ALTERNATIVE PRODUCTION SYSTEMS FOR

TRADITIONAL MONOCULTURE WHEAT

ACRES IN THE SOUTHERN PLAINS

FOR TWO FARM SIZES

By

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CHAPTER I

INTRODUCTION

Continuous hard red winter wheat is the primary crop grown in the Southern Plains. Wheat is not typically rotated with other crops, but it can be grown for either grain-only, forage-only, or for both fall-winter forage plus grain (dual-purpose). In the Southern Plains region, wheat can be planted as early as September 1 to maximize fall forage or as late as October 20 for grain production (Krenzer, 2000). Fall forage production is typically maximized when wheat is planted in early-September and production steadily declines as wheat is planted later in the season.

Grazing of winter wheat forage typically begins in late October. In a forage-only system, cattle may continue to graze until May of the following year. For a dual-purpose (forage plus grain) system cattle must be removed from the wheat prior to the development of first hollow stem which usually occurs in late February. After the livestock are removed, the crop is permitted to mature and produce grain that may be harvested in June. In a dual-purpose system where fall forage and grain are both considered important, growers traditionally plant wheat in mid-September (Krenzer, 2000). If the intended use of the wheat is for grain-only, the optimum planting date for maximizing grain yield is between late September and early October after which grain yields begin to decline (Heer and Krenzer, 1989; Krenzer, 2000; Lyon et al., 2007).

The USDA provides annual estimates of the wheat acres planted and harvested for grain. However, they do not differentiate among wheat uses. Hence, there are no routine data available from the USDA on the proportion of wheat acres used for each of the three purposes. Surveys conducted by True et al. (2001) and Hossain et al. (2004) found that between 9-20 percent of the wheat acres planted in Oklahoma were intended for forage-only; 49-66 percent were intended for dual-purpose; and 25-31 percent for grain-only.

The number of acres tilled with a moldboard plow has declined considerably; however, some form of conventional tillage continues to be used on the vast majority of acres in the region used to produce wheat. The reduction in tillage and corresponding increase in surface residue has been associated with an increase in weed problems. Particularly, annual ryegrass, which was introduced to the region as a pasture grass, has invaded many wheat fields and is extremely difficult to control.

Efforts to introduce no-till systems have been hampered by the inability of registered herbicides to provide effective and inexpensive weed control during the winter wheat growing season that extends from September through June, and by the inability to find an economically competitive crop that can be rotated with winter wheat. Prior to 1996, the search for alternatives to wheat, and crops to rotate with wheat, was hampered by federal policy that provided financial incentives for farmers in the region to produce wheat and build wheat base acres to the exclusion of other crops. Under the policy, farmers were required to plant wheat base acres to wheat only. There were government subsidy payments under the policy, and farmers had no incentive to plant other crops because they would stop receiving their government payments. After 1996, wheat producers in Oklahoma were no longer required to plant only wheat on base acres and had the freedom to plant any crop they desired. As a result, there are incentives to find alternative crops today (Epplin, 1997).

Foxtail millet could be a summer rotated crop with monoculture winter wheat in Oklahoma. A common practice for continuous winter wheat acres is to have a three month fallow period between crops of winter wheat with the intent to increase the amount of water stored in the soil for the next crop. Foxtail millet is a short season, summer annual grown primarily for forage that could be double cropped with wheat. From planting the foxtail millet to harvesting it for hay requires approximately 60 days, which fits the three month summer fallow period (Baker, 2003). Foxtail millet has a low water requirement and can produce 2,000 pounds per acre with 2.5 inches of water, which makes it capable of producing forage during hot, dry summers typical of the Southern Plains (Baker, 2003; Koch, 2002).

Herbicides may be used to control weeds during the summer fallow period between wheat crops and is commonly used to control weeds under a no-till system. Since the introduction of glyphosate in 1974, it has been the herbicide of choice for most no-till farmers because of its effective control of a broad spectrum of weed species. Generic glyphosate became available in 2000 after the original patent expired and the price declined substantially (Baylis, 2000; Franz et al., 1997; Mueller et al., 2005). The glyphosate price decreased from $7 per pint in 1999 to $3.5 in 2003, which increased the relative economics of no-till when compared to conventional tillage (National Agricultural Statistics Service, 2000). The increase in net returns for no-till systems occurred because of a decrease in weed controll cost for no-till while conventional tillage weed control costs remained the same.

Some anticipated that the introduction of glyphosate-tolerant wheat would provide an additional means for controlling weeds, enable expansion of no-till acres, and enhance soil conservation efforts. However, in May of 2004, Monsanto announced that it was going to defer the introduction of glyphosate-tolerant wheat. As a result, production systems for managing weed infestations on the traditional wheat acres can not rely on the in-season use of glyphosate.

Several factors have motivated additional investigation into the relative economics of the three wheat production systems and the economics of no-till relative to conventional tillage for continuous wheat production in the region. The increase in the price of diesel fuel and the decrease in the price of glyphosate after patent expiration have changed the cost of weed control with herbicides relative to the cost of weed control with tillage during the three month summer fallow period. In addition, the increase in the price of feed grains has increased the relative value of wheat forage and has increased the opportunity cost of the summer fallow that could be used to produce a short-season double-cropped forage such as foxtail millet.

Objectives

The objectives of this study are to determine the net returns of five alternative cropping systems, for both conventional tillage and no-till, for two farm sizes; 640-acres and 2,560-acres. The five cropping systems include: early September planted wheat for dual-purpose (fall forage for grazing plus wheat grain) (ESD); early September planted wheat for forage-only (fall forage for grazing plus wheat hay harvested in the spring) (ESF); early September planted forage-only double cropped with foxtail millet (fall forage for grazing plus wheat hay harvested in the spring plus millet hay harvested in the summer) (ESFM); late September planted wheat for dual-purpose (fall forage for grazing plus wheat grain) (LSD); October planted wheat for grain-only (OG). The net returns of each of the five cropping systems will be determined for both conventional tillage and no-till for both farm sizes.

This study has several unique aspects. First, the field experiments were conducted over three years on farm fields in three counties (Morley, 2006). Second, in most previous research of dual-purpose wheat, the plots have been clipped to simulate grazing. It is not practical to graze small plots on most experiment station sites. In this study, wheat grain yields from both dual-purpose (ESD and LSD) production systems were taken from portions of the plots that were grazed during the fall and winter by steers and heifers owned by the farmers at stocking densities typical for the region. Third, the study includes a double cropping system designed to take advantage of the traditional summer fallow period.

CHAPTER II

REVIEW OF LITERATURE

Conventional Tillage versus No-till Wheat Production

Conventional tillage is used to control weeds and to prepare a seedbed. Prior to the development of effective chemical herbicides, tillage was essential. Tillage enabled production of grain from annual crops such as winter wheat. However, since tillage reduces surface residue, especially between periods of growing crops, weather events, wind and rain, may cause soil erosion. One alternative to conventional tillage is no-till farming, which consists of substituting chemical herbicides for tillage to control weeds, and substituting a no-till seeder for a conventional drill or planter. According to Krause and Black (1995, p. 299), "No-till technology excludes any pre-plant tillage and can reduce soil erosion by 80-90 percent compared to conventional tillage."

Among Oklahoma wheat producers, there is a concern of the costs and changes that are likely when switching to no-till farming. Several management factors need to be considered when switching to no-till farming. An extension fact sheet published by Oklahoma State University compared management practices for conventional tillage and no-till and found that the managerial requirement increases with no-till, but the labor requirement decreases. They also found that the equipment requirements are quite different for no-till. The drill/planter expense increases, however the horsepower requirements, the tillage equipment needs, and the fuel expenses decrease under no-till compared to conventional tillage. From the environmental aspect of switching to no-till, the stratification of nutrients and acidity, and the plant-available moisture increase with no-till while the soil erosion decreases (Edwards et al., 2005). One important note for producers in Oklahoma considering a conversion to no-till is that there is not a one-size fits all approach to converting. Each producer has to consider their current operation, and choose a conversion method that is most cost efficient for their operation.

Heer and Krenzer (1989) reported that tillage method affected grain production only in years when precipitation was limited. In drier years, yields were higher with no-till. A ten-year study of continuous winter wheat trials was conducted to compare the economics of six tillage systems. The no-till system produced lower wheat grain yields than the conventional systems (Epplin et al., 1994). Conventional tillage systems produced greater net returns because of the greater yields and the high cost of (pre-generic) glyphosate used to control weeds during the fallow period between wheat harvest in June and wheat planting in September on the no-till plots. Other studies have shown that no-till did lower fuel and labor cost, but the cost of herbicide to control weeds was greater than the money saved on fuel and labor (Epplin et al., 1993; Williams et al., 1990).

There has been a vast amount of research done concerning no-till and conventional tillage systems for corn and soybeans. In comparison, there have been very few studies that compare no-till and conventional tillage systems for continuous monoculture winter wheat. Based on the findings, no-till for continuous monoculture wheat has been found to be less economical than conventional tillage for continuous monoculture wheat. The no-till systems could be less economical because of yield differences in conventional tillage monoculture wheat and no-till monoculture wheat yields. Table II-1 includes a summary of the yields reported in past research that compared no-till and conventional tillage yields for monoculture wheat production systems.

Table II-1. Agronomic Results from Previous Studies Comparing Conventional Tillage and No-Till Wheat Yields.

Authors	Years of Study	Location	Annual Rainfall	Previous Crop	Important Information	Mean NT Yield*	Mean CT Yield*
						bu/ac	
Epplin, Al-Sakkaf, and Peeper (1994)	1977-1986	North-Central Oklahoma	28 in.	N/A	Lahoma	24	31
Heer and Krenzer (1989)	1982-1984	North-Central Oklahoma	N/A	Wheat	Lahoma	$40^{\pm}$	$41^{\pm}$
					Stillwater	$41^{\pm}$	$46^{\pm}$
Bordovsky, Choudhary, Gerard (1998)	1979-1989	Northwest Texas	17 to 24 in.	N/A		32	35
Ribera, Hons, and Richardson (2004)	1984-2001	South-Central Texas	N/A	N/A		25	26
Devuyst and Halvorson (2004)	1984-1996	Central North Dakota	N/A	N/A	45 kg/ha of N	16	17
					22 kg/ha of N	16	17
					0 kg/ha of N	15	16
Ciha, A.J. (1982)	1979-1980	Palouse Region, Washington	17-20.5 in.	Wheat	Spring Wheat	35	30
Melaj, et al. (2003)	1998-1999	Argentina	18 in.	Sunflowers	1998 yield data	82	70
			22 in.		1999 yield data	69	66
Williams, Llewelyn, and Barnaby (1990)	1976-1986	West-Central Kansas	N/A	N/A		23	21.7

*CT=Conventional Tillage, and NT= No-tillage.
$^{\pm}$The yields in the study were averaged across three years and 4 different planting dates.

According to the yields reported by studies in Table II-1, conventional tillage monoculture wheat had higher grain yields than no-till monoculture wheat in all studies completed in the United States except Washington. The Washington study reported five bushels per acre more for no-till than conventional tillage over a two year average. The study completed in Argentina reports higher yields for no-till than conventional tillage for both years of the study, which could be caused by different growing conditions. The lower yields for no-till in the United States could be the reason for a lack of producers converting from conventional tillage to a no-till system.

Crop Rotations and Dual-purpose Use of the Land

According to USDA projections, "crop rotations increasingly favor crops other than wheat" (National Association of Wheat Growers). This is one of the main reasons why wheat is losing the competitive edge. Along with crop rotations, there are also many acres in Oklahoma that are used for dual-purpose. Dual-purpose wheat is wheat that is planted for the dual purposes of fall-winter grazing for livestock and wheat grain. Epplin and Al-Sakkaf (1995) explained that winter wheat is an important grain and forage crop in the Southern Plains. Livestock may be pastured on wheat forage during the winter months, then once cattle are removed the wheat is allowed to mature and produce a grain crop. Due to the large amount of dual-purpose wheat planted in Oklahoma, research has been conducted to compare grain-only wheat with dual-purpose wheat.

Epplin, Krenzer, and Horn (2001) found that two-thirds of the wheat acres planted in the fall of 1995 were intended for dual-purpose, which confirms that dual-purpose wheat is very important in Oklahoma. The study found, "for the twenty wheat production seasons from 1980 to 1999, grain-only wheat generated more net returns to land, labor, machinery fixed costs, overhead, risk, and management in four seasons, and dual-purpose wheat generated more net returns in 16 seasons" (Epplin, Krenzer, and Horn, 8). On average over the time period of the study, dual-purpose wheat produced higher net returns, and grazing of cattle helped to offset the overhead cost of producing wheat in Oklahoma.

Crop rotations are not common in Oklahoma's winter wheat belt. Few crops that are economically competitive fit well with winter wheat in a rotation. Typically, the summers are too hot and too dry for successful dryland corn and soybeans. Williams, Llewelyn, and Barnaby (1990) found that in Kansas the rotation of grain sorghum and wheat had higher yields when using a no-till system rather than a conventional tillage system. The five crop rotations used in the study were wheat-fallow, continuous wheat, continuous grain sorghum, grain sorghum-fallow, and wheat-grain sorghum-fallow. Each of the five systems was tested using conventional tillage and no-till. The yields and costs of each system were collected and analyzed and the results showed that a rotation of wheat and grain sorghum was the most economical system.

Farm Size

In this study, economic analysis for both tillage systems and five production systems is completed for a 2,560-acre farm and a 640-acre farm. Economies of size result when average cost per unit of output decreases as farm size increases. Alternatively, over a range of farm size, production cost per acre decreases as acres farmed increases. Fixed machinery costs are spread out over more acres, and use and allocation of farm equipment across more acres can reduce the per acre fixed costs. Epplin et.al (2005) completed a study in Oklahoma that took into account different farm size. The estimated fixed costs for a conventional tillage farm planting continuous winter wheat were $35 per acre for a 320-acre farm, $28 per acre for a 640-acre farm, and $25 per acre for a 1,280-acre farm. Over this range in farm size, machinery fixed costs per acre decrease as the number of acres farmed increase.

