		$ 109.37
Net Returns	$/acre			$ 61.07		$ 33.93

Table I-11. Net Returns for OGC and OGN Production Systems

			OGC		OGN	
	Unit	Price or Cost/Unit	Quantity	Value	Quantity	Value
Gross Returns						
Millet Hay	Lbs.	$ 0.029				
Wheat						
Grain	Bu.	$ 2.93	37	$ 108.41	32	$ 93.76
Pasture (February)	Lbs.	$ 0.023				
Hay (May)	Lbs.	$ 0.023				
Gross Returns				$ 108.41		$ 93.76
Cash Costs						
Millet Seed	Acre	$ 7.99				
Wheat Seed	Acre	$ 10.50	1	$ 10.50	1	$ 10.50
Fertilizers						
Urea	Lbs.	$ 0.09	196	$ 17.64	196	$ 17.64
Diammonium Phosphate	Lbs.	$ 0.11	50	$ 5.50	50	$ 5.50
Herbicides						
Glyphosate	Pint	$ 2.50			3.5	$ 8.75
Insecticides						
Lorsban	Pint	$ 4.25				
Dimethoate	Pint	$ 4.00	0.75	$ 3.00	0.75	$ 3.00
Custom Application Charge						
Urea	Acre	$ 2.60	1	$ 2.60	1	$ 2.60
Dimethoate	Acre	$ 3.04	1	$ 3.04	1	$ 3.04
Glyphosate	Acre	$ 3.66			3	$ 10.98
Custom Millet and Wheat Hay Harvest						
Cutting, Raking, and Baling	Lbs.	$ 0.013				
Custom Grain Harvest and Hauling						
Base Charge	Bu.	$ 13.00	1	$ 13.00	1	$ 13.00
Hauling	Bu.	$ 0.13	37	$ 4.81	32	$ 4.16
Excess for >20	Bu.	$ 0.13	17	$ 2.21	12	$ 1.56
Annual Operating Capital (6.75%)	$	$ 0.0675	26.09	$ 1.76	32.34	$ 2.18
Machinery Fuel, Lube, and Repair	Acre		1	$ 9.90	1	$ 2.67
Total Cash Costs	$/acre			$ 73.96		$ 85.58
Machinery Fixed Costs	$/acre			$ 28.09		$ 22.49
Total Operating Costs				$ 102.05		$ 108.07
Net Returns	$/acre			$ 6.36		$ (14.31)

CONCLUSIONS

Wheat may be produced either for grain-only, forage-only, or as a dual-purpose crop for both forage and grain. Research was conducted to determine the most economical production system across five cropping alternatives and two tillage methods for a 640-acre farm size. The five cropping alternatives included: (1) wheat seeded in early September for forage-only; (2) wheat seeded in early September for forage-only with foxtail millet seeded as a summer forage double crop; (3) wheat seeded in early September for dual-purpose (forage plus grain); (4) wheat seeded in late September for dual-purpose (forage plus grain); and (5) wheat seeded in mid October for grain-only. The two tillage methods included conventional tillage and no-till.

Yield data, input requirements, and required field operations were obtained from a designed replicated experiment conducted on two farms. The farms are located near Loyal (Kingfisher County) and Hunter (Garfield County), Oklahoma. Forage and grain yields were gathered for the 2002-2003 crop, the 2003-2004 crop, and the 2004-2005 crop.

The dual-purpose system, ESDC, had the highest pre hollow stem fall-winter wheat forage yield of 2,540 pounds per acre, while the ESDN system produced 2,518 pounds per acre. The lowest yields for the early and late September systems were produced from the LSDC and LSDN systems. The LSDC system produced 1,566 pounds per acre of fall-winter forage compared to 1,517 pounds per acre from the LSDN system.

The ESFMN and ESFMC systems produced 2,249 and 2,013 pounds per acre of pre hollow stem fall-winter wheat forage, respectively. The ESFC system forage yields were higher for the late September seeding date compared to the ESFN system. The ESFC and ESFN systems yielded 2,370 and 2,257 pounds per acre of pre first hollow stem fall-winter wheat forage, respectively. The wheat forage yields were consistent with the pattern reported by Krenzer that expected fall-winter wheat forage yields are less for later planted wheat.

The post first hollow stem fall-winter forage yield for the ESFC system was 7,207, resulting in the highest post first hollow stem forage yield. This system was followed by ESFN at 7,080 pounds per acre and ESFMN at 6,944 pounds per acre. The lowest yielding post first hollow stem fall-winter forage yield was the ESFMN system at 6,661 pounds per acre.

Grain yields were harvested from each of the dual-purpose and grain-only systems. Conventional-till wheat grain yields were approximately six bushels per acre more than the no-till yields. The ESDN and ESDC systems yielded 36 and 42 bushels to the acre while the LSDN and LSDC systems produced 37 and 44 bushels per acre. The OGN system yielded only 32 bushels per acre as compared to the OGC system that had 37 bushels per acre.

The MACHSEL machinery complement selection program was used to prepare machinery complements for each system. It was assumed that grain and hay would be custom harvested so the machinery complements did not include grain and forage harvesting machinery and equipment. In general, average machinery investment was found to be lower for the no-till system.

A wheat enterprise budget was used to determine the returns to land, labor, and management for each system. The no-till systems had overall greater operating costs than the conventional tillage systems. The no-till systems ranged from $10.50 to $19.25 per acre higher than the conventional systems. Herbicide and insecticide costs were a major factor for the increased operating costs. Herbicide and insecticide costs averaged $11 per acre higher for the no-till systems.

No-till machinery variable costs were lower than conventional tillage costs for every system. Conventional tillage systems had higher machinery variable costs because they spend more time going over the field while the no-till systems hired custom applicators to apply herbicides. For all systems except ESFMC and ESFMN, the no-till system costs were approximately $7 less per acre than the conventional till systems. Costs for the ESFMN system were $4 less per acre than costs for the ESFMC system.

Machinery fixed costs were lower for all no-till systems compared to the conventional-till systems. Machinery fixed costs were $28.09 per acre for the conventional tillage systems. All no-till farms had machinery fixed cost of $22.49 per acre.

Total costs excluding land, labor, and management were calculated. For all systems, ESFMN resulted in higher total costs then all the other systems with the ESFMC system having the second highest total cost.

By using the ESDN method, a farmer could save 41 minutes an acre. 54 minutes per acre are saved using the LSDN and OGN systems. If a farmer did the ESFN system instead of the ESFC practice, the farmer could save 54 minutes per acre. Minutes saved are for machinery labor for budgeted machine operations and not labor associated with forage or grain harvest, taking care of livestock, fixing fences and water gaps, or any other management practices.

The ESDC system had the greatest net return to land, labor, and management. The LSDC system had the second highest net return followed by the ESFMN, ESFMC, and ESDN systems. The OGN system generated negative net returns across all three production years at both locations.

SUMMARY

The overall objective of the research was to determine the most economical tillage system (conventional till, no-till) for continuous monoculture wheat production in Oklahoma for a 640-acre farm. The specific objective of this thesis was to determine the most economical wheat production system. The ESDC system was the most economical of all production systems followed by the LSDC system. The ESDC system had a net return of $78.13 per acre, which was $17.06 per acre more, than the LSDC system, $22.08 more than the highest no-till system, ESFMN, $22.87 more than the ESFMC system, $28.24 more than the ESDN system and $71.77 more than the OGC system. The OGN treatment netted $92.44 per acre less than the ESDC system. The OGN treatment was the least economical. It generated $20.67 per acre less than the comparable conventional-till system.

REFERENCES

Aase, J. K., and G.M. Schaefer. "Economics of Tillage Practices and Spring Wheat and Barley Crop Sequence in the Northern Great Plains." *Journal of Soil and Water Conservation* 51-2(1996): 167-177.

Adams, T.J. John Deere Company. Personal Communication. 22 June 2005.

Al-Kaisi, M. M., X.A. Yin, M.E Hanna, and M. D. Duffy. "Considerations in Selecting No-till." Iowa State University University Extension. Bull. No. PM 1901d, December 2002.

American Society of Agricultural Engineers Standards. "Agricultural Machinery Management Data." ASAE D497.4 JAN98. 2001.

Bauer, A. and A.L. Black. "Effect of Management Method of Erect Stubble at Spring Planting on Performance of Spring Wheat." *North Dakota State University Agricultural Experiment Station Research Report No. 524,* March 1992.

DeVuysta, E. A. and A. D. Halvorson. "Economics of Annual Cropping versus Crop–Fallow in the Northern Great Plains as Influenced by Tillage and Nitrogen." *Agronomy Journal* 96(2004): 148-153.