CHAPTER III

METHODOLOGY

Agronomic

Experiments were conducted on three farm fields located in north central Oklahoma to evaluate the effect of conventional tillage and no-till on different forage and grain production systems. Each of five cropping systems (Early September dual purpose wheat (ESD), Early September wheat with a foxtail millet rotation (ESFM), Early September wheat planted for forage only (ESF), Late September wheat planted for dual purpose (LSD), and October planted wheat for grain only (OG)) was replicated four times on each of three farms for each of three growing seasons. The system used on each plot was maintained the same for the duration of the experiment. Individual plot dimensions were 10 by 15 yards.

The field research was initiated in the summer of 2002 and completed with grain harvest in June and foxtail millet hay harvest in September of 2005. The fields were located in Alfalfa, Garfield, and Kingfisher counties in Oklahoma. Data from the 2003-04 crop year from the Alfalfa county site were deemed invalid and not used as a result of a stubble fire in August of 2003 that destroyed surface residue. Table III-1 contains a listing of field operations for each of the five production systems for both tillage systems.

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

		Systems									
		Conventional Tillage					No-till				
Field Operations	Date	ESF	ESFM	ESD	LSD	OG	ESF	ESFM	ESD	LSD	OG
Chisel	May	✓	✓								
Disk	May	✓	✓								
Apply Fertilizer (82-0-0)	May		✓					✓			
Apply Herbicide (Glyphosate and AMS)	May						✓	✓			
Band Fertilizer (18-46-0)	May		✓					✓			
Plant German Foxtail millet (Conventional-Till Drill)	May		✓								
Plant German Foxtail millet (No-Till Drill)	May							✓			
Moldboard Plow (Used on 20% of Acres)	June	✓		✓	✓	✓					
Chisel (Used on 80% of Acres)	June	✓		✓	✓	✓					
Disk	June	✓									
Apply Herbicide (Glyphosate and AMS)	June						✓		✓	✓	✓
Harvest Millet Forage	August		✓					✓			
Apply Herbicide (Glyphosate, AMS, and 2,4-D)	August						✓		✓	✓	✓
Disk	August	✓	✓	✓	✓	✓					
Apply Fertilizer (82-0-0)	August	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Apply Herbicide (Glyphosate and AMS) & Pesticide (Chlorpyrifos)	August						✓	✓	✓		
Disk	Early Sept.	✓	✓	✓	✓	✓					
Band Fertilizer (18-46-0)	Early Sept.	✓	✓	✓			✓	✓	✓		
Plant Wheat (Conventional-Till Drill)	Early Sept.	✓	✓	✓							
Plant Wheat (No-Till Drill)	Early Sept.						✓	✓	✓		
Apply Herbicide (Glyphosate and AMS)	Late Sept.									✓	
Disk	Late Sept.				✓						
Band Fertilizer (18-46-0)	Late Sept.				✓					✓	
Plant Wheat (Conventional-Till Drill)	Late Sept.				✓						
Plant Wheat (No-Till Drill)	Late Sept.									✓	
Apply Herbicide (Glyphosate and AMS)	October										✓
Disk	October					✓					
Band Fertilizer (18-46-0)	October					✓					✓
Plant Wheat (Conventional-Till Drill)	October					✓					
Plant Wheat (No-Till Drill)	October										✓
Harvest Wheat Forage	February	✓	✓	✓	✓		✓	✓	✓	✓	
Apply Pesticide (Dimethoate)	April	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Harvest Wheat Hay	May	✓	✓				✓	✓			
Harvest Wheat Grain	June			✓	✓	✓			✓	✓	✓

ESF = wheat seeded in early September for forage-only
ESFM = wheat seeded in early September for forage-only with foxtail millet seeded as a summer forage double crop
ESD = wheat seeded in early September for dual-purpose (forage plus grain)
LSD = wheat seeded in late September for dual-purpose (forage plus grain)
OG = wheat seeded in mid October for grain-only

The field operations completed in the experiment are typical for north central Oklahoma wheat production. Field operations are similar across systems. However, wheat planting date differs. The average wheat planting date across the three locations and three years was September 6 for ESD, ESF, and ESFM, September 25 for LSD, and October 17 for OG. The double cropped foxtail millet in the ESFM system was planted after wheat harvest in early June. For additional details regarding the field experiments see Morley (2006).

The yield data collected from the plots were statistically analyzed using the PROC MIXED procedure in SAS. The procedure allows the user to not only analyze the means, but also analyze the variance and covariance. PROC MIXED was used to model the random effects (year to year variability) and the repeated measures (same treatment on a plot across years) aspects of the data (Littell et al., 1996). Differences across each tillage method, across each production system, and then across each production system under each tillage method were tested. Results were pooled across all three locations, and also provided for each individual location. Tables in Chapter IV include the mean results and illustrate the statistical differences across production and tillage systems.

Economics

Enterprise crop budgets were prepared to conduct the economic analysis. A budget was constructed for each production system, for both tillage systems, and both farm sizes. The budgets were used to determine net returns to land, labor, management, risk, and overhead. Custom harvest of grain and hay is typical in the region as was assumed in the budgets. Custom application of fertilizer, herbicide, and insecticide was assumed for the 640-acre farm. However, the 2,560-acre farm was assumed to own spray and fertilizer application equipment.

Average grain, forage, and hay yields reported across the three locations over the three years for each system were used for the base budgets. Historical averages (2003-

2005) for June and July wheat prices were used because farmers in the region typically sell most of their wheat in those two months (Oklahoma Agricultural Statistics Service).

Hay prices were based upon reports contained in the Oklahoma Annual Bulletin. The price for wheat hay was calculated by averaging prices from 2003-2005 for the month of May which was approximately $53 per ton. For the price of foxtail millet hay, the prices were averaged across 2003-2005 for the month of August instead of May. The average price for wheat hay in August was $49 per ton (Oklahoma Agricultural Statistics Service). No reported prices are available for foxtail millet hay. Based on differences in nutrient content, the price for foxtail millet hay was assumed to be 20 percent greater than the price of wheat hay (National Research Council, 1996).

The calculation of the forage for pasture price was arrived at by using the average value of a pound of gain for cattle grazing wheat pasture and dividing that value by the estimated quantity of wheat forage required to achieve a pound of gain. Prior research has found that one pound of gain for wheat pasture stockers requires approximately ten pounds of standing wheat forage (Kaitbie et al., 2002). A standard rental rate for wheat pasture forage is $0.33 per pound of gain (Doye and Sahs, 2005). Hence, the base price for fall-winter forage was set at $0.033 per pound of dry matter.

Prices for operating inputs including seed, herbicides, insecticides, and fertilizer were collected from Oklahoma State University base enterprise budgets that are updated annually to reflect prices specific to Oklahoma. Prices for items not included in the base budgets such as foxtail millet seed were collected from dealers and distributors.

Prices for custom applications and custom harvesting were based upon responses to surveys reported by Doye, Sahs, and Kletke (2006). The budgeted price for custom anhydrous ammonia application for conventional tillage plots was taken from the report. The budgeted custom rate for anhydrous ammonia application for no-till plots was increased by $1.00 per acre due to the higher cost of knifing fertilizer into fields that have not been tilled. Table III-2 shows the operating input amounts and cost per unit. In the table, the systems for conventional tillage, contain a C after the production system label (i.e ESFC). The no-till systems contain an N after the production system abbreviation (i.e. ESFN), which will be used throughout the following pages.

Table III-2. Per Acre Operating Inputs for Alternative Wheat Production Systems

Operating Inputs	Date	Unit	Price ($)	Production Systems									
				ESFC	ESFMC	ESDC	LSDC	OGC	ESFN	ESFMN	ESDN	LSDN	OGN
Anhydrous Ammonia (82-0-0)	May	Lbs.	$ 0.24		95					95			
Custom Application No-till		Acre	$ 9.29							1			
Custom Application Conventional		Acre	$ 8.29		1								
Diammonium Phosphate (18-46-0)	May	Lbs.	$ 0.15		50					50			
Glyphosate	May	Pt.	$ 3.50						1.5	1.5			
AMS		Lbs.	$ 0.24						1.7	1.7			
Custom Application		Acre	$ 4.00						1	1			
Glyphosate	June	Pt.	$ 3.50						1.5		1.5	1.5	1.5
AMS		Lbs.	$ 0.24						1.7		1.7	1.7	1.7
Custom Application		Acre	$ 4.00						1		1	1	1
Glyphosate	August	Pt.	$ 3.50						1		1	1	1
AMS		Lbs.	$ 0.24						1.7		1.7	1.7	1.7
2,4-D		Pt.	$ 3.70						0.75		0.75	0.75	0.75
Custom Application		Acre	$ 4.00						1		1	1	1
Anhydrous Ammonia (82-0-0)	August	Lbs.	$ 0.24	110	110	110	110	110	110	110	110	110	110
Custom Application No-Till		Acre	$ 9.29						1	1	1	1	1
Custom Application Conventional Till		Acre	$ 8.29	1	1	1	1	1					
Glyphosate	August	Pt.	$ 3.50						1	1	1		
AMS		Lbs.	$ 0.24						1.7	1.7	1.7		
Chlorpyrifos		Pt.	$ 4.66						1	1	1		
Custom Application		Acre	$ 4.00						1	1	1		
Diammonium Phosphate (18-46-0)	Early Sept.	Lbs.	$ 0.15	50	50	50			50	50	50		
Glyphosate	Late Sept.	Pt.	$ 3.50									1	
AMS		Lbs.	$ 0.24									1.7	
Custom Application		Acre	$ 4.00									1	
Diammonium Phosphate (18-46-0)		Lbs.	$ 0.15				50					50	
Glyphosate	October	Pt.	$ 3.50										1
AMS		Lbs.	$ 0.24										1.7
Custom Application		Acre	$ 4.00										1
Diammonium Phosphate (18-46-0)	October	Lbs.	$ 0.15					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	$ 4.69	1	1	1	1	1	1	1	1	1	1
Millet Seed		Bu.	$ 18.00		1					1			
Wheat Seed		Bu.	$ 9.00	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5

ESFC = Conventional-till wheat seeded in early September for forage-only, EFMC = Conventional-till wheat seeded in early September for forage-only with 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, EFMN = No-till wheat seeded in early September for forage-only with 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

Fixed cost for machinery and equipment for each of the ten systems was calculated using MachSel software (Kletke, and Sestak, 1991). MachSel allows the user to select the number of times each machine is used and the month of use. MachSel produces an estimate of the total machinery fixed costs per acre, as well as the estimated costs for fuel, lubricants, and repairs. Epplin et al. updated prices and parameter values per conversations with dealers and information listed on manufacturer's websites in 2005 and those prices were used in this research. (Epplin et al., 2005). The software accounts for farm size and number of times the equipment is used. The equipment for each of the ten systems was selected to meet the needs of that system. Table III-3 includes a list of machines selected for each farm size for both tillage systems. Refer to Appendix A for equipment values used in MachSel.

Table III-3. Machinery Complements for Conventional Tillage and No-till Wheat Production Systems for Two Farm Sizes

Machine	Conventional Tillage	No-till
640-acre Farm		
155 hp Tractor	✓	✓
Moldboard Plow	✓	
Chisel	✓	
Disk	✓	
Conventional Till Drill	✓	
No-Till Drill		✓
2,560-acre Farm		
95 hp Tractor	✓	✓
Sprayer	✓	✓
255 hp Tractor	✓	✓
Disk	✓	
Chisel	✓	
Conventional Till Air Seeder	✓	
No-Till Air Seeder		✓
No-Till Anhydrous Applicator		✓
255 hp Tractor	✓	
Moldboard Plow	✓	
Chisel	✓	
Disk	✓	
Cultivator w/ Anhydrous Applicator	✓	

The net return for each system was calculated by subtracting cash costs and fixed machinery costs from gross revenues. The net return for each system is stated in terms of return to land, labor, management, risk, and overhead. A budget was created for each farm size, and each tillage method. Within each of those four budgets, are the production system budgets.

CHAPTER IV

FINDINGS

Agronomic

The agronomic findings are from Morley, 2006, and are included here to provide the reader with the data upon which the economic findings are based. Table IV-1 includes the results of the analysis of variance for wheat grain yields. At each location, wheat grain yields were significantly greater ($P<0.05$) with the conventional tillage system. When pooled across locations, and production system, grain yields produced with conventional tillage were significantly greater than those produced with no-till. The differences are noted by letter a, b, and c, with a being significantly greater than b, and b being significantly greater than c.

Table IV-1. Wheat grain yield (bu/acre) by tillage system, location, and production system.