Epplin, F.M. Agricultural Economics Department, Oklahoma State University. Personal Communication. 19 August 2005.

Epplin, F. M., C. J. Stock, D. D. Kletke, and T. F. Peeper "Cost of Conventional Tillage and No-till Continuous Wheat Production for Four Farm Sizes." *Journal of American Society of Farm Managers and Rural Appraisers* 69(2005):69-76.

Epplin, Francis M., Ghazi A. Al-Sakkaf, and Thomas F. Peeper. "Impacts of Alternative Tillage Methods for Continuous Wheat on Grain Yield and Economics: Implications for Conservation Compliance." *Journal of Soil and Water Conservation* 49-4(1994): 394-399

Harman, W.L., and J.R. Martin. "Economics of Conservation Tillage Research in Texas." Presentation at the 10th Annual Southern Conservation Tillage Conference for Sustainable Agriculture. College Station, TX, 1-2 July 1987.

Heer, W.F., and E.G. Krenzer, Jr. *"Soil Water Availability for Spring Growth of Winter Wheat (Triticum Aestivum L.) as Influenced by Early Growth and Tillage." Soil and Tillage Research* 14(1989): 185-196.

John Deere. "Products and Equipment." Available at http://www.deere.com/en_US/ProductCatalog/FR/landingpage/FR_LandingPage.html. Accessed on June 10, 2005.

Kletke, D. and D.G. Doye. 2002. "Oklahoma Farm and Ranch Custom Rates, 2001-2002." Department of Agricultural Sciences and Natural Resources. Oklahoma Cooperative Extension Service Current Report CR-205. Oklahoma State University.

Kletke, D., and R. Sestak. 1991. The operation and use of MACHSEL: A farm machinery selection template. Department of Agricultural Economics Computer Software Series CSS-53. Oklahoma State Univ., Stillwater, OK.

Krenzer, E.G. "Management Practices and Net Returns in a Wheat-Stocker Enterprise." Report Production Technology –Crops 95-18. Oklahoma Cooperative Extension Service, Stillwater, OK 7(1995): 1-5.

Krenzer Jr., E.G., R.L. Burton, and F.J. Gough. "Effect of Crop Residues on Crop Pests, Soil Water, and Soil Temperature." Presentation at the 10th Annual Southern Conservation Tillage Conference for Sustainable Agriculture, College Station, TX, 1-2 July 1987.

Marlow, Michael. Monsanto Seed Company. Personal Communication. 22 July 2005.

Mathis, J.B. Estes Chemicals. Personal Communication. 25 June 2005.

Morley, Deena. Department of Plant and Soil Sciences. Oklahoma State University. Personal Communication. 20 October 2005.

Oklahoma Agricultural Statistics Service. 2002a. 2001 Bulletin. Available at http://www.nass.usda.gov/ok/5yr00/Garfield.htm. Accessed on June 23, 2005.

Oklahoma State University. *2003 Oklahoma Crop and Livestock Enterprise Budgets*. Department of Agricultural Economics, Oklahoma Cooperative Extension Service, Oklahoma State University.

Redmon, L.A., Krenzer, E.G., Bernardo, D.J. and G.W. Horn. "Effect of Wheat Morphological Stage at Grazing Termination on Economic Return." *Agronomy Journal.* 88(1996): 94-97.

Ribera, Luis A., F.M. Hons, James W. Richardson "An Economic Comparison between Conventional and No-Tillage Farming Systems in Burleson County, Texas." *Agronomy Journal* 96(2004): 415-424.

SAS Online Doc. Version Eight. "PROC MIXED SAS Manual" Available at http://v8doc.sas.com/sashtml/. Accessed on November 2, 2005.

Stock, C. "Winter Wheat Cropping and Tillage Systems." MS Thesis, Oklahoma State University, 2004.

U.S. Department of Agriculture. "Wheat production costs and returns, Prairie Gateway, 1998-2001." Available at http://www.ers.usda.gov/data/costsandreturns/dat/recent/Whea/R-PGWhea.xls. Accessed on July 5, 2005

Vyn, T. J. "Strip-Till: A Closer Look." Available at: http://www.agry.purdue.edu/staffbio/Fargo,ND,02-20,2004.pdf. Accessed on October 22, 2004.

Wiese, A. F., W.L. Harman, B.W. Bean, and C.D. Salisbury. "Effectiveness and Economic of Dryland Conservation Tillage Systems in the Southern Great Plains." *Agronomy Journal* 86(1994): 725-730.

Williams, J.R., Llewelyn, R.V., and G.A. Barnaby. "Risk Analysis of Tillage Alternatives with Government Programs." *American Journal of Agricultural Economics.* 72(1990): 172-181.

Williams, J.R., T.W. Roth, and M.M Claassen. "Profitability of Alternative Production and Tillage Strategies for Dryland Wheat and Grain Sorghum in the Central Great Plains." *Journal of Soil and Water Conservation* 55-1(2000): 49-56.

PAPER II

BREAKEVEN YIELDS FOR WINTER CANOLA IN A TRADITIONAL OKLAHOMA WINTER WHEAT ENVIRONMENT

BREAKEVEN YIELDS FOR WINTER CANOLA IN A TRADITIONAL OKLAHOMA WINTER WHEAT ENVIRONMENT

ABSTRACT

Oklahoma crop producers have few alternatives. The leading crop in Oklahoma is continuous monoculture hard red winter wheat. Historically, net returns from alternative winter crops that could work in a rotation with winter wheat are less than net returns from wheat. A profitable alternative crop to use in a rotation with wheat might reduce some of the weed and disease problems associated with continuous wheat. This research was conducted to analyze the economics of winter canola relative to winter wheat for Oklahoma. The objective of the research is to determine for several sets of expected wheat price, canola price, and wheat yield, the breakeven yield for canola. An enterprise budgeting procedure that considers three crops (wheat, Roundup Ready® canola, and Non-Roundup Ready canola) for a 640-acre farm size was used to determine the breakeven canola yield. For the budgeted prices and expected levels of input use, conventional canola yields of 1,975 to 2,331 pounds per acre would be required to breakeven with wheat yields of 45 to 55 bushels per acre, respectively.

BREAKEVEN YIELDS FOR WINTER CANOLA IN A TRADITIONAL OKLAHOMA WINTER WHEAT ENVIRONMENT

INTRODUCTION

The majority of Oklahoma cropland is seeded to hard red winter wheat and most is in continuous wheat production. When annual crops are grown in monocultures, weed species that can thrive in the environment may become established and become expensive to control. Similarly, when the same crop is grown year after year, diseases that infect the crop may become established in the field and become a persistent problem. If crop residue is retained on the soil surface, the disease organism may bridge from old crop residue to the new crop.

Farmers have found that often the most effective and economical method to manage weeds and diseases in a monoculture system is to use conventional tillage (Epplin, Al-Sakkaf, and Peeper). However, on some soils, under some weather conditions, conventional tillage may result in excessive soil erosion, violate the farm's conservation compliance plan, and jeopardize government subsidies.

Previous efforts to find an economical alternative crop to rotate with wheat in Oklahoma have not been successful (Biermacher, Epplin, and Keim). Historically, the search has been hampered by government program requirements. Prior to 1996 farmers were often required to seed monoculture wheat to maintain wheat program base acres that were important for determining government subsidy payments. The 1996 farm bill changed the wheat planting requirement but, unfortunately, researchers were not prepared with an alternative.

Several varieties of winter canola have been developed. Winter canola may fit in a rotation with winter wheat. Conley et al., argue that winter canola creates two potential advantages. First, it provides a crop for farmers to rotate with winter wheat. Secondly, it has potential to increase the yields of wheat in a rotation with canola. Therefore, the research question is "What canola yield is required for canola to be economically competitive with Oklahoma continuous monoculture winter wheat?"

LITERATURE REVIEW

In some regions of the country rotations with crops such as barley, corn, and soybeans are profitable (Aase and Shaefer; DeVuysta and Halvorson; Vyn). To date, there has been no economic research on a winter wheat-winter canola rotation for Oklahoma. Future research on a wheat-canola rotation should determine the circumstances under which canola is economically competitive with Oklahoma continuous monoculture winter wheat. However, there are many issues to be resolved to determine if a wheat-canola rotation is more economical than continuous wheat.

Since canola is a broadleaf plant, herbicides are available and may be used to control winter annual grass weeds such as cheat, downy brome, and ryegrass that have become serious weed problems in many monoculture wheat fields. Further, glyphosate tolerant varieties of winter canola are also available to enable the use of the very broad-spectrum glyphosate herbicide.

In several respects a wheat-canola rotation is analogous to a corn-soybean rotation. Wheat and canola are winter crops whereas corn and soybeans are summer crops. Wheat and corn are grasses, whereas canola and soybeans are broadleaf species. One difference is that soybeans are legumes and canola is not. However, the rationale for a wheat-canola rotation is to greatly enhance weed control alternatives, enable no-till, reduce disease problems, enhance grain quality, diversify risk, and improve yield per harvested acre. With the development of new winter tolerant varieties (both conventional and glyphosate tolerant), canola offers promise as a rotational crop with winter wheat.

OBJECTIVE

The general objective of this research is to provide information that farmers may use to aid in their decision of whether or not to adopt canola. The specific objective is to determine the breakeven yield for canola for a given set of expected wheat price, wheat yield, and canola price, under a conventional tillage system.

PROCEDURES

Ideally a comprehensive whole field or whole farm analysis would be conducted to enable a comparison of continuous monoculture wheat with several alternatives. Potential alternatives include continuous canola, a wheat-canola rotation, and a wheat-wheat-canola rotation. However, data from crop rotations that include wheat and canola are not available and yield data from winter canola trials in Oklahoma are extremely limited. Therefore, for this economic analysis, given basic assumptions about input requirements and prices, yields necessary for canola to break even with wheat are computed.

Producers are assumed to attempt to maximize expected profit, defined as expected returns less expected costs of production. Expected returns are estimated on a dollar per acre basis as expected price times expected yield. Expected costs include the estimated costs associated with production of the crop. For example, expected costs of wheat production include the cost of seed, fertilizer, herbicide, machinery operating and fixed costs, and any other costs that might be incurred during the production process. If estimates of yields were available, the expected profit of canola could be estimated in a similar fashion, followed by yields of wheat in the subsequent year of canola.

The breakeven canola yield (the yield at which the expected returns for canola equals the expected returns for wheat) may be computed by adding the expected returns from wheat to the expected canola production costs and dividing by the expected price.

To illustrate, assume an expected wheat yield of 40 bushels per acre, an expected wheat price of \$3.20 per bushel, and expected production costs other than for land, overhead and management of \$90 per acre. The expected profit (in this case returns to land, overhead, and management) is \$38 per acre. The current loan rate for canola in Oklahoma is \$7.80 per hundred pounds (Farm Service Agency). Given the limited history of the crop in the state, the loan rate could be used as a conservative estimate of the expected price. Assume that the expected cost to produce canola other than for land, overhead and management is \$100 per acre. The breakeven yield (the yield at which the expected returns for canola are \$38 per acre) may be computed by adding the expected returns from wheat (\$38) to the expected canola production costs (\$100) and dividing by the expected price (\$7.80). For this example, the breakeven canola yield is 1,769 pounds per acre.

Field Operations

A set of production practices are defined and budgeted for wheat, conventional canola, and Roundup Ready® canola. Forage production is not considered for the two alternatives. Dual-purpose (fall-winter forage plus grain) wheat is not considered. Wheat for grain-only and canola are compared.

Table II-1 includes a list of the field operations budgeted for the wheat, conventional canola, and Roundup Ready® canola production systems. Custom direct cut harvest and custom application of herbicide, insecticide, and fertilizer is assumed for all systems.

Table II-1. Field Operations for Wheat, Conventional Canola, and Roundup Ready® Canola Production

Field Operations	Month	Wheat	Canola (Conventional)	Canola (Roundup Ready®)
Moldboard Plow (Used on 20% of Acres)	June	✓	✓	✓
Chisel (Used on 80% of Acres)	June	✓	✓	✓
Tandem Disk	August	✓	✓	✓
Broadcast Fertilizer (46-0-0)	August	✓	✓	✓
Broadcast Fertilizer (21-0-0-24S)	August		✓	✓
Tandem Disk	September	✓	✓	✓
Apply Herbicide (e.g. Treflan®)	September		✓	
Sweep Cond.	September		✓	
Apply Fertilizer (18-46-0)	September		✓	✓
Plant Canola	September		✓	✓
Tandem Disk	October	✓		
Apply Herbicide	October	✓		
Apply Fertilizer (18-46-0)	October	✓		
Plant Wheat	October	✓		
Apply Herbicide (e.g. Assure II®)	November		✓	
Apply Herbicide (e.g. Roundup UltraMAX®)	November			✓
Broadcast Fertilizer (46-0-0)	February		✓	✓
Apply Herbicide (e.g. Roundup UltraMAX®)	March			✓
Apply Insecticide (e.g. Dimethoate)	April	✓		
Apply Insecticide (e.g. Warrior®)	April		✓	✓
Harvest Canola	June		✓	✓
Harvest Wheat	June	✓		

The machinery complements for a 640-acre farm includes a 155 horsepower John Deere tractor, moldboard plow, chisel, tandem disk, sweep conditioner, and drill. After grain harvest in June, a moldboard plow operation is budgeted to be performed on 20 percent of the acres and a chisel plow on the other 80 percent. For the wheat production system, tillage operations are budgeted for August, September, and October.

For a wheat yield goal of 45 bushels per acre, urea (46-0-0) is broadcast in August at 143 pounds per acre. Herbicide is applied in October followed by wheat seed drilled at a rate of 60 pounds per acre with 50 pounds per acre of diammonium phosphate banded with the seed. An insecticide application of dimethoate is budgeted for April.

For the conventional canola system, a moldboard plow operation is budgeted to be performed on 20 percent of the acres and a chisel plow on the other 80 percent in June. Two tillage operations are budgeted, one in August and one in September. For a canola yield goal of 2,000 pounds per acre, a total of 165 pounds per acre of urea is broadcast, one-third in August and two-thirds in February. Following the August application of urea, in alternate years, 42 pounds per acre of ammonium sulfate (21-0-0-24S) is broadcast to provide sulfur. It is budgeted at a rate of 21 pounds per acre per year and one half acre application costs per year. Following the fertilizer application, a tandem disk is used to till the soil before adding two pints per acre of Treflan® herbicide. This Treflan® is incorporated with a sweep conditioner tillage operation prior to planting five pounds per acre of conventional canola seed in September. Diammonium phosphate is applied through the drill. A second herbicide application (eight ounces per acre) of Assure II® is applied in November. The remaining two-thirds of the urea (46-0-0) is broadcast in mid February followed by an application of Warrior® insecticide in April.

For the Roundup Ready® canola production system, a moldboard plow operation is budgeted to be performed on 20 percent of the acres and a chisel plow on the other 80 percent in June. Two tillage operations are budgeted, one in August and one in September. For a canola yield goal of 2,000 pounds per acre, urea is broadcast in August at one-third of the 165 pounds per acre after the completion of the tillage operation.

Following the tandem disk operation in September, another fertilizer application of diammonium phosphate (18-46-0) is banded at 50 pounds per acre through the drill combined with five pounds per acre of Roundup Ready® seed. This is followed by two eleven ounce per acre applications of Roundup UltraMAX® (glyphosate). The UltraMAX® formulation of Roundup contains five pounds of emulsifiable concentrate per gallon as opposed to the four pounds per gallon provided by generic glyphosate. Two eleven ounce per acre applications of the Roundup UltraMAX® formulation are registered for application over the top of Roundup Ready® canola. The budget includes one eleven ounce application in November and a second application in March. For winter canola, it is recommended that only a third of the nitrogen be applied preplant with the remaining two thirds applied as a top-dress in February. An April application of Warrior® insecticide is included in the budget.

Machinery Ownership and Operating Costs

MACHSEL, a machinery complement selection software program developed by Kletke and Sestak, was used to determine the machinery ownership and operating costs for a 640-acre farm for each of the three alternatives. It was assumed that fertilizer, herbicide, and insecticide applications would be done by custom operators. When establishing candidate machines, machinery parameters were key components into determining which machines were appropriate matches with the farm size and production scheme. Diesel fuel price was set at $1.75 per gallon, interest rate at nine percent, insurance rate at $0.006 of average value, and a tax rate of $0.01 of purchase price was assumed.

Enterprise Budgets

Enterprise budgets were developed to determine the return to labor, land, and management. Table II-2 includes prices used in the budgets. Prices differ across regions, months, and dealers. In some cases differences in prices reflect differences in services, quality, and timeliness. Most prices are negotiable and many producers negotiate with a good understanding of expected differences in services, quality and timeliness that are not readily apparent in posted prices.