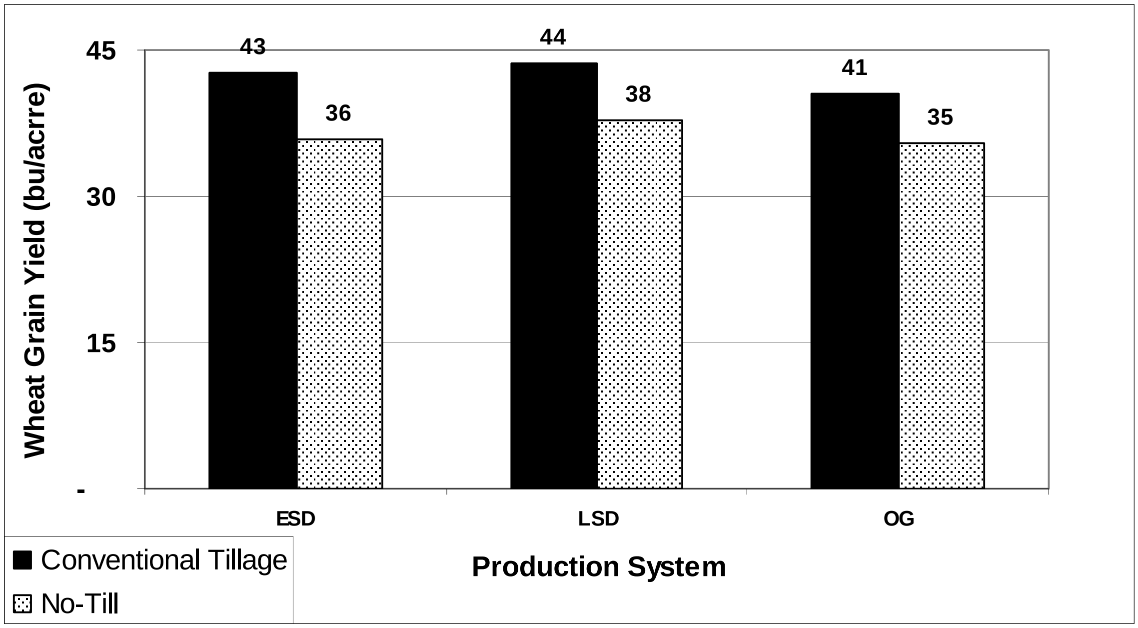
Location	System	Conventional Tillage	No-Till	Mean
Cherokee	ESD	41.8	32.9	
	LSD	41.1	38.9	
	OG	44.6	37.0	
	Mean	42.5[a]	36.3[b]	
Hunter	ESD	44.9	39.9	
	LSD	44.1	38.8	
	OG	38.6	34.1	
	Mean	42.6[a]	37.6[b]	
Loyal	ESD	39.0	31.9	
	LSD	43.3	34.3	
	OG	38.1	34.1	
	Mean	40.1[a]	33.4[b]	
All Locations	ESD	42.6[ab‡]	35.8[c]	39.2
	LSD	43.7[a]	37.8[bc]	40.7
	OG	40.5[abc]	35.4[c]	38.0
	Mean	42.3[a†]	36.3[b]	

ESD = wheat seeded in early September for dual-purpose (forage plus grain) LSD = wheat seeded in late September for dual-purpose (forage plus grain) OG = wheat seeded in mid October for grain-only

† Different letters in the same row indicate significant difference at $p < 0.05$ estimated with Proc Mixed LSMeans with Tukey-Kramer Correction

‡ Identical letters in the block for a given location indicate no significant difference at $p < 0.05$ estimated with Proc Mixed LSMeans with Tukey-Kramer Correction.

Figure IV-1 contains wheat grain yields for each of the three systems that include wheat grain harvest (ESD, LSD, and OG) for both conventional tillage and no-till averaged across the three locations and three years.

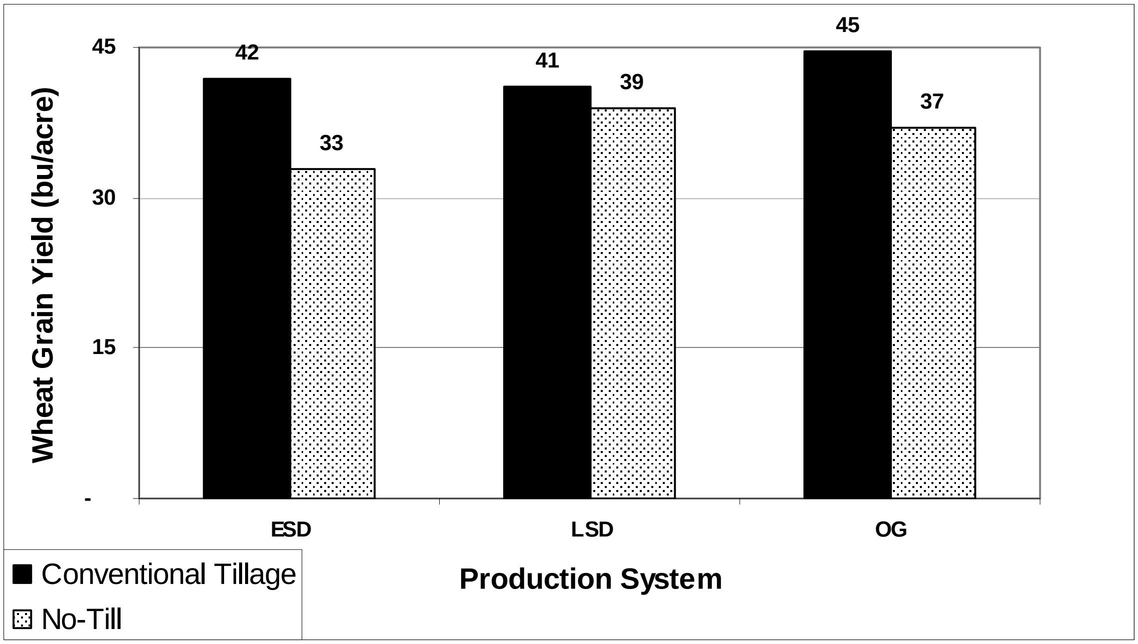


ESD = wheat seeded in early September for dual-purpose (forage plus grain) LSD = wheat seeded in late September for dual-purpose (forage plus grain) OG = wheat seeded in mid October for grain-only

Figure IV-1. Average wheat grain yield (bu/ac) from conventional tillage and no-till for three production systems.

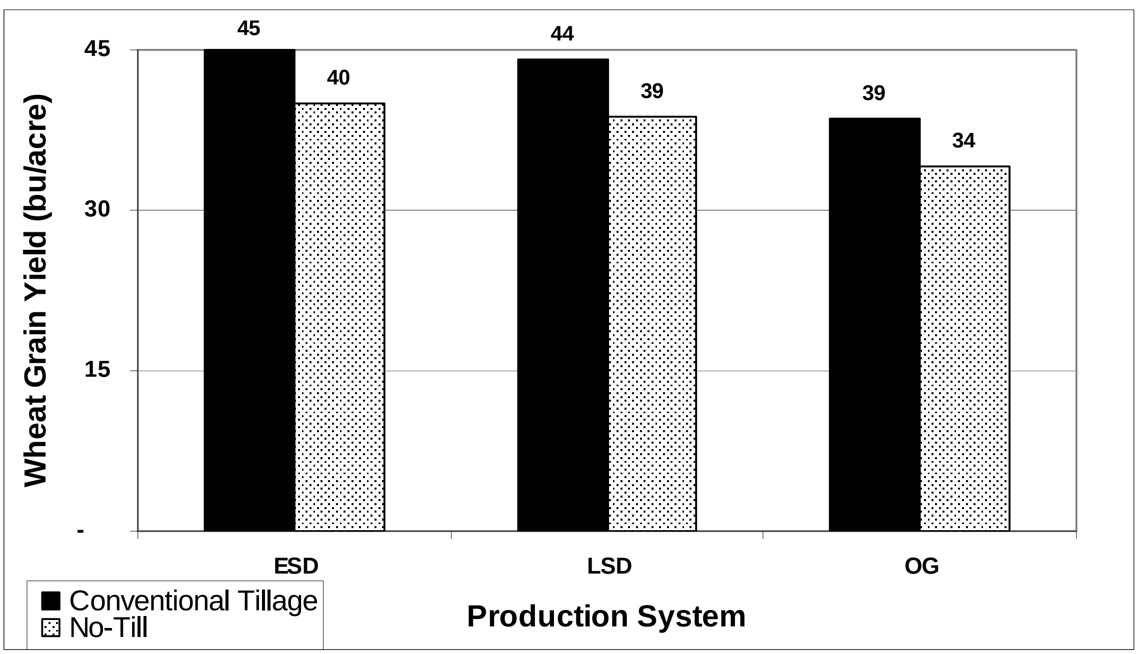
The yield reported in each bar is the average of 32 harvested plots (four replications at two locations for three years plus four replications at one location for two years). At each location the wheat grain yield from the conventional tillage plots was significantly greater ($P < 0.05$) than for the no-till plots. The overall average yield from the conventional tillage plots of 42.3 bushels per acre was more than 16% greater than the yield from the no-till plots of 36.3. Yields from the plots that were conventionally tilled were not significantly different across production system. Similarly yields from the no-till plots were not significantly different across production system.

Figures IV-2 to IV-4 show the grain yield differences between conventional tillage and no-till at each location (Cherokee, Loyal, and Hunter respectively).



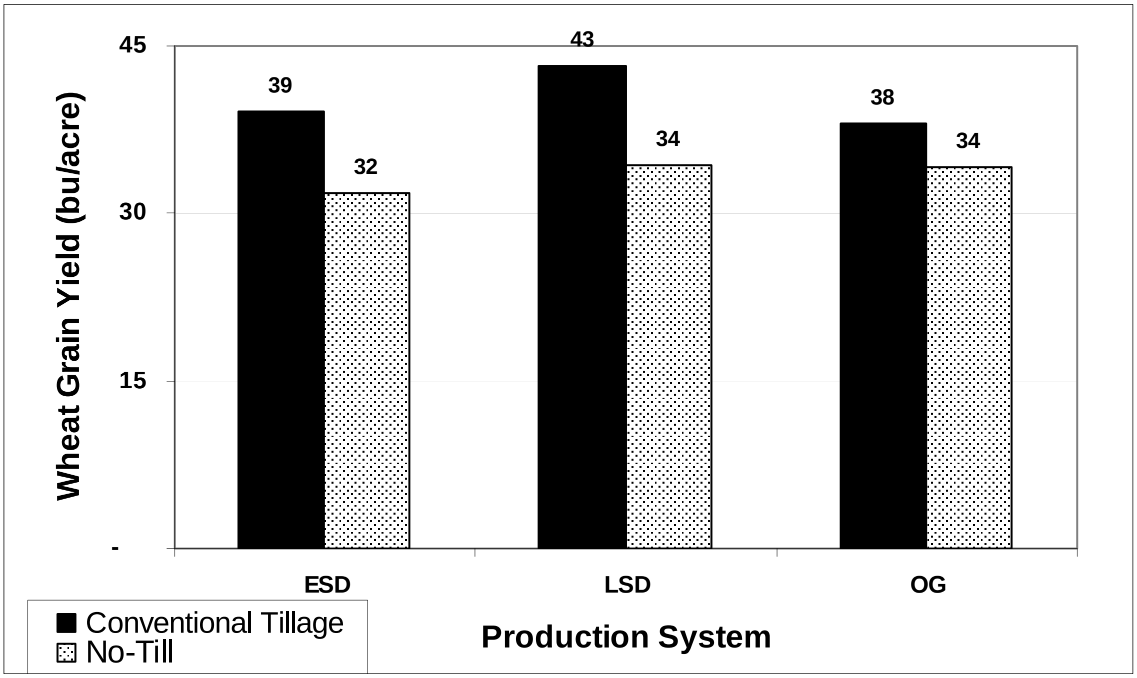
ESD = wheat seeded in early September for dual-purpose (forage plus grain) LSD = wheat seeded in late September for dual-purpose (forage plus grain) OG = wheat seeded in mid October for grain-only

Figure IV-2. Average wheat grain yield (bu/ac) from conventional tillage and no-till for three production systems at Cherokee.



ESD = wheat seeded in early September for dual-purpose (forage plus grain) LSD = wheat seeded in late September for dual-purpose (forage plus grain) OG = wheat seeded in mid October for grain-only

Figure IV-3. Average wheat grain yield (bu/ac) from conventional tillage and no-till for three production systems at Hunter.



ESD = wheat seeded in early September for dual-purpose (forage plus grain) LSD = wheat seeded in late September for dual-purpose (forage plus grain) OG = wheat seeded in mid October for grain-only

Figure IV-4. Average wheat grain yield (bu/ac) from conventional tillage and no-till for three production systems at Loyal.

The wheat fall forage yields produced under no-till were significantly greater than those produced with conventional tillage when pooled across location and production system. When pooled only across production systems, the no-till method produced significantly greater fall forage than the conventional tillage method at each location. For production systems results, when pooled across location and tillage method, the Early September dual purpose (ESD) system produced significantly greater forage than each of the other systems, however when analyzed without pooling locations, the yield differences are not significant. Table IV-2 includes the results of the analysis of variance for wheat fall forage yields for all locations averaged across the three years.

Table IV-2. Wheat fall forage yield (lb DM/acre) by tillage system, location, and production system.

Location	System	Conventional Tillage	No-Till	Mean
Cherokee	ESD	1899[ab§]	2356[a]	2127[a‡]
	ESF	1027[bc]	1638[abc]	1333[b]
	ESFM	925[c]	1081[bc]	1003[b]
	LSD	910[c]	853[c]	882[b]
	Mean	1190[b†]	1482[a]	
Hunter	ESD	1681[ab§]	1999[a]	1840[a‡]
	ESF	1568[ab]	1819[ab]	1694[ab]
	ESFM	1393[bc]	1426[b]	1409[b]
	LSD	651[d]	857[cd]	754[c]
	Mean	1323[b†]	1525[a]	
Loyal	ESD	1528[ab§]	1705[a]	1616[a‡]
	ESF	1169[b]	1580[ab]	1375[a]
	ESFM	1326[ab]	1464[ab]	1395[a]
	LSD	656[c]	691[c]	674[b]
	Mean	1170[b†]	1360[a]	
All Locations	ESD	1694[ab§]	1994[a]	1844[a‡]
	ESF	1299[c]	1701[ab]	1500[b]
	ESFM	1267[c]	1370[bc]	1318[b]
	LSD	734[d]	810[d]	772[c]
	Mean	1249[b†]	1469[a]	