Table II-2. Prices Used for Budgeting

Item	Units	Price/Unit
Canola Seed	lb	$1
Canola Seed (Roundup Ready) + Tech Fee	lb	$4.60
Wheat Seed	bu	$9
Urea (46-0-0)	ton	$320
Ammonium Sulfate (21-0-0-24S)	ton	$240
Diammonium Phosphate (18-46-0)	ton	$280
Treflan® (trifluralin)	pint	$2.75
Assure II® (quizalofop-p-ethyl)	pint	$18.00
Roundup UltraMAX® (glyphosate)	gallon	$35.00
Dimethoate	pint	$4.00
Warrior® (lambda-cyhalothrin)	oz	$2.07
Herbicide Application	acre	$3.50
Fertilizer Application	acre	$3.25
Aerial Insecticide Application	acre	$4.00

Insecticide prices were obtained from Estes Chemical Company, Enid, Oklahoma. Dimethoate is priced at $32.00 per gallon. Applications were based on labeled rates.

Fertilizer, diammonium phosphate and urea prices were obtained from the Oklahoma State University Enterprise Budgets. Roundup UltraMAX® was budgeted at $35.00 per gallon (Marlow). Conventional canola seed was budgeted at a price of $1 per pound. The Roundup Ready® canola seed price includes the price for the seed and the technology fee. It was budgeted at $4.60 per pound. A seeding rate of five pounds per acre was budgeted for both conventional and Roundup Ready® production systems. A wheat seed price of $9.00 per bushel or $0.16 per pound was from the OSU Enterprise Budgets. Wheat seeding rate was budgeted at 60 pounds per acre at a cost of $10.50 per acre.

Both wheat and canola are commodities eligible for the loan rate provisions of the Farm Bill. The 2005 national loan rates are set at $2.75 per bushel of wheat and $0.093 per pound of canola. County rates are adjusted to reflect differences in transportation costs, markets, and other factors. Oklahoma county loan rates range from $2.71 to $2.84 per bushel for wheat and from $0.0734 to $0.0794 per pound for canola (Farm Service Agency). To take full advantage of the loan program producers must place the crop in storage and maintain beneficial interest. For the base budgets, prices of $3 per bushel for wheat and $0.08 per pound for canola were used.

Nitrogen, harvest costs, and hauling costs are adjusted with yield. Costs for other inputs are assumed to be independent of yield. The expected nitrogen requirement for wheat is computed by multiplying the expected yield (bu/a) by 2 (lb N/bu) and subtracting the assumed level of soil nitrogen of 15 (lb/a) (carryover). For 45 bushels per acre expected yield the required level of nitrogen, in addition to the expected carryover and that applied in the diammonium phosphate (18-46-0), is estimated to be 66 pounds per acre [(45 bu/a × 2 lb/bu) – (50 lb/a × 0.18) – (15 lb/a carryover)]. This requirement can be met with 143 pounds per acre of urea (46-0-0). Similarly, for an expected yield of 2,000 pounds per acre of canola and an expected requirement of 0.05 pounds of nitrogen per pound of canola, 50 pounds per acre of 18-46-0 and 15 pounds per acre carryover, 165 pounds of urea would be required per acre. For winter canola, it is recommended that only a third of the nitrogen be applied preplant with the remaining two thirds applied as a top-dress in February.

An energy price sensitivity analysis was performed on the base calculations by doubling the cost of diesel fuel, lubricants, and fertilizers.

Breakeven Yield

Calculating the breakeven yield for canola involves first calculating the net return for wheat. This net return can then be implemented into our breakeven equation to determine the pounds per acre required to breakeven with wheat. The net return equation for wheat production is:

$$\pi_W = P_W(Y_W) - [\ U(Y_W)\ ]\left[1+\frac{i}{2}\right] - HC_W(Y_W) - CVC - FC \tag{1}$$

where π_W is the net return to wheat production, P_W is the price of wheat, Y_W is the wheat grain yield (bu/acre), $[\ U(Y_W)\ ]\left[1+\frac{i}{2}\right]$ is the cost of urea, including interest cost, as a function of the wheat yield. It was assumed that the cost of the capital invested in urea would be unavailable for other uses for a six month time period, so interest rate of 7% was divided by two (6/12). As the wheat yields change, the harvest and hauling cost also change. Therefore, HC_W is the harvest and hauling cost. For every bu/acre over 20 bu/acre, the harvest cost is \$0.15/bu. There is also a \$0.15 bu/acre charge for hauling the wheat. CVC is the constant variable costs incurred by the farmer. These costs include wheat seed, fertilizer application charge, herbicide, herbicide application charge, insecticide, insecticide application charge, fuel, lube, and repair. The fixed costs are denoted by FC which include machinery and equipment, depreciation, taxes, insurance, and interest costs associated with production.

The breakeven yield for canola production is:

(2) $$BE_C = \frac{\left[\left(P_{WH} Y_{WH} \right) - C_{WH} + C_C \right]}{P_C}$$

where BE_C is the breakeven canola yield, P_{WH} is the price of wheat, Y_{WH} is the wheat grain yield (bu/acre), C_{WH} is the cost of producing wheat, C_C is the cost of producing canola, and P_C is the price of canola.

RESULTS

Table II-3 includes base enterprise budgets for the three systems (wheat, conventional canola, and Roundup Ready® canola). Since limited data are available to determine relative yields for wheat and canola across Oklahoma regions and soil types, the base budgets include yields of 45 bushels per acre for wheat and 2,000 pounds per acre for canola. Table II-4 includes base enterprise budgets for the three systems (wheat, conventional canola, and Roundup Ready® canola) using doubled diesel fuel, lube, and fertilizer prices.

Table II-3. Base Budgets for Wheat, Conventional Canola, and Roundup Ready® Canola

			Production System					
		Price	Wheat (grain-only)		Canola (conventional)		Canola (Roundup Ready®)	
	Unit of	per unit						
Item	Measure		Quantity	Value	Quantity	Value	Quantity	Value
Production								
Wheat	bu	$3.00	45.00	135.00				
Canola	lbs	$0.08			2000	160.00	2000	160.00
Gross Returns				135.00		160.00		160.00
"Cash" Costs								
Wheat Seed	bu	$9.00	1	9.00				
Canola Seed (conventional)	lbs	$1.00			5	5.00		
Canola Seed (Roundup Ready) + Technology Fee	lbs	$4.60					5	23.00
Urea (46-0-0)	lbs	$0.16	143	22.96	165	26.43	165	26.43
Diammonium Phosphate (18-46-0)	lbs	$0.14	50	7.00	50	7.00	50	7.00
Ammonium Sulfate (21-0-0-24S)	lbs	$0.12			21	2.52	21	2.52
Fertilizer Application	acre	$3.25	1	3.25	2.5	8.13	2.5	8.13
Herbicide	acre	$5.00	1	5.00				
Herbicide (e.g.Treflan® (trifluralin))	pint	$2.75			2	5.50		
Herbicide (e.g. Assure II® (quizalofop-p-ethyl))	oz	$1.13			8	9.04		
Herbicide (e.g. Roundup UltraMAX® (glyphosate))	oz	$0.27					22	5.94
Herbicide Application	acre	$3.50	1	3.50	2	7.00	2	7.00
Insecticide (e.g. dimethoate)	pint	$4.00	0.75	3.00				
Insecticide (e.g. Warrior® (lambda-cyhalothrin))	oz	$2.07			3	6.21	3	6.21
Aerial Insecticide Application	acre	$4.00	1	4.00	1	4.00	1	4.00
Fuel	acre		1	8.00	1	7.83	1	6.56
Lube	acre		1	1.20	1	1.17	1	0.98
Repair	acre		1	4.64	1	3.74	1	3.09
Annual Operating Capital	$	$0.07	36	2.50	47	3.27	50	3.53
Wheat Custom Harvest & Haul								
Base Charge	acre	$15.00	1	15.00				
Excess for >= 20 bu/a	bu	$0.15	25	3.75				
Hauling	bu	$0.15	45	6.75				
Canola Custom Harvest & Haul								
Base Charge	acre	$16.00			1	16.00	1	16.00
Excess for > 12.5 cwt/a	cwt	$0.32			7.5	2.40	7.5	2.40
Hauling	cwt	$0.32			20.00	6.40	20.00	6.40
Total "Cash" Costs	$/acre			$ 100		$ 122		$ 129
Fixed Costs								
Depreciation	$/acre		1	$ 13.76	1	$ 14.42	1	$ 13.76
Taxes	$/acre		1	$ 2.06	1	$ 2.21	1	$ 2.06
Insurance	$/acre		1	$ 0.77	1	$ 0.81	1	$ 0.77
Interest	$/acre		1	$ 11.50	1	$ 12.17	1	$ 11.50
Total Fixed Costs	$/acre			$ 28.09		$ 29.61		$ 28.09
Return to								
Labor, Land, Management, and Overhead	$/acre			$ 7		$ 9		$ 3

Table II-4. Base Budgets with Doubled Fuel and Fertilizer Prices

			------------------------Production System-------------------					
		Price	Wheat (grain-only)		Canola (conventional)		Canola (Roundup Ready®)	
Item	Unit of Measure	per unit	Quantity	Value	Quantity	Value	Quantity	Value
Production								
Wheat	bu	$3.00	45.00	135.00				
Canola	lbs	$0.08			2000	160.00	2000	160.00
Gross Returns				135.00		160.00		160.00
"Cash" Costs								
Wheat Seed	bu	$9.00	1	9.00				
Canola Seed (conventional)	lbs	$1.00			5	5.00		
Canola Seed (Roundup Ready) + Technology Fee	lbs	$4.60					5	23.00
Urea (46-0-0)	lbs	$0.32	143	45.91	165	52.87	165	52.87
Diammonium Phosphate (18-46-0)	lbs	$0.28	50	14.00	50	14.00	50	14.00
Ammonium Sulfate (21-0-0-24S)	lbs	$0.24			21	5.04	21	5.04
Fertilizer Application	acre	$3.25	1	3.25	2.5	8.13	2.5	8.13
Herbicide	acre	$5.00	1	5.00				
Herbicide (e.g.Treflan® (trifluralin))	pint	$2.75			2	5.50		
Herbicide (e.g. Assure II® (quizalofop-p-ethyl))	oz	$1.13			8	9.04		
Herbicide (e.g. Roundup UltraMAX® (glyphosate))	oz	$0.27					22	5.94
Herbicide Application	acre	$3.50	1	3.50	2	7.00	2	7.00
Insecticide (e.g. dimethoate)	pint	$4.00	0.75	3.00				
Insecticide (e.g. Warrior® (lambda-cyhalothrin))	oz	$2.07			3	6.21	3	6.21
Aerial Insecticide Application	acre	$4.00	1	4.00	1	4.00	1	4.00
Fuel	acre		1	16.00	1	15.66	1	13.12
Lube	acre		1	2.40	1	2.34	1	1.96
Repair	acre		1	4.64	1	3.74	1	3.09
Annual Operating Capital	$	$0.07	55	3.87	69	4.85	72	5.05
Wheat Custom Harvest & Haul								
Base Charge	acre	$15.00	1	15.00				
Excess for >= 20 bu/a	bu	$0.15	25	3.75				
Hauling	bu	$0.15	45	6.75				
Canola Custom Harvest & Haul								
Base Charge	acre	$16.00			1	16.00	1	16.00
Excess for > 12.5 cwt/a	cwt	$0.32			7.5	2.40	7.5	2.40
Hauling	cwt	$0.32			20.00	6.40	20.00	6.40
Total "Cash" Costs	$/acre			$ 140		$ 168		$ 174
Fixed Costs								
Depreciation	$/acre		1	$ 13.76	1	$ 14.42	1	$ 13.76
Taxes	$/acre		1	$ 2.06	1	$ 2.21	1	$ 2.06
Insurance	$/acre		1	$ 0.77	1	$ 0.81	1	$ 0.77
Interest	$/acre		1	$ 11.50	1	$ 12.17	1	$ 11.50
Total Fixed Costs	$/acre			$ 28.09		$ 29.61		$ 28.09
Return to								
Labor, Land, Management, and Overhead	$/acre			$ (33)		$ (38)		$ (42)

Breakeven Canola Yields

Breakeven charts have been constructed and may be used to determine the expected breakeven canola yields for a given expected wheat yield. Breakeven yields were determined for canola prices of $0.08 and $0.10/lb. Canola breakeven yields were determined for wheat yields of 25, 35, 45, 55, and 65 bu/acre. Table II-5 includes the wheat and breakeven canola yields for both conventional and Roundup Ready® canola with a $0.08/lb canola price.

Table II-5. Base Breakeven Canola Yields for Conventional and Roundup Ready® Canola with an $0.08/lb Canola Price

Conventional and Roundup Ready® Canola Breakeven Yields With an $0.08 Canola Price			
Wheat Yield (bu/acre)	Breakeven Conventional Canola Yield (lbs/acre)	Wheat Yield (bu/acre)	Breakeven Roundup Ready® Canola Yield (lbs/acre)
25	1,263	25	1,371
35	1,619	35	1,727
45	1,975	45	2,083
55	2,331	55	2,440
65	2,687	65	2,796

The breakeven conventional canola yield is on average 108 lbs/acre less than the Roundup Ready® canola yield. Table II-6 includes the wheat and breakeven canola yields for conventional and Roundup Ready® canola with a $0.10 canola price.

Table II-6. Base Breakeven Canola Yields for Conventional and Roundup Ready® Canola Using a \$0.10/lb Canola Price

Conventional and Roundup Ready® Canola Breakeven Yields With a \$0.10 Canola Price			
Wheat Yield (bu/acre)	Breakeven Conventional Canola Yield (lbs/acre)	Wheat Yield (bu/acre)	Breakeven Roundup Ready® Canola Yield (lbs/acre)
25	929	25	1,008
35	1,191	35	1,270
45	1,453	45	1,532
55	1,714	55	1,794
65	1,976	65	2,056

The same observation is made by increasing the price to \$0.10; however, it takes approximately 79 pounds per acre more of canola to breakeven under the Roundup Ready® canola production system. Figure II-1 and Figure II-2 below show the breakeven yield for conventional and Roundup Ready® canola, respectively with the canola prices of \$0.08 and \$0.10 per pound.

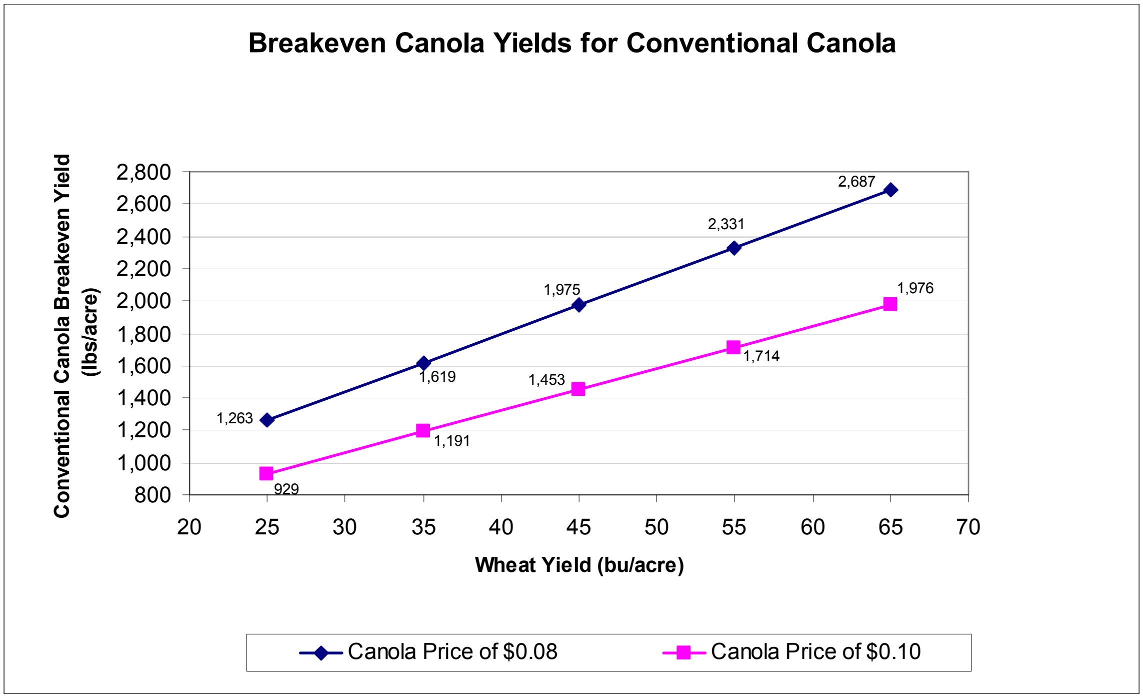

Figure II-1. Breakeven Canola Yields for Conventional Canola with an $0.08 and $0.10 Canola Price

Increasing the canola price from $0.08 to $0.10 decreased the breakeven canola yield by 428 lbs/acre from 1,619 lbs/acre to 1,191 lbs/acre for the conventional canola production system with $3 per bushel wheat yielding 35 bu/acre. The breakeven canola yield associated with a 55 bu/acre wheat yield at $0.08 was 2,331 lbs/acre, while the breakeven canola yield at $0.10 was 1,714 lbs/acre, a 617 lb/acre decrease.