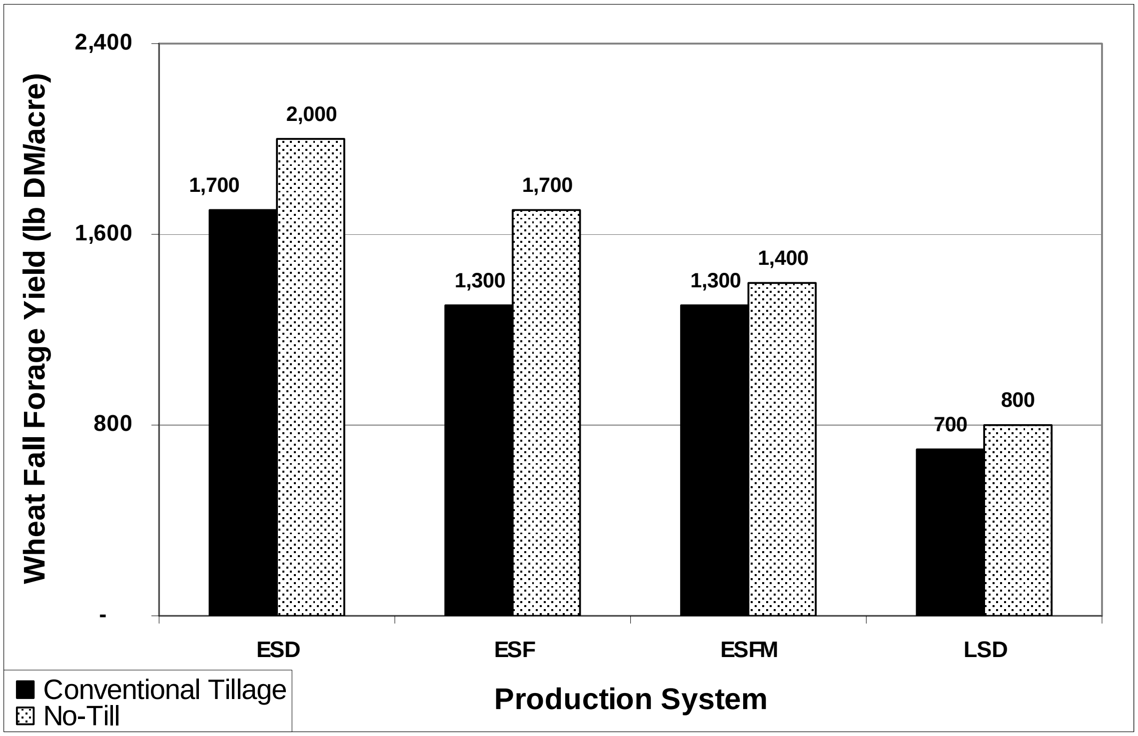
ESF = wheat seeded in early September for forage-only ESFM = wheat seeded in early September for forage-only with foxtail millet seeded as a summer forage double crop ESD = wheat seeded in early September for dual-purpose (forage plus grain) LSD = wheat seeded in late September for dual-purpose (forage plus grain)

[†] Identical letters in the same row indicate no significant difference at $p < 0.05$ estimated with Proc Mixed LSMeans with Tukey-Kramer Correction.

[‡] Identical letters in the same column indicate no significant difference at $p < 0.05$ estimated with Proc Mixed LSMeans with Tukey-Kramer Correction.

[§] Identical letters in the block for a given location indicate no significant difference at $p < 0.05$ estimated with Proc Mixed LSMeans with Tukey-Kramer Correction

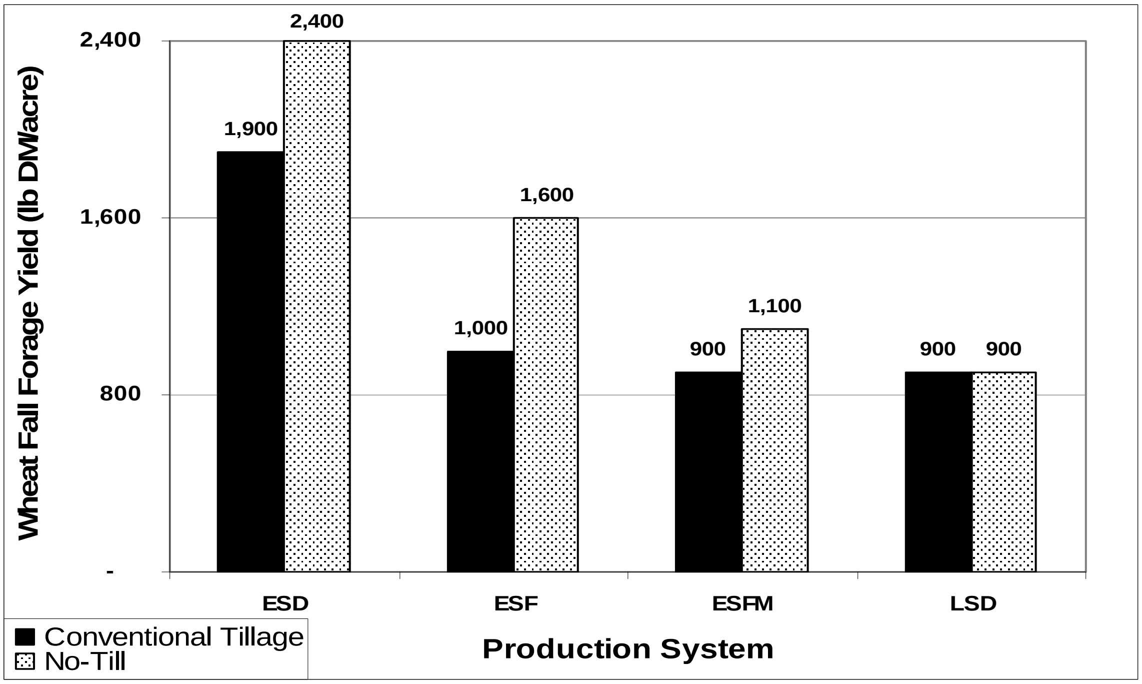
Figure IV-5 includes a chart of wheat fall forage yields for each of the four systems that included wheat fall forage harvest (ESD, ESF, ESFM, LSD) for both conventional tillage and no-till averaged across the three farms and three years.



ESF = wheat seeded in early September for forage-only ESFM = wheat seeded in early September for forage-only with foxtail millet seeded as a summer forage double crop ESD = wheat seeded in early September for dual-purpose (forage plus grain) LSD = wheat seeded in late September for dual-purpose (forage plus grain)

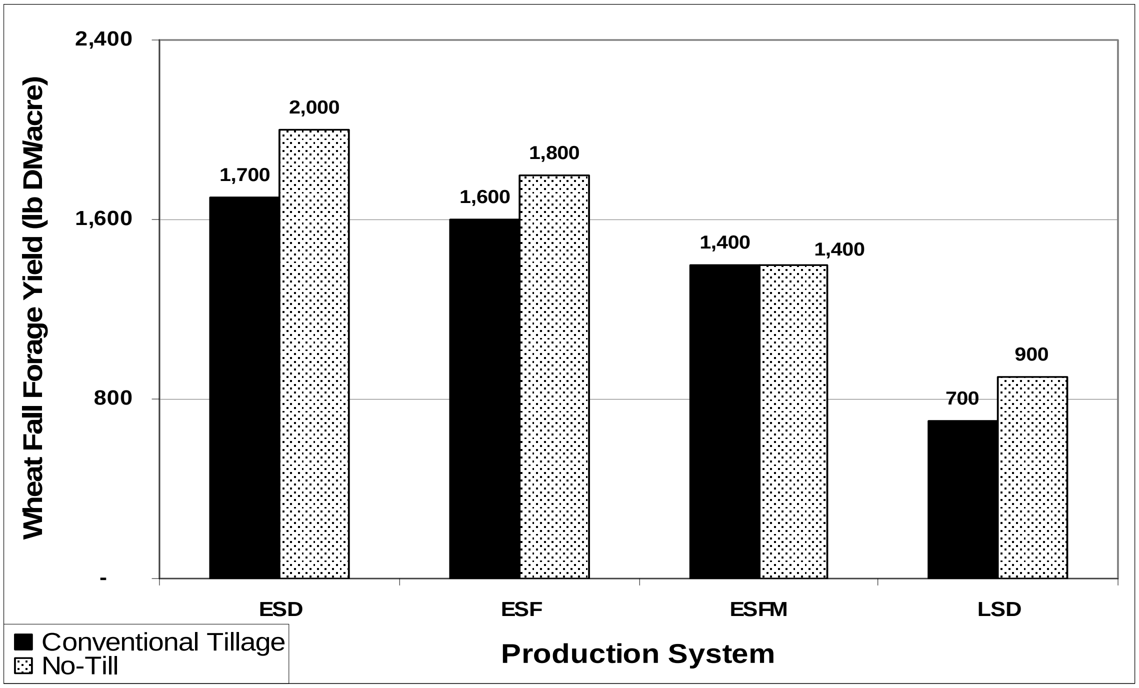
Figure IV-5. Average wheat fall forage yields from conventional tillage and no-till for four production systems.

At each location the wheat fall forage yield from the conventional tillage plots was significantly less ($P < 0.05$) than the yield obtained from the no-till plots which is shown in Figures IV-6 through IV-8. The overall average yield from the no-till plots of 1,469 pounds per acre was more than 17% greater than the 1,249 pounds per acre obtained from the conventional tillage plots. For the no-till plots, yields from the ESD system were significantly ($P < 0.05$) greater than yields from ESFM and LSD, and yields from ESFM were significantly greater than yields from LSD. For the conventional tillage plots, yields from ESD were significantly greater than yields from the other systems. And, no-till wheat fall forage yields for both ESF and ESFM were greater than yields from LSD.



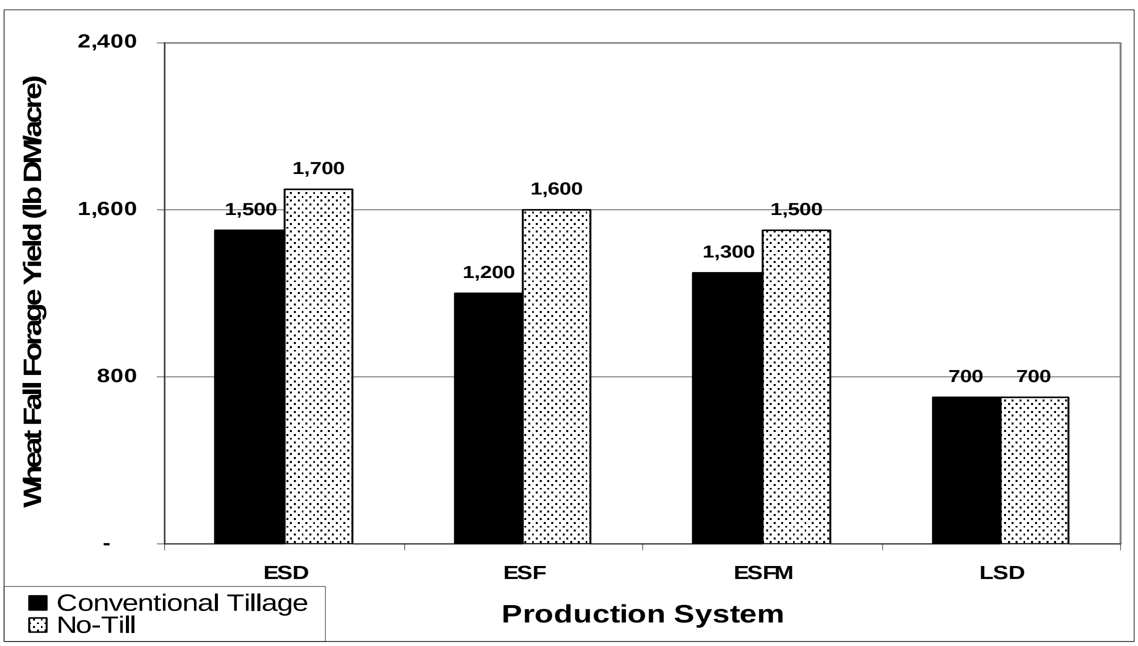
ESF = wheat seeded in early September for forage-only ESFM = wheat seeded in early September for forage-only with foxtail millet seeded as a summer forage double crop ESD = wheat seeded in early September for dual-purpose (forage plus grain) LSD = wheat seeded in late September for dual-purpose (forage plus grain)

Figure IV-6. Average wheat fall forage yields from conventional tillage and no-till for four production systems at Cherokee.



ESF = wheat seeded in early September for forage-only ESFM = wheat seeded in early September for forage-only with foxtail millet seeded as a summer forage double crop ESD = wheat seeded in early September for dual-purpose (forage plus grain) LSD = wheat seeded in late September for dual-purpose (forage plus grain)

Figure IV-7. Average wheat fall forage yields from conventional tillage and no-till for four production systems at Hunter.



ESF = wheat seeded in early September for forage-only ESFM = wheat seeded in early September for forage-only with foxtail millet seeded as a summer forage double crop ESD = wheat seeded in early September for dual-purpose (forage plus grain) LSD = wheat seeded in late September for dual-purpose (forage plus grain)

Figure IV-8. Average wheat fall forage yields from conventional tillage and no-till for four production systems at Loyal.

Table IV-3 includes the results of the analysis of variance for wheat hay yields. There were no significant differences among the yields when pooled across location or when analyzed separately at each location.

Table IV-3. Wheat hay yield (lb DM/acre) by tillage system, location, and production system

Location	System	Conventional Tillage	No-Till	Mean
Cherokee	ESF	6256	7187	
	ESFM	6949	6590	
Hunter	ESF	8356	8303	
	ESFM	7616	8006	
Loyal	ESF	6058	5856	
	ESFM	5706	5882	
All Locations	ESF	7106	7244	7175
	ESFM	6870	6993	6932
	Mean	6988	7119	

ESF = wheat seeded in early September for forage-only ESFM = wheat seeded in early September for forage-only with foxtail millet seeded as a summer forage double crop

Table IV-4 includes the analysis of variance results for foxtail millet hay which was only produced under the ESFM production system. The yields for conventional tillage were not significantly different from no-till foxtail millet hay yields.

Table IV-4. Foxtail millet hay yield (lb DM/acre) by tillage system, and location.

Location	System	Conventional Tillage	No-Till
Cherokee	ESFM	3794	5888
Hunter	ESFM	4952	4817
Loyal	ESFM	2595	2824
All Locations	ESFM	3739	4297

The only production system included in this table was the ESFM= wheat seeded in early September for forage-only with foxtail millet seeded as a summer forage double crop

Overall for the agronomic findings, there were significantly greater grain yields for the conventional tillage systems over the no-till systems. For forage production, the no-till systems produced significantly higher forage yields than the conventional tillage systems. Also, for the hay production, no-till yields were greater, however when statistically analyzed, there was no significant differences between no-till and conventional tillage.