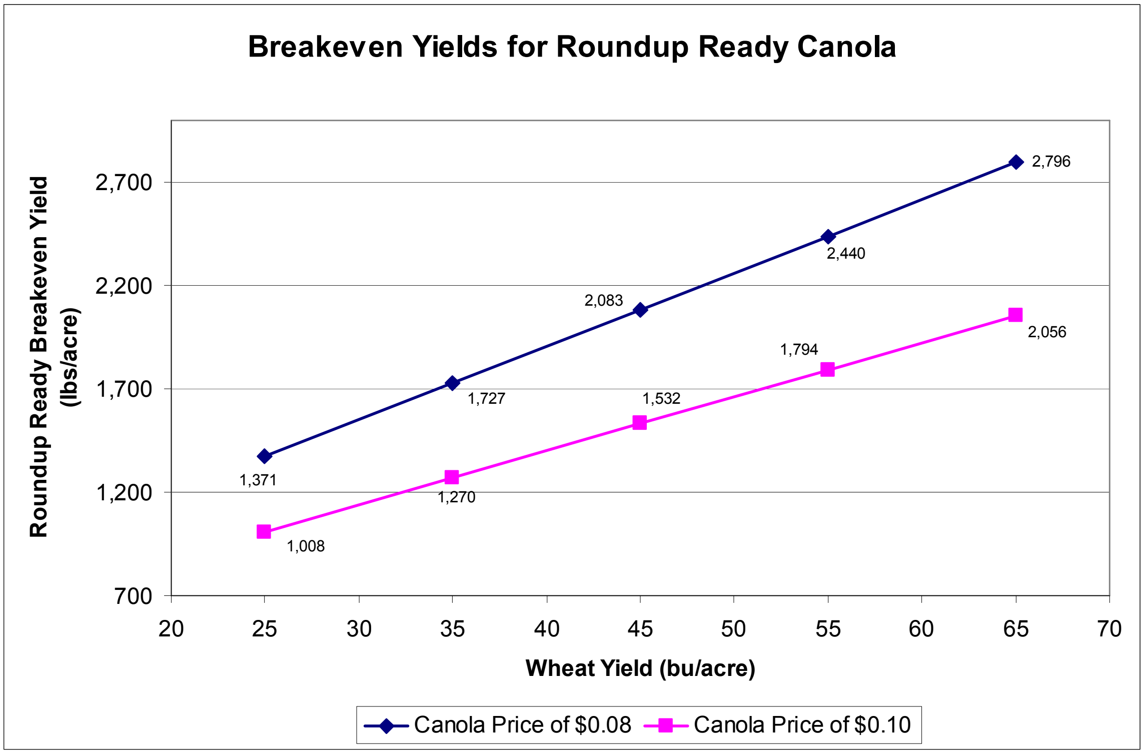

Figure II-2. Breakeven Canola Yields for Roundup Ready® Canola with an $0.08 and $0.10 Canola Price

Increasing the canola price from $0.08 to $0.10 decreased the breakeven canola yield by 457 lbs/acre for the Roundup Ready® canola production system with a wheat price of $3 per bushel and a wheat yield of 35 bu/acre. A wheat yield of 55 bu/acre at a $0.08 canola price observed a canola breakeven canola yield of 2,440 lbs/acre, while the breakeven canola yield at $0.10 was 1,794 lbs/acre, a 646 lb/acre decrease.

Energy Sensitivity Analysis

To perform an energy sensitivity analysis, the same procedures were used as for the base measures except diesel fuel and lube prices and fertilizer prices were doubled and breakeven canola yields were computed. Table II-7 and Table II-8 include the conventional and Roundup Ready® canola breakeven yields with an $0.08 and $0.10 canola price with diesel fuel and fertilizer prices doubled.

Table II-7. Conventional and Roundup Ready® Canola Breakeven Yields with an $0.08 Canola Price and Diesel Fuel and Fertilizer Prices Doubled

Conventional and Roundup Ready® Canola Breakeven Yields With an $0.08 Canola Price			
Wheat Yield (bu/acre)	Breakeven Conventional Canola Yield (lbs/acre)	Wheat Yield (bu/acre)	Breakeven Roundup Ready® Canola Yield (lbs/acre)
25	1,428	25	1,530
35	1,763	35	1,865
45	2,098	45	2,200
55	2,433	55	2,535
65	2,768	65	2,870

Table II-8. Conventional and Roundup Ready® Canola Breakeven Yields with an $0.10 Canola Price and Diesel Fuel and Fertilizer Prices Doubled

Conventional and Roundup Ready® Canola Breakeven Yields With a $0.10 Canola Price			
Wheat Yield (bu/acre)	Breakeven Conventional Canola Yield (lbs/acre)	Wheat Yield (bu/acre)	Breakeven Roundup Ready® Canola Yield (lbs/acre)
25	932	25	999
35	1,151	35	1,217
45	1,370	45	1,436
55	1,588	55	1,655
65	1,807	65	1,874

The breakeven conventional canola yield is on average 102 lbs/acre less than the Roundup Ready® canola yield. To observe the differences in a price change, Table II-8 includes the wheat and breakeven canola yields for conventional and Roundup Ready® canola for grain-only wheat production using a $0.10 canola price.

The same observation is made by increasing the price to $0.10; however, it takes approximately 67 pounds per acre more of canola to breakeven under the Roundup Ready® canola production system. Therefore, when the of diesel fuel, lube, and fertilizer are increased, it will take more pounds of canola to breakeven with wheat.

Figure II-3 and Figure II-4 below shows the breakeven yield for conventional and Roundup Ready® canola, respectively, with Diesel fuel and fertilizer prices doubled and the canola prices of $0.08 and $0.10 per lb.

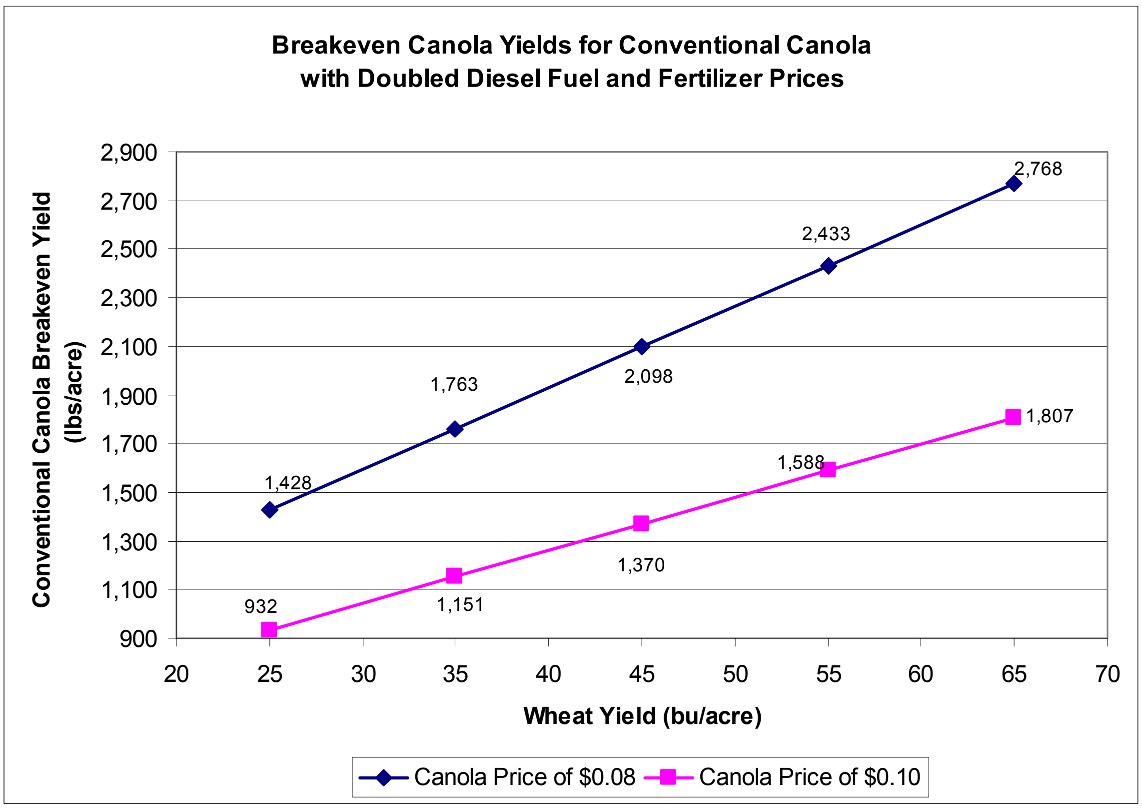

Figure II-3. Breakeven Canola Yields for Conventional Canola with Doubled Diesel Fuel and Fertilizer Prices

Increasing the canola price from $0.08 to $0.10 decreased the breakeven canola yield by 612 lbs/acre from 1,763 lbs/acre to 1,151 lbs/acre for the conventional canola production system with wheat yielding 35 bu/acre. The breakeven canola yield associated with a 55 bu/acre wheat yield at $0.08 was 2,433 lbs/acre, while the breakeven canola yield at $0.10 was 1,588 lbs/acre, an 845 lb/acre decrease.