Across production system results, the system that produced the highest grain yield was the LSD (late September dual-purpose) system, however it was not statistically different from the ESD (early September dual-purpose) or the OG (October grain only) systems. For forage production across productions systems, the ESD system produced the largest amount of forage followed by the ESF (early September forage only), ESFM(early September foxtail millet rotation), and LSD (late September dual-purpose) systems respectively.

The LSD (late September dual-purpose) system produced the highest grain yield, however it also produced the least amount of forage. Possible reasons for the yield loss in forage could be due to the late September planting date. The systems producing more forage were planted in early September. Other causes for this difference are unknown at this time.

Economics

Enterprise crop budgets were prepared for all of the productions systems under conventional tillage and no-till for a 640-acre farm and a 2,560-acre farm. The budgets are included in Tables IV-5 through IV-8. Fixed machinery costs, fuel, lube and repair costs for equipment were computed using MachSel software and the breakdown of the results is included in Appendix B. The budgets include the per unit price for each input and output, as well as the quantity and yield for each line item.

Table IV-5. Per Acre Production Returns and Cost Estimates for a No-Tillage 640-acre Farm

			Production System									
			ESF		ESFM		ESD		LSD		OG	
Item	Unit	Price	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
PRODUCTION												
Wheat												
Grain	bu	3.053					35.80	109.31	37.80	115.42	35.40	108.09
Hay	lbs	0.027	7244.00	191.97	6993.00	185.31						
Pasture	lbs	0.033	1701.00	56.13	1370.00	45.21	1994.00	65.80	810.00	26.73		
Millet Hay	lbs	0.029			4297.00	126.05						
GROSS REVENUES				248.10		356.57		175.11		142.15		108.09
CASH COSTS												
Wheat Seed	bu	9.00	1.50	13.50	1.50	13.50	1.50	13.50	1.50	13.50	1.50	13.50
Foxtail millet Seed	bu	18.00			0.28	5.10						
Fertilizer												
Anhydrous Ammonia (82-0-0)	lb	0.24	110.00	26.40	205.00	49.20	110.00	26.40	110.00	26.40	110.00	26.40
Diammonium Phosphate (18-46-0)	lb	0.15	50.00	7.50	100.00	15.00	50.00	7.50	50.00	7.50	50.00	7.50
Custom Fertilizer Application	acre	9.29	1.00	9.29	2.00	18.58	1.00	9.29	1.00	9.29	1.00	9.29
Herbicide												
Glyphosate	pint	3.50	5.00	17.50	2.50	8.75	3.50	12.25	3.50	12.25	3.50	12.25
AMS	Lb	0.24	6.80	1.63	3.40	0.82	5.10	1.22	5.10	1.22	5.10	1.22
2,4-D	pint	3.70	0.75	2.78			0.75	2.78	0.75	2.78	0.75	2.78
Custom Herbicide Application	acre	4.00	4.00	16.00	2.00	8.00	3.00	12.00	3.00	12.00	3.00	12.00
Insecticide												
Dimethoate	pint	4.00	0.75	3.00	0.75	3.00	0.75	3.00	0.75	3.00	0.75	3.00
Chlorpyrifos	pint	4.66	1.00	4.66	1.00	4.66	1.00	4.66				
Custom Pesticide Application	acre	4.00	2.00	8.00	2.00	8.00	2.00	8.00	1.00	4.00	1.00	4.00
Diesel Fuel	gallon	2.25	0.96	2.16	1.93	4.34	0.96	2.16	0.96	2.16	0.96	2.16
Lube	acre			0.32		0.65		0.32		0.32		0.32
Repair	acre			1.51		6.46		1.51		1.51		1.51
Annual Operating Capital	$	0.07	76.17	5.33	93.97	6.58	69.73	4.88	63.96	4.48	63.96	4.48
Wheat Custom Harvest & Haul												
Base Charge	acre	14.85					1.00	14.85	1.00	14.85	1.00	14.85
Excess for > 20 bu/a	bu	0.15					15.80	2.37	17.80	2.67	15.40	2.31
Hauling	bu	0.15					35.80	5.37	37.80	5.67	35.40	5.31
Millet and Wheat Hay Custom Harvest & Haul												
Base Charge for Mowing	acre	8.25	1.00	8.25	2.00	16.50						
Base Charge for Raking	acre	3.15	1.00	3.15	2.00	6.30						
Baling Large Round Bales	bale	13.20	5.01	66.17	7.81	103.13						
Hauling	bale	4.45	5.01	22.31	7.81	34.77						
TOTAL CASH COSTS				219.46		313.34		132.06		123.60		122.88
Machinery Fixed Costs				25.01		25.01		25.01		25.01		25.01
Return to Land, Labor, Mgmt, Risk, and Overhead	$/acre			3.62		18.22		18.04		-6.46		-39.80

ESF = wheat seeded in early September for forage-only, ESFM = wheat seeded in early September for forage-only with foxtail millet seeded as a summer forage double crop, ESD = wheat seeded in early September for dual-purpose (forage plus grain), LSD = wheat seeded in late September for dual-purpose (forage plus grain), OG = wheat seeded in mid October for grain-only

Table IV-6. Per Acre Production Returns and Cost Estimates for a Conventional Tillage 640-acre Farm

			Production System									
			ESF		ESFM		ESD		LSD		OG	
Item	Unit	Price	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
PRODUCTION												
Wheat												
Grain	bu	3.053					42.60	130.07	43.70	133.43	40.50	123.66
Hay	lbs	0.027	7106.00	188.31	6870.00	182.06						
Pasture	lbs	0.033	1299.00	42.87	1267.00	41.81	1694.00	55.90	734.00	24.22		
Millet Hay	lbs	0.029			3739.00	109.68						
GROSS RETURNS				231.18		333.54		185.97		157.65		123.66
CASH COSTS												
Wheat Seed	bu	9.00	1.50	13.50	1.50	13.50	1.50	13.50	1.50	13.50	1.50	13.50
Foxtail millet Seed	bu	18.00			0.28	5.10						
Fertilizer												
Anhydrous Ammonia (82-0-0)	lb	0.24	110.00	26.40	205.00	49.20	110.00	26.40	110.00	26.40	110.00	26.40
Diammonium Phosphate (18-46-0)	lb	0.15	50.00	7.50	100.00	15.00	50.00	7.50	50.00	7.50	50.00	7.50
Custom Fertilizer Application	acre	8.29	1.00	8.29	2.00	16.58	1.00	8.29	1.00	8.29	1.00	8.29
Insecticide												
Dimethoate	pt	4.00	0.75	3.00	0.75	3.00	0.75	3.00	0.75	3.00	0.75	3.00
Custom Pesticide Application	acre	4.00	1.00	4.00	1.00	4.00	1.00	4.00	1.00	4.00	1.00	4.00
Diesel Fuel	gallon	2.25	6.25	14.06	5.25	11.81	4.57	10.28	4.57	10.28	4.57	10.28
Lube	acre			2.11		1.77		1.54		1.54		1.54
Repair	acre			7.73		7.29		4.64		4.64		4.64
Annual Operating Capital	$	0.07	57.73	4.04	81.44	5.70	52.77	3.69	52.77	3.69	52.77	3.69
Wheat Custom Harvest & Haul												
Base Charge	acre	14.85					1.00	14.85	1.00	14.85	1.00	14.85
Excess for > 20 bu/a	bu	0.15					22.60	3.39	23.70	3.56	20.50	3.08
Hauling	bu	0.15					42.60	6.39	43.70	6.56	40.50	6.08
Millet and Wheat Hay Custom Harvest & Haul												
Base Charge for Mowing	acre	8.25	1.00	8.25	2.00	16.50						
Base Charge for Raking	acre	3.15	1.00	3.15	2.00	6.30						
Baling Large Round Bales	bale	13.20	4.92	64.91	7.34	96.91						
Hauling	bale	4.45	4.92	21.88	7.34	32.67						
TOTAL CASH COSTS				188.83		285.33		107.48		107.81		106.85
Machinery Fixed Costs				28.09		25.06		28.09		28.09		28.09
Return to Land, Labor, Mgmt, Risk, and Overhead	$/acre			14.26		23.15		50.41		21.75		-11.28

ESF = wheat seeded in early September for forage-only, ESFM = wheat seeded in early September for forage-only with foxtail millet seeded as a summer forage double crop, ESD= wheat seeded in early September for dual-purpose (forage plus grain), LSD= wheat seeded in late September for dual-purpose (forage plus grain), OG = wheat seeded in mid October for grain-only

Table IV-7. Per Acre Production Returns and Cost Estimates for a No-Tillage 2,560-acre Farm

			Production System									
			ESF		ESFM		ESD		LSD		OG	
Item	Unit	Price	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
PRODUCTION												
Wheat												
Grain	bu	3.053					35.80	109.31	37.80	115.42	35.40	108.09
Hay	lbs	0.027	7244.00	191.97	6993.00	185.31						
Pasture	lbs	0.033	1701.00	56.13	1370.00	45.21	1994.00	65.80	810.00	26.73		
Millet Hay	lbs	0.029			4297.00	126.05						
GROSS RETURNS				248.10		356.57		175.11		142.15		108.09
CASH COSTS												
Wheat Seed	bu	9.000	1.50	13.50	1.50	13.50	1.50	13.50	1.50	13.50	1.50	13.50
Foxtail millet Seed	bu	18.000			0.28	5.10						
Fertilizer												
Anhydrous Ammonia (82-0-0)	lb	0.240	110.00	26.40	205.00	49.20	110.00	26.40	110.00	26.40	110.00	26.40
Diammonium Phosphate (18-46-0)	lb	0.150	50.00	7.50	100.00	15.00	50.00	7.50	50.00	7.50	50.00	7.50
Herbicide												
Glyphosate	pt	3.500	5.00	17.50	2.50	8.75	3.50	12.25	3.50	12.25	3.50	12.25
AMS	lb	0.240	6.80	1.63	3.40	0.82	5.10	1.22	5.10	1.22	5.10	1.22
2,4-D	pt	3.700	0.75	2.78			0.75	2.78	0.75	2.78	0.75	2.78
Insecticide												
Dimethoate	pt	4.000	0.75	3.00	0.75	3.00	0.75	3.00	0.75	3.00	0.75	3.00
Chlorpyrifos	pint	4.660	1.00	4.66	1.00	4.66	1.00	4.66				
Diesel Fuel	gallon	2.250	2.70	6.08	4.00	9.00	2.70	6.08	2.70	6.08	2.70	6.08
Lube	acre			0.91		1.35		0.91		0.91		0.91
Repair	acre			7.64		22.26		7.64		7.64		7.64
Annual Operating Capital	$	0.070	61.06	4.27	85.02	5.95	57.29	4.01	54.18	3.79	54.18	3.79
Wheat Custom Harvest & Haul												
Base Charge	acre	14.850					1.00	14.85	1.00	14.85	1.00	14.85
Excess for > 20 bu/a	bu	0.150					15.80	2.37	17.80	2.67	15.40	2.31
Hauling	bu	0.150					35.80	5.37	37.80	5.67	35.40	5.31
Millet and Wheat Hay Custom Harvest & Haul												
Base Charge for Mowing	acre	8.250	1.00	8.25	2.00	16.50						
Base Charge for Raking	acre	3.150	1.00	3.15	2.00	6.30						
Baling Large Round Bales	bale	13.200	5.01	66.17	7.81	103.13						
Hauling	bale	4.450	5.01	22.31	7.81	34.77						
TOTAL CASH COSTS				195.75		299.29		112.54		108.26		107.54
Machinery Fixed Costs				17.97		17.97		17.97		17.97		17.97
Return to Land, Labor, Mgmt, Risk, and Overhead	$/acre			34.38		39.31		44.61		15.92		-17.42

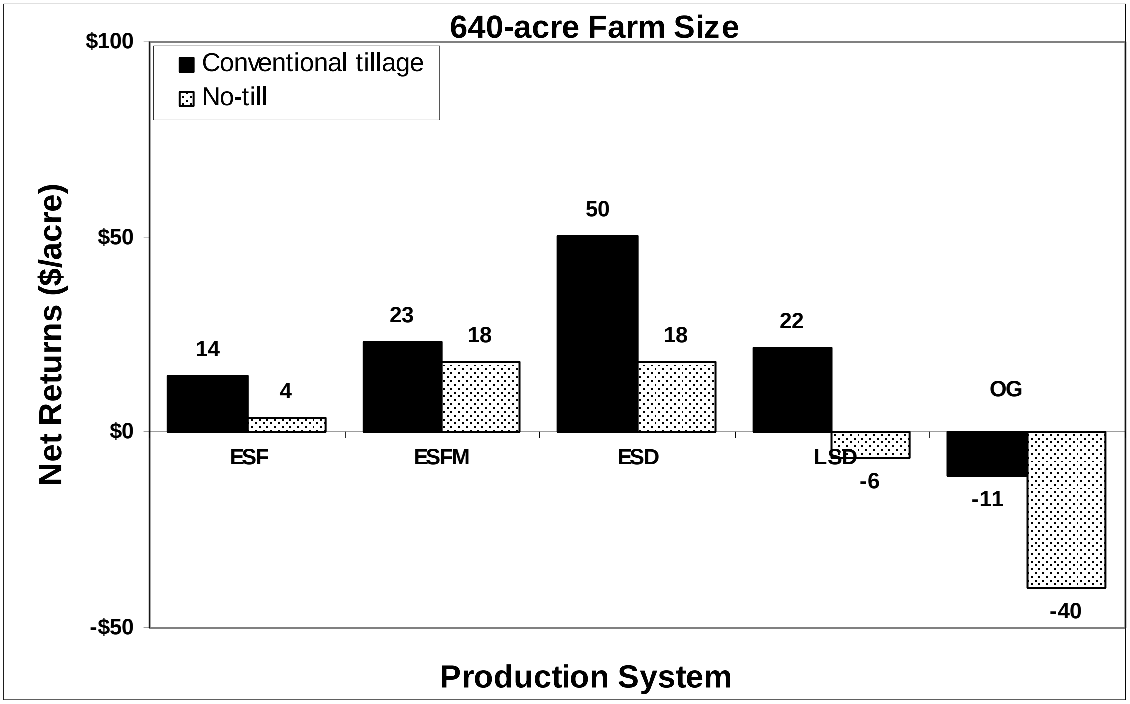
ESF = wheat seeded in early September for forage-only, ESFM = wheat seeded in early September for forage-only with foxtail millet seeded as a summer forage double crop, ESD= wheat seeded in early September for dual-purpose (forage plus grain), LSD = wheat seeded in late September for dual-purpose (forage plus grain), OG = wheat seeded in mid October for grain-only

Table IV-8. Per Acre Production Returns and Cost Estimates for a Conventional Tillage 2,560-acre Farm

			Production System									
			ESF		ESFM		ESD		LSD		OG	
Item	Unit	Price	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
PRODUCTION												
Wheat												
Grain	bu	3.053					42.60	130.07	43.70	133.43	40.50	123.66
Hay	lbs	0.027	7106.00	188.31	6870.00	182.06						
Pasture	lbs	0.033	1299.00	42.87	1267.00	41.81	1694.00	55.90	734.00	24.22		
Millet Hay	lbs	0.029			3739.00	109.68						
GROSS RETURNS				231.18		333.54		185.97		157.65		123.66
CASH COSTS												
Wheat Seed	bu	9.000	1.50	13.50	1.50	13.50	1.50	13.50	1.50	13.50	1.50	13.50
Foxtail millet Seed	bu	18.000			0.28	5.10						
Fertilizer												
Anhydrous Ammonia (82-0-0)	lb	0.240	110.00	26.40	205.00	49.20	110.00	26.40	110.00	26.40	110.00	26.40
Diammonium Phosphate (18-46-0)	lb	0.150	50.00	7.50	100.00	15.00	50.00	7.50	50.00	7.50	50.00	7.50
Insecticide												
Dimethoate	pt	4.000	0.75	3.00	0.75	3.00	0.75	3.00	0.75	3.00	0.75	3.00
Diesel Fuel	gallon	2.250	7.22	16.25	6.95	15.64	4.72	10.62	5.55	12.49	5.55	12.49
Lube	acre			2.44		2.35		1.59		1.87		1.87
Repair	acre			14.38		25.53		8.34		10.24		10.24
Annual Operating Capital	$	0.070	55.64	3.89	82.81	5.80	47.30	3.31	50.00	3.50	50.00	3.50
Wheat Custom Harvest & Haul												
Base Charge	acre	14.850					1.00	14.85	1.00	14.85	1.00	14.85
Excess for > 20 bu/a	bu	0.150					22.60	3.39	23.70	3.56	20.50	3.08
Hauling	bu	0.150					42.60	6.39	43.70	6.56	40.50	6.08
Millet and Wheat Hay Custom Harvest & Haul												
Base Charge for Mowing	acre	8.250	1.00	8.25	2.00	16.50						
Base Charge for Raking	acre	3.150	1.00	3.15	2.00	6.30						
Baling Large Round Bales	bale	13.200	4.92	64.91	7.34	96.91						
Hauling	bale	4.450	4.92	21.88	7.34	32.67						
TOTAL CASH COSTS				185.55		287.49		98.89		103.46		102.50
Machinery Fixed Costs				28.76		27.59		28.76		28.76		28.76
Return to Land, Labor, Mgmt., Risk, and Overhead	$/acre			16.86		18.46		58.32		25.43		-7.60

ESF = wheat seeded in early September for forage-only, ESFM = wheat seeded in early September for forage-only with foxtail millet seeded as a summer forage double crop, ESD= wheat seeded in early September for dual-purpose (forage plus grain), LSD= wheat seeded in late September for dual-purpose (forage plus grain), OG = wheat seeded in mid October for grain-only

Figure IV-9 is a chart of the net returns to land, labor, management, risk, and overhead for each of five production systems for both tillage systems for the 640-acre farm.

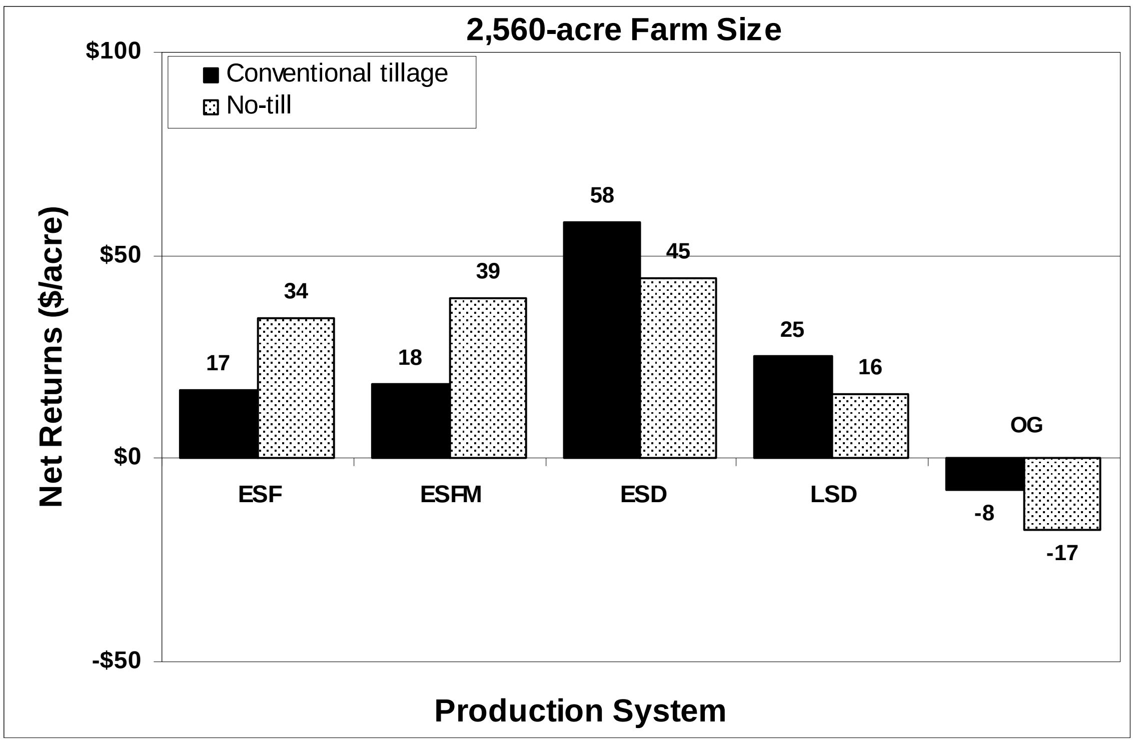


ESF = wheat seeded in early September for forage-only, ESFM = wheat seeded in early September for forage-only with foxtail millet seeded as a summer forage double crop, ESD = wheat seeded in early September for dual-purpose (forage plus grain), LSD = wheat seeded in late September for dual-purpose (forage plus grain), OG = wheat seeded in mid October for grain-only

Figure IV-9. Net returns to land, labor, management, risk, and overhead for a 640-acre farm from conventional tillage and no-till from five wheat production systems.

Net returns ranged from -$40 per acre for the OG no-till system to $50 per acre for the ESD conventional tillage system. For each of the three systems that included harvest of wheat grain (ESD, LSD, OG), the returns are from $26 to $30 per acre greater for the conventional tillage systems. Net returns were also greater for the conventional tillage systems that produced only forage and hay (ESF, ESFM). However, for the double-cropped ESFM system, the net returns were $5 per acre greater for the conventional tillage system. For the 640-acre farm, the double-cropped ESFM system added $6 per acre to net returns above the ESF system for conventional tillage and $15 per acre above the ESF system for no-till.

Figure IV-12 includes a chart of the net returns to land, labor, management, risk, and overhead for each of five production systems for both tillage systems for the 2,560-acre farm.



ESF = wheat seeded in early September for forage-only, ESFM = wheat seeded in early September for forage-only with foxtail millet seeded as a summer forage double crop, ESD = wheat seeded in early September for dual-purpose (forage plus grain), LSD = wheat seeded in late September for dual-purpose (forage plus grain), OG = wheat seeded in mid October for grain-only

Figure IV-10. Net returns to land, labor, management, risk, and overhead for a 2,560-acre farm from conventional tillage and no-till from five wheat production systems.

Net returns ranged from $58 per acre for the ESD conventional tillage system to -$17 per acre for the OG no-till system. For each of the three systems that included harvest of wheat grain (ESD, LSD, OG), the returns are from $5 to $10 per acre greater for the conventional tillage systems. However, net returns for systems that produced only forage and hay (ESF, ESFM) were $20 to $26 per acre greater for the no-till system than for the conventional tillage system.

For the systems that included grain harvest (ESD, LSD, OG), the economics of conventional tillage benefited from the 16% yield increase associated with conventional tillage. For both farm sizes, the conventional tillage ESD production system generates the greatest net returns. This finding is consistent with survey results reported by True et al. (2001) and Hossain et al. (2004) that found that most of the acres planted to wheat in the state are intended for dual-purpose.

For larger farms that intend to produce for forage-only, (ESF), no-till generates the most net returns. However, adding a foxtail millet double crop to the system (going from ESF to ESFM) added only $1 per acre net returns if under conventional tillage and $7 per acre if under no-till.

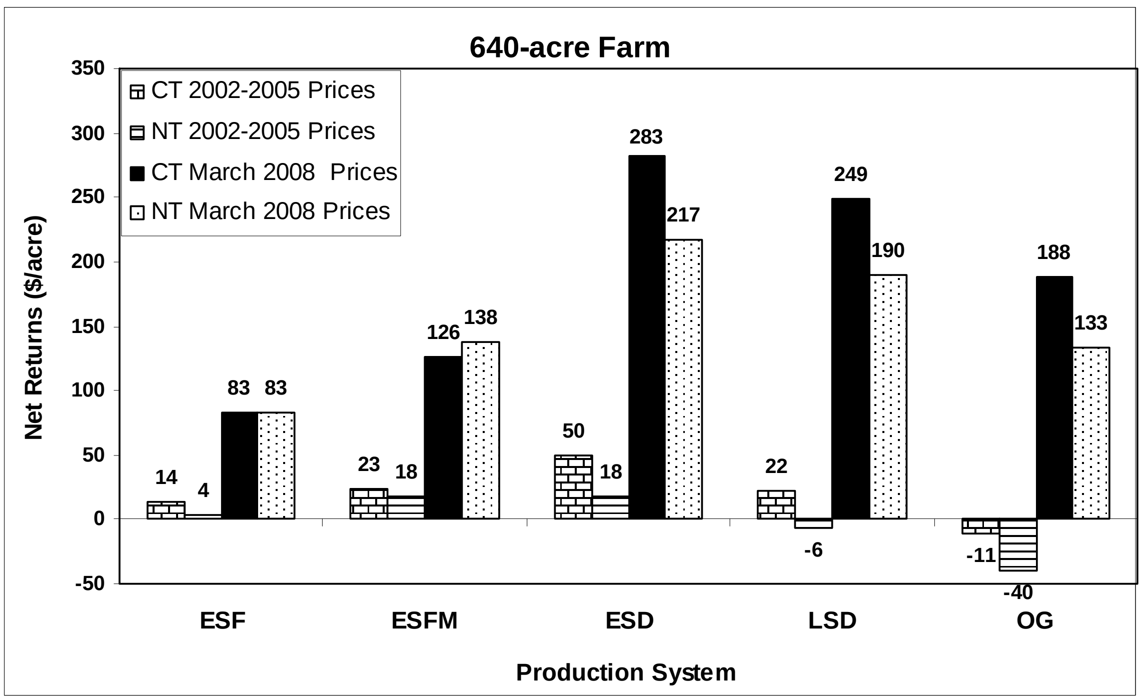
Price Sensitivity Analysis

Oklahoma farm prices have significantly changed over the last five years which presents a need for price sensitivity analysis. The prices used in the original economic budgets were averaged across the length of the study 2002-2005. Table IV-9 shows the prices from 2002-2005 and from March, 2008.

Table IV-9. Price Comparison for Commodity and Input Prices

	Unit	2002-2005 Prices	2008 Prices
Wheat		$	$
Grain	bu	3.05	9.00
Hay	ton	53.00	80.00
Pasture (per pound of gain)	lbs	0.33	0.50
Foxtail Millet Hay	ton	59.00	90.00
Fertilizer			
Anhydrous Ammonia (82-0-0)	lbs	0.24	0.35
Diammonium Phosphate (18-46-0)	lbs	0.15	0.35
Diesel Fuel	gallon	2.25	3.00

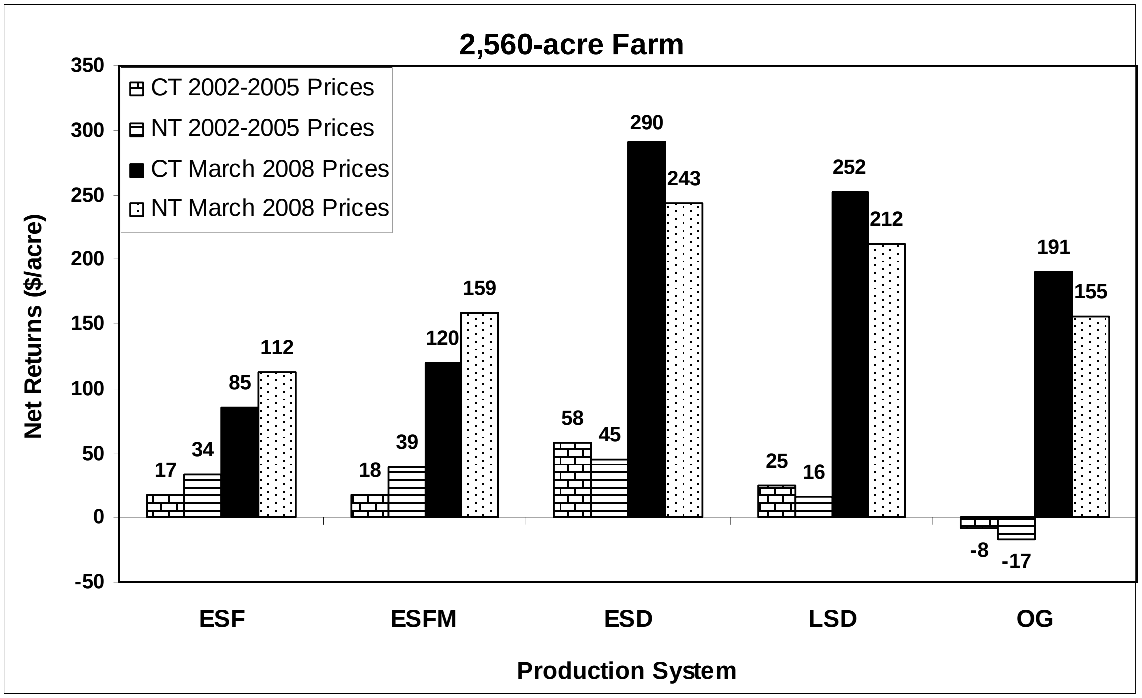
The net returns for the five production systems under no-till and conventional tillage increase substantially when using the March 2008 prices. Figure IV-11 shows the net return differences for a 640-acre farm. The net returns across all productions systems increased with the increase in prices. The Early September Dual-Purpose wheat system has the highest net returns of $283. The October Grain-only system under conventional tillage increased net return from -$11 to $188. When using the March 2008 prices, the early September forage only system reported the lowest net returns of $83 per acre.