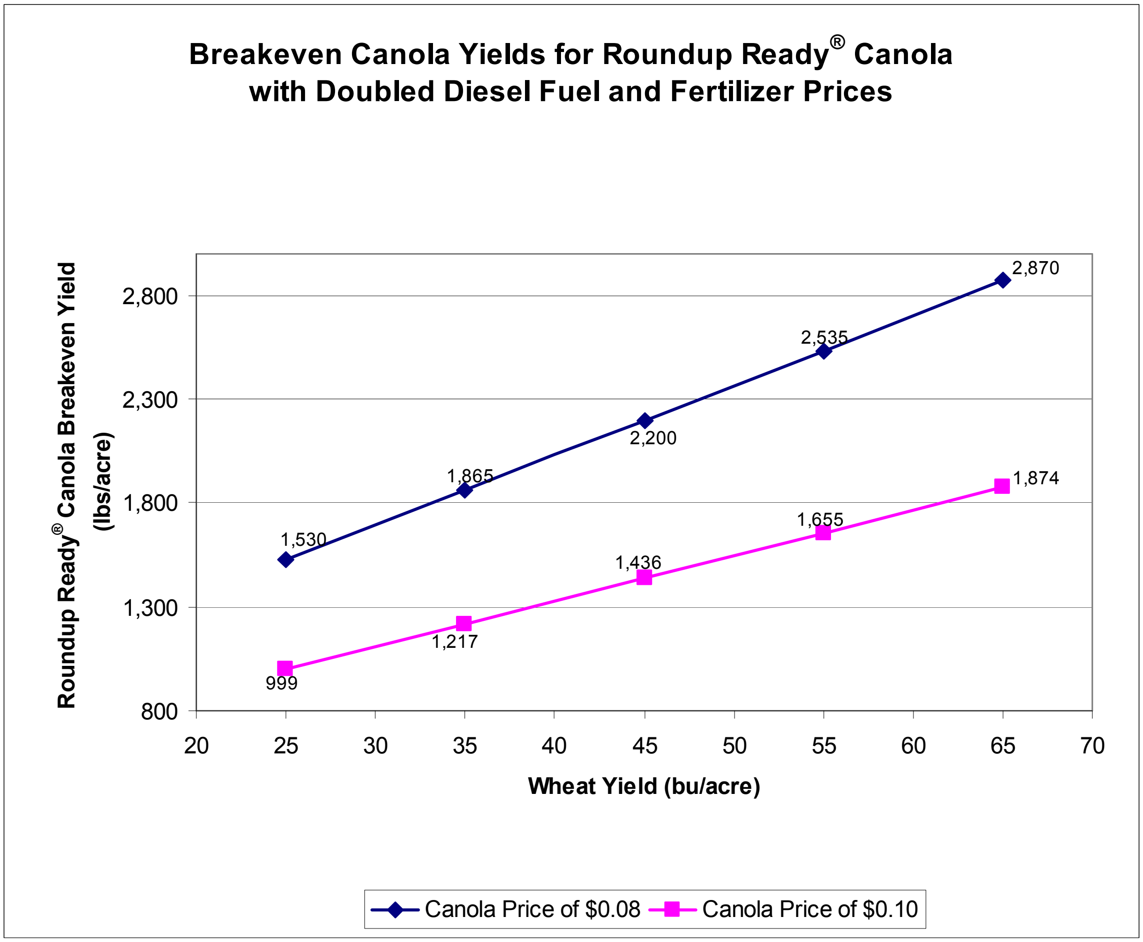

Figure II-4. Breakeven Canola Yields for Roundup Ready® Canola with Doubled Diesel Fuel and Fertilizer Prices

Doubling the diesel fuel, lube, and fertilizer prices increased the breakeven canola yield. The average increase yield for both conventional and Roundup Ready® canola production activities ranged from 15 lbs/acre to cover the additional costs associated with doubled diesel fuel and fertilizer prices.

Given the information currently available, an individual producer may use the breakeven charts to determine the canola yield necessary to breakeven with a specific wheat yield. If it is estimated that the breakeven canola yield can be exceeded on the field in question then canola may be a good option. Decisions are field specific. Canola may not be an option on a specific field depending upon prior herbicide applications to the field. However, if a grower has decided to seed a particular field to canola, the next step is to identify the field's historical weed problems. If either herbicide system will control the targeted weeds then select the best variety from among all potential varieties.

This economic analysis is based upon information that is currently available. As more field research is conducted, and more actual data become available from trials in which wheat, canola, and rotations that include both crops, are compared, more precise economic analysis can be conducted. The consequences of crop rotation in terms of yield, yield variability, grain quality, and herbicide, insecticide, tillage, and fertilizer requirements, can be incorporated into the economic analysis.

CONCLUSIONS

Research was conducted to provide information that farmers could use to assist with decisions of whether or not to adopt canola. A wheat and canola enterprise budget was used to determine the returns to labor, land, and management for each system. Breakeven charts were constructed to illustrate the expected breakeven canola yields for a given expected wheat yield based on two canola prices, \$0.08 and \$0.10 per pound.

A set of production practices were defined and budgeted for wheat, conventional canola, and Roundup Ready® canola. Forage production was not considered for the two alternatives. Dual-purpose (fall-winter forage plus grain) wheat is not considered. Wheat for grain-only and canola are compared.

The MACHSEL machinery complement selection program was used to prepare machinery complements for each system. The machinery complements include a 155 horsepower John Deere tractor, moldboard plow, chisel, tandem disk, sweep conditioner, and drill. Custom direct cut harvest and custom application of herbicide, insecticide, and fertilizer is assumed for all three systems.

Enterprise budgets were developed to determine the return to labor, land, and management for wheat, conventional canola, and Roundup Ready® canola. Costs for conventional canola seed, Roundup Ready® canola seed, wheat seed, herbicides, fertilizers, and insecticides were determined through dealers. Applications were based on labeled rates. An energy price sensitivity analysis was performed on the base calculations by doubling the cost of Diesel fuel, lubricants, and fertilizers.

Breakeven canola yields were determined for a given expected wheat yield. Canola breakeven yields were determined for wheat yields of 25, 35, 45, 55, and 65 bushels per acre observing a price increase of canola from $0.08 to $0.10 per pound. The breakeven conventional canola yield for a wheat yield of 45 bushels per acre and a canola price of $0.08 per pound was 1,975 pounds, while the Roundup Ready® canola yield at a wheat yield of 45 bushels per acre was 2,083. Due to the increased costs of Roundup Ready® canola, an extra 108 pounds per acre are required to breakeven. Increasing the canola price from $0.08 to $0.10 per pound, the breakeven conventional canola yield at a wheat yield of 45 bushels per acre was 1,453 pounds, while the Roundup Ready® canola yield at a wheat yield of 45 bushels per acre was 1,532.

To perform an energy sensitivity analysis, the same procedures were used as for the base measure except diesel fuel, lubricants, and fertilizer prices were doubled. The breakeven conventional canola yield at a wheat yield of 45 bushels per acre and a canola price of $0.08 per pound was 2,098 pounds, while the Roundup Ready® canola yield at a wheat yield of 45 bushels per acre was 2,200. Due to the increased costs of Roundup Ready® canola, an extra 102 pounds per acre are required to breakeven. Increasing the canola price from $0.08 to $0.10 per pound, the breakeven conventional canola yield at a wheat yield of 45 bushels per acre was 1,370 pounds, while the Roundup Ready® canola yield at a wheat yield of 45 bushels per acre was 1,436. The same observation is made; however, it takes an additional 67 pounds per acre of canola to breakeven.