ESF = wheat seeded in early September for forage-only, ESFM = wheat seeded in early September for forage-only with foxtail millet seeded as a summer forage double crop, ESD = wheat seeded in early September for dual-purpose (forage plus grain), LSD = wheat seeded in late September for dual-purpose (forage plus grain), OG = wheat seeded in mid October for grain-only

Figure IV-11. Comparison of per acre net returns to land, labor, management, risk, and overhead for a 640-acre farm.

Figure IV-12 shows the net return differences for a 2,560-acre farm.



ESF = wheat seeded in early September for forage-only, ESFM = wheat seeded in early September for forage-only with foxtail millet seeded as a summer forage double crop, ESD = wheat seeded in early September for dual-purpose (forage plus grain), LSD = wheat seeded in late September for dual-purpose (forage plus grain), OG = wheat seeded in mid October for grain-only

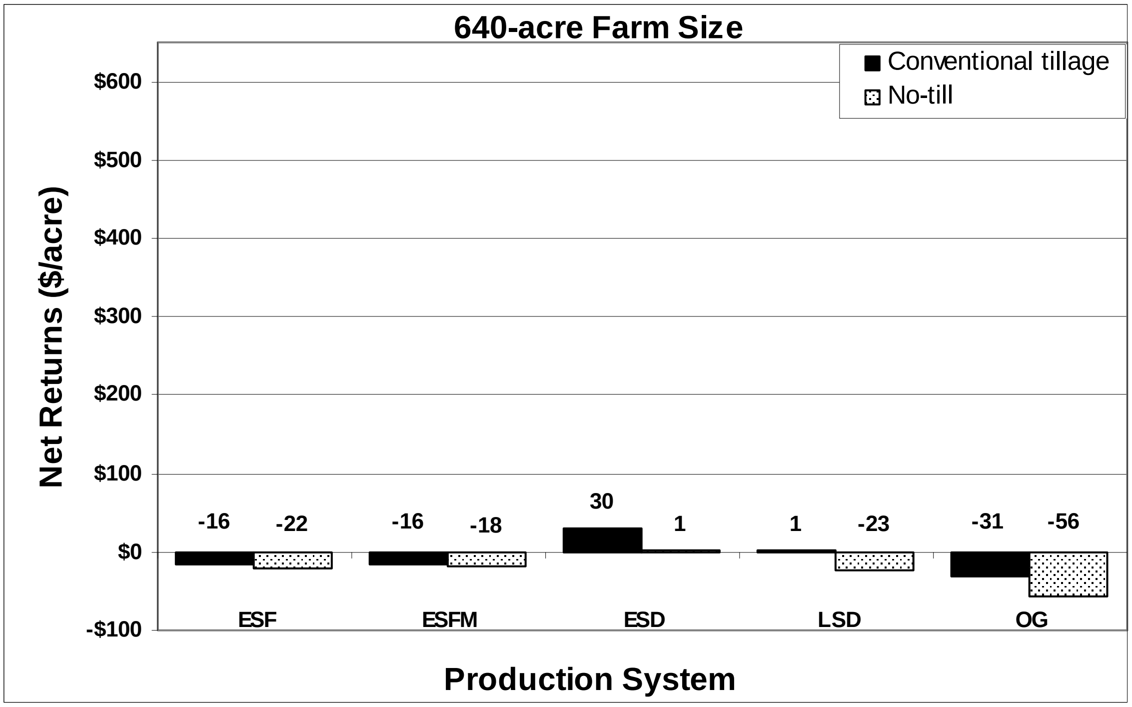
Figure IV-12. Comparison of net returns to land, labor, management, risk, and overhead for a 2,560-acre farm.

For the 2,560-acre farm, the net returns increased for all systems using the March 2008 prices. The system with the highest net returns was the Early September Dual purpose wheat using conventional tillage with net returns of $290. The system with the lowest net returns under the 2002-2005 prices was the no-till October grain only system, and under the March 2008 prices, the early September forage only conventional tillage system had the lowest net returns of $85. The net returns ranged from $58 to -$17 when using the 2002-2005 prices, however when using March 2008 prices, the net returns ranged from $290 to $85 which is significantly higher than the 2002-2005 net returns.

Price sensitivity analysis was also conducted to determine the sensitivity of results to differing price levels of wheat grain, forage, hay and foxtail millet hay. The average 2002-2005 input prices were used. The procedures for price sensitivity analysis were the same for both the 640-acre farm and the 2,560-acre farm. The base prices used for the analysis are slightly different from those used in the original enterprise budgets for the sake of simplicity. The base prices used are $3.00 per bushel for the wheat grain price. Wheat Hay base price was $50 per ton, or $0.025 per pound. The millet hay price was $10 higher for reasons previously explained making the base price $0.03 per pound. The base price for forage was $0.03.

Three possible hay prices of $50, $100, and $150 per ton were converted into a per pound price and used for evaluation of the wheat hay. For the millet hay, $10 was added to each of the possible wheat hay prices, which created a possible $60, $110, and $160 per ton price. In the analysis, it was assumed that if the price of wheat hay increased, the price of millet hay would increase by the same amount. Two fall winter wheat forage prices were considered: a base forage price of $0.03 per pound, and an alternative $0.05 per pound. Three possible prices of wheat evaluated were $3.00, $6.00, and $9.00 per bushel.

<u>640-acre Farm.</u> Figure IV-17 shows the net returns for each production system and each tillage method for the 640-acre farm using the base prices.



ESF = wheat seeded in early September for forage-only, ESFM = wheat seeded in early September for forage-only with foxtail millet seeded as a summer forage double crop, ESD = wheat seeded in early September for dual-purpose (forage plus grain), LSD = wheat seeded in late September for dual-purpose (forage plus grain), OG = wheat seeded in mid October for grain-only

Figure IV-13. Net Returns for a 640-acre Farm Using Base Prices

When wheat prices increase, and hay and forage price remain the same, the ESD system for no-till and conventional tillage continue to produce the greatest returns. Figures IV-18 and IV-19 include charts of net returns for each system using $6 per bushel, and $9 per bushel for wheat grain, respectively. The grain prices increase, and given this set of yields and data, the producer would still produce wheat under a dual purpose system. The grain only system would still not be favored under no-till or conventional till.

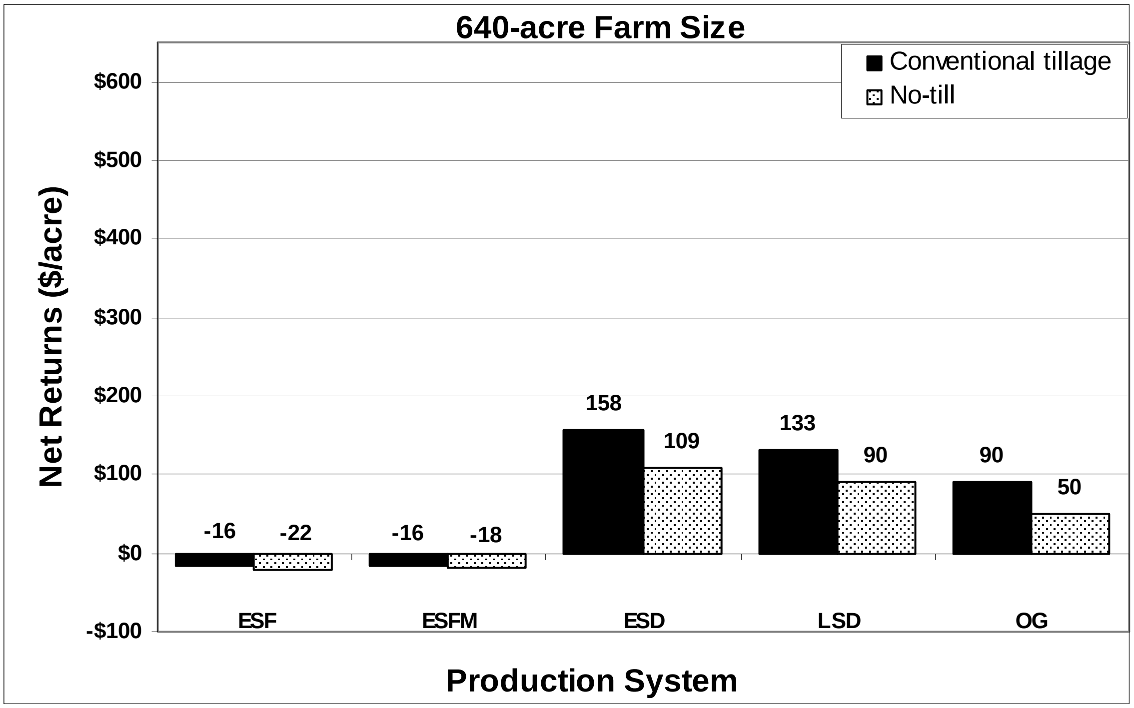


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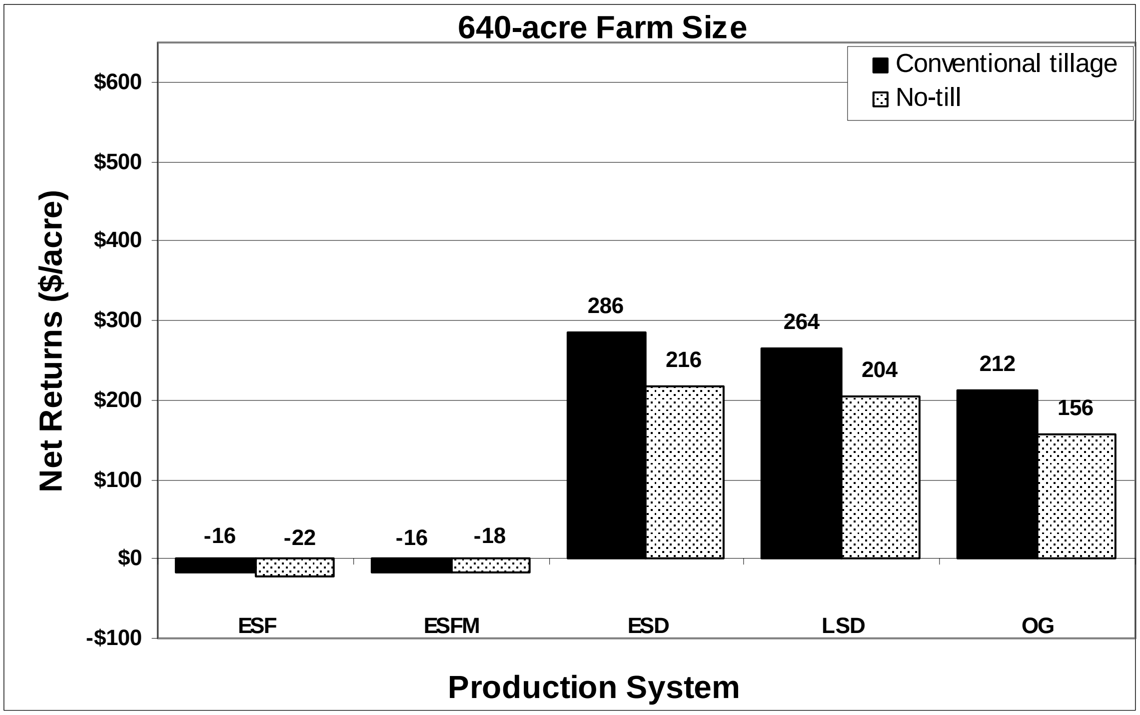
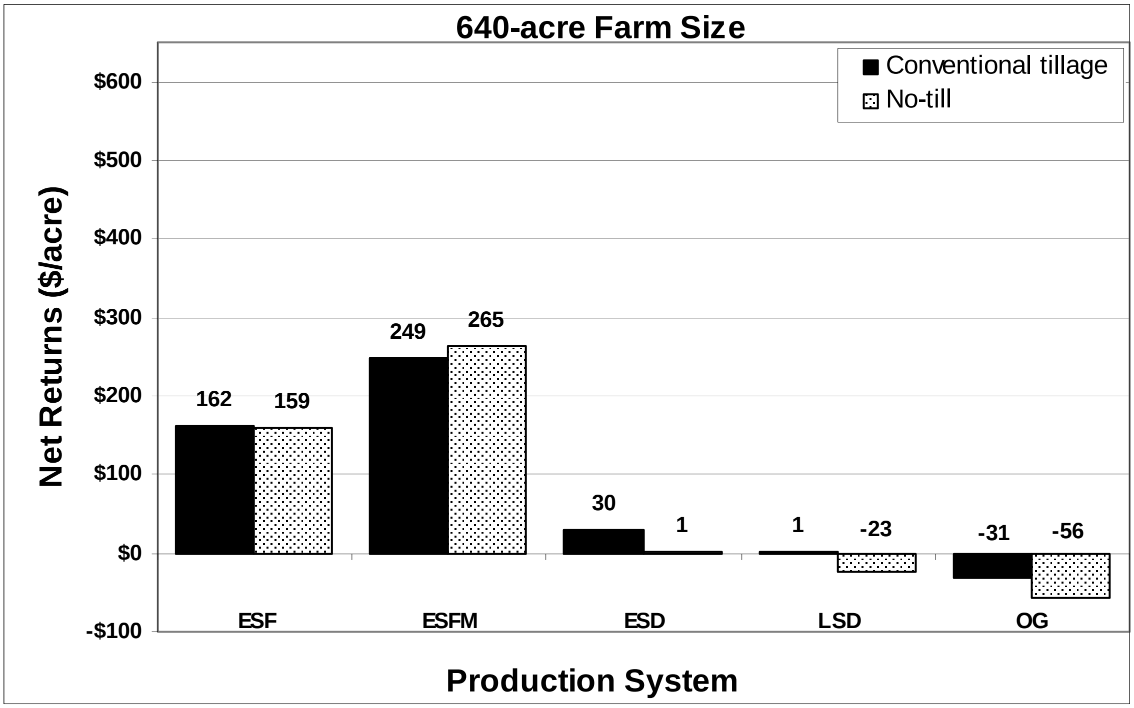
Figure IV-14. Per Acre Net Returns for a 640-acre Farm with wheat grain price of $6/bu, forage price of $0.03/lbDM, wheat hay price of $0.025/lbDM, and millet hay price of $0.03/lbDM.