REFERENCES

Aase, J. K., and G.M. Schaefer. "Economics of Tillage Practices and Spring Wheat and Barley Crop Sequence in the Northern Great Plains." *Journal of Soil and Water Conservation* 51-2(1996): 167-177.

Al-Kaisi, Mahdi M., Xinhua Yin, Mark Hanna, and Mike D. Duffy. "Considerations in Selecting No-till." Iowa State University University Extension. Bull. No. PM 1901d, December 2002.

Bauer, Armand and A. L. Black. "Effect of Management Method of Erect Stubble at Spring Planting on Performance of Spring Wheat." North Dakota State University Agricultural Experiment Station Bull. No. 524, March 1992.

Biermacher, Jon, Francis M. Epplin, and Kent R. Keim. "Wheat and Soybean Cropping Systems for the Southern Great Plains of the United States as Influenced by Federal Policy." Renewable Agriculture and Food Systems 20(2005): in press.

Conley, Shawn P., David Bordovsky, Charlie Rife, and William J. Wiebold. "Winter Canola Survival and Yield Response to Nitrogen and Fall Phosphorus." *Crop Management* 10(2004): 1-8.

DeVuysta, E. A. and A. D. Halvorson. "Economics of Annual Cropping versus Crop–Fallow in the Northern Great Plains as Influenced by Tillage and Nitrogen." *Agronomy Journal* 96(2004): 148-153.

Epplin, F.M. Agricultural Economics Department, Oklahoma State University. Personal Communication. 20 September 2005.

Epplin, Francis M., Curtis J. Stock, Darrel D. Kletke, and Thomas F. Peeper "Cost of Conventional Tillage and No-till Continuous Wheat Production for Four Farm Sizes." *Journal of American Society of Farm Managers and Rural Appraisers* 69(2005):69-76.

Epplin, Francis M., Ghazi A. Al-Sakkaf, and Thomas F. Peeper. "Impacts of Alternative Tillage Methods for Continuous Wheat on Grain Yield and Economics: Implications for Conservation Compliance." *Journal of Soil and Water Conservation* 49-4(1994): 394-399.

Epplin, Francis M. "Oklahoma Wheat Acreage Response to Commodity Programs." *Oklahoma Current Farm Economics* 70-3(1997): 3-15.

Epplin, Francis M. "Wheat Yield Response to Changes in Production Practices Induced by Program Provisions." *Journal of Agricultural and Resource Economics* 22-2(1997): 333-344.

Farm Service Agency. Price Support Programs. Available at http://www.fsa.usda.gov/dafp/psd/ldp/pstatecldp.htm. Accessed on October 21, 2005

Gray, Richard S., Stavroula Malla, and Peter Phillips. "Gains to Yield Increasing Research in the Evolving Canadian Canola Research Industry." Paper presented at the International Consortium on Agricultural Biotechnology Research Conference, Rome Tor Vergata Italy, 17-19 June 1999.

Klemme, Richard M. "A Stochastic Dominance Comparison of Reduced Tillage Systems in Corn and Soybean Production under Risk." *American Journal of Agricultural Economics* 67(1985): 550-557.

Kletke, D., and R. Sestak. 1991. The operation and use of MACHSEL: A farm machinery selection template. Department of Agricultural Economics Computer Software Series CSS-53. Oklahoma State Univ., Stillwater, OK.

Marlow, Michael. Monsanto Seed Company. Personal Communication. 15 June 2005.

Mathis, J.B. Estes Chemicals. Personal Communication. 25 June 2005.

Oklahoma State University. *2004 Oklahoma Crop and Livestock Enterprise Budgets*. Department of Agricultural Economics, Oklahoma Cooperative Extension Service, Oklahoma State University.

Pullins, Emily E., Robert L. Myers and Harry C. Minor. "Alternative Crops in Double-Crop Systems for Missouri." University of Missouri-Columbia Extension. Bull. No. G 4090, September 1997.

Ribera, Luis A., F.M. Hons, and James W. Richardson "An Economic Comparison between Conventional and No-Tillage Farming Systems in Burleson County, Texas." *Agronomy Journal* 96(2004):415-424.

Vyn, Tony J. "Strip-Till: A Closer Look." Presented to the Advanced Crop Advisers Workshop, Fargo ND, 19-20 February 2004. Available at: http://www.agry.purdue.edu/staffbio/Fargo,ND,02-20,2004.pdf.

Williams, J.R., T.W. Roth, and M.M Claassen. "Profitability of Alternative Production and Tillage Strategies for Dryland Wheat and Grain Sorghum in the Central Great Plains." *Journal of Soil and Water Conservation* 55-1(2000): 49-56.

Williams, Jeffery R. "A Stochastic Dominance Analysis of Tillage and Crop Insurance Practices in a Semiarid Region." *American Journal of Agricultural Economics* 70(1988): 112-120.

Williams, Risk, Jeffery R. Richard, V. Llewely, and G. Art Barnaby. "Analysis of Tillage Alternatives with Government Programs." *American Journal of Agricultural Economics* 72(1990):172-181.

Zentner, Robert P., David D. Wall, Cecil N. Nagy, Elwin G. Smith, Doug L. Young, Perry R. Miller, Con A. Campbell, Brian G. McConkey, Stewart A. Brandt, Guy P. Lafond, Adrian M. Johnston, and Doug A. Derksen. "Economics of Crop Diversification and Soil Tillage Opportunities in the Canadian Praries." *Agronomy Journal* 94(2002): 216-230.

VITA

Elisha Ann Henderson

Candidate for the degree of

Master of Science

TITLE: Economics of Wheat and Canola Cropping Systems for Oklahoma

Major Field: Agricultural Economics

Biographical:

Personal Data: Born in Chickasha, Oklahoma, August 20, 1981, the daughter of Gene and Marilyn Henderson

Education: Graduated form Tuttle High School, Tuttle, Oklahoma in May 2000; received Bachelor of Science degree in Agricultural Economics with a double major in Accounting from Oklahoma State University, Stillwater, Oklahoma in May 2004. Completed the requirements for the Master of Science degree with a major in Agricultural Economics at Oklahoma State University in December 2005.

Experience: Graduate Research Assistant, Department of Agricultural Economics, Oklahoma State University, June, 2004 to December, 2005.

Name: Elisha Ann Henderson Date of Degree: December, 2005

Institution: Oklahoma State University Location: Stillwater, Oklahoma

Title of Study: ECONOMICS OF WHEAT AND CANOLA CROPPING SYSTEMS FOR OKLAHOMA

Pages in Study: 78 Candidate for the Degree of Master of Science

Major Field: Agricultural Economics

Scope and Method of Study: Continuous monoculture hard red winter wheat is the predominate crop in Oklahoma. It has not been very profitable. Winter canola varieties have recently been developed. A crop rotation that includes winter wheat and winter canola may enable producers in the region to better manage weeds and diseases, increase yields, and potentially increase net returns. The first objective is to determine the costs and net returns of conventional tillage and no-till management farm practices for five wheat production systems. The second objective is to determine the breakeven yield for canola for a given expected wheat price, wheat yield, and canola price, under a conventional tillage system. Data were obtained from field experiments conducted on farms located near Loyal (Kingfisher County) and Hunter (Garfield County), Oklahoma. Conventional-till and no-till management practices were examined for five alternatives: wheat seeded in (a) early September for forage-only, (b) early September for forage-only with foxtail millet seeded as a summer forage double crop, (c) early September for dual-purpose (forage plus grain), (d) late September for dual-purpose (forage plus grain), and (e) mid October for grain-only.

Findings and Conclusions: The conventionally tilled early September wheat planted for forage plus grain was the most economical of all production systems with a net return to land, labor, and management of $78.13 per acre. This was $17.06 per acre more than that produced by the second ranking system, conventionally tilled late September wheat planted for forage plus grain. The October no-till planted grain only treatment was the least economical. It returned an average of $92.44 per acre less than the most economical system. Yields at which canola would breakeven with wheat were computed for a wheat price of $3 per bushel and canola prices of $0.08 and $0.10 per pound. The breakeven conventional canola yield for a wheat yield of 45 bushels per acre and a canola price of $0.08 per pound was 1,975 pounds per acre. For the same parameters, the Roundup Ready® canola breakeven yield was 2,083. Due to the increased costs of Roundup Ready® canola production, an extra 108 pounds per acre are required to breakeven.

Advisor's Approval: Francis M. Epplin