ESF = wheat seeded in early September for forage-only, ESFM = wheat seeded in early September for forage-only with foxtail millet seeded as a summer forage double crop, ESD = wheat seeded in early September for dual-purpose (forage plus grain), LSD = wheat seeded in late September for dual-purpose (forage plus grain), OG = wheat seeded in mid October for grain-only

Figure IV-15. Per Acre Net Returns for a 640-acre Farm with wheat grain price of $9/bu, forage price of $0.03/lbDM, wheat hay price of $0.025/lbDM, and millet hay price of $0.03/lbDM.

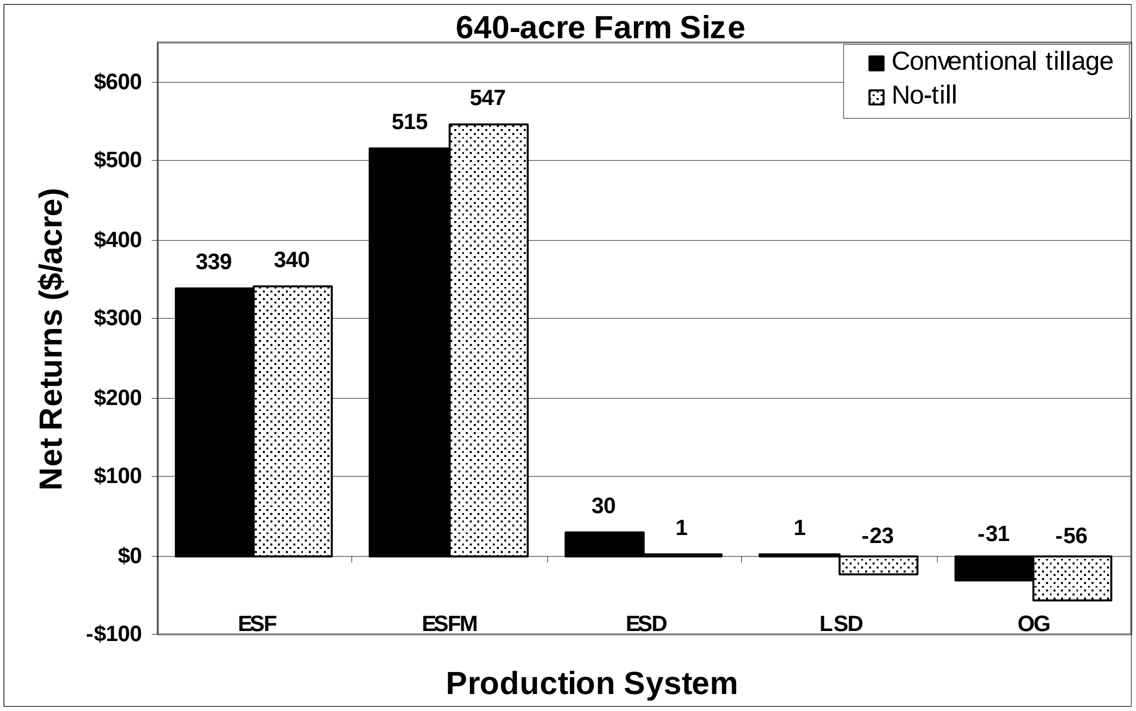
Figure IV-20 includes a chart with wheat hay prices set at $100 per ton, or $0.05 per pound, and then millet hay prices set at $110 per ton, or $0.055 per pound. In this case, the price change only affects two systems, the ESF, and the ESFM systems. If the price of hay increases and the price of wheat and forage are held constant, the producers would use the ESFM system, which produces wheat hay and foxtail millet hay, or the ESF system. The other three systems would produce significantly lower net returns in comparison.



ESF = wheat seeded in early September for forage-only, ESFM = wheat seeded in early September for forage-only with foxtail millet seeded as a summer forage double crop, ESD = wheat seeded in early September for dual-purpose (forage plus grain), LSD = wheat seeded in late September for dual-purpose (forage plus grain), OG = wheat seeded in mid October for grain-only

Figure IV-16. Per Acre Net Returns for a 640-acre Farm with wheat grain price of $3/bu, forage price of $0.03/lbDM, wheat hay price of $0.05/lbDM, and millet hay price of $0.055/lbDM.

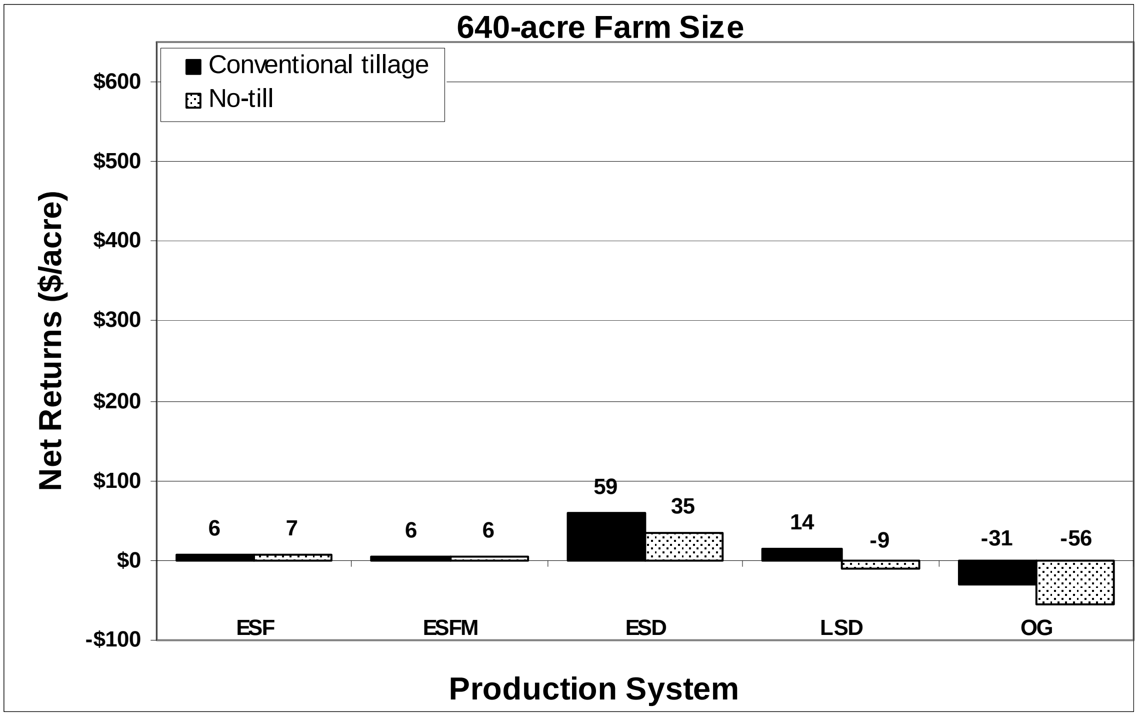
When wheat hay prices are increased to $150 per ton or $0.075 per pound and millet hay prices are set at $160 per ton, or $0.08 per pound, the results are similar to those reported in Figure IV-20, but showing greater net returns for the ESF and ESFM systems. Figure IV-21 shows the results.



ESF = wheat seeded in early September for forage-only, ESFM = wheat seeded in early September for forage-only with foxtail millet seeded as a summer forage double crop, ESD = wheat seeded in early September for dual-purpose (forage plus grain), LSD = wheat seeded in late September for dual-purpose (forage plus grain), OG = wheat seeded in mid October for grain-only

Figure IV-17. Per Acre Net Returns for a 640-acre Farm with wheat grain price of $3/bu, forage price of $0.03/lbDM, wheat hay price of $0.075/lbDM, and millet hay price of $0.08/lbDM.

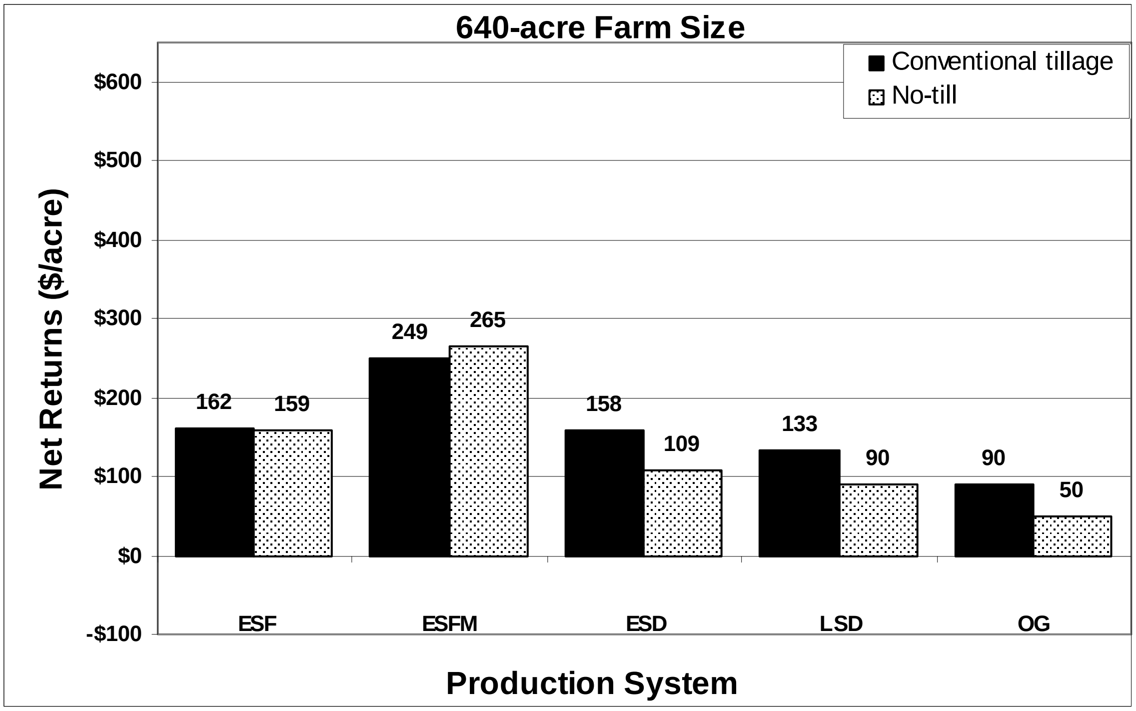
The final single price change comparison is an increased forage price from $0.03 to $0.05 per pound. When the forage price increases, net return for every system but OG is increased; however the system with the highest net returns is still the ESD. Figure IV-22 includes a chart of the net returns for each system when the price of forage increases.



ESF = wheat seeded in early September for forage-only, ESFM = wheat seeded in early September for forage-only with foxtail millet seeded as a summer forage double crop, ESD = wheat seeded in early September for dual-purpose (forage plus grain), LSD = wheat seeded in late September for dual-purpose (forage plus grain), OG = wheat seeded in mid October for grain-only

Figure IV-18. Per Acre Net Returns for a 640-acre Farm with wheat grain price of $3/bu, forage price of $0.05/lbDM, wheat hay price of $0.025/lbDM, and millet hay price of $0.03/lbDM.

Next, if the price of wheat increases to $6 per bushel, and the price of hay increases as well, the net returns for the ESF and the ESFM systems have the highest net returns when compared to the other systems. Figure IV-23 includes a graph showing the net returns for all systems when the price of wheat is $6 per bushel, the price of wheat hay is $0.05 per pound, and the millet hay price is $0.055 per pound.



ESF = wheat seeded in early September for forage-only, ESFM = wheat seeded in early September for forage-only with foxtail millet seeded as a summer forage double crop, ESD = wheat seeded in early September for dual-purpose (forage plus grain), LSD = wheat seeded in late September for dual-purpose (forage plus grain), OG = wheat seeded in mid October for grain-only

Figure IV-19. Per Acre Net Returns for a 640-acre Farm with wheat grain price of $6/bu, forage price of $0.03/lbDM, wheat hay price of $0.05/lbDM, and millet hay price of $0.055/lbDM.

With an increase in grain and hay price, each system has positive net returns. The ESD system is no longer the system with the highest net returns, and producers would receive the highest return under the ESFM system, followed by the ESF system. The range of returns for the systems under this set of prices is $52 to $268. When the price of hay is increased to $0.075 for wheat hay and $0.08 for millet hay, the range of net returns is significantly greater. Figure IV-24 includes a graph with the price of wheat at $6, and the price of hay increased to $0.075 and $0.08.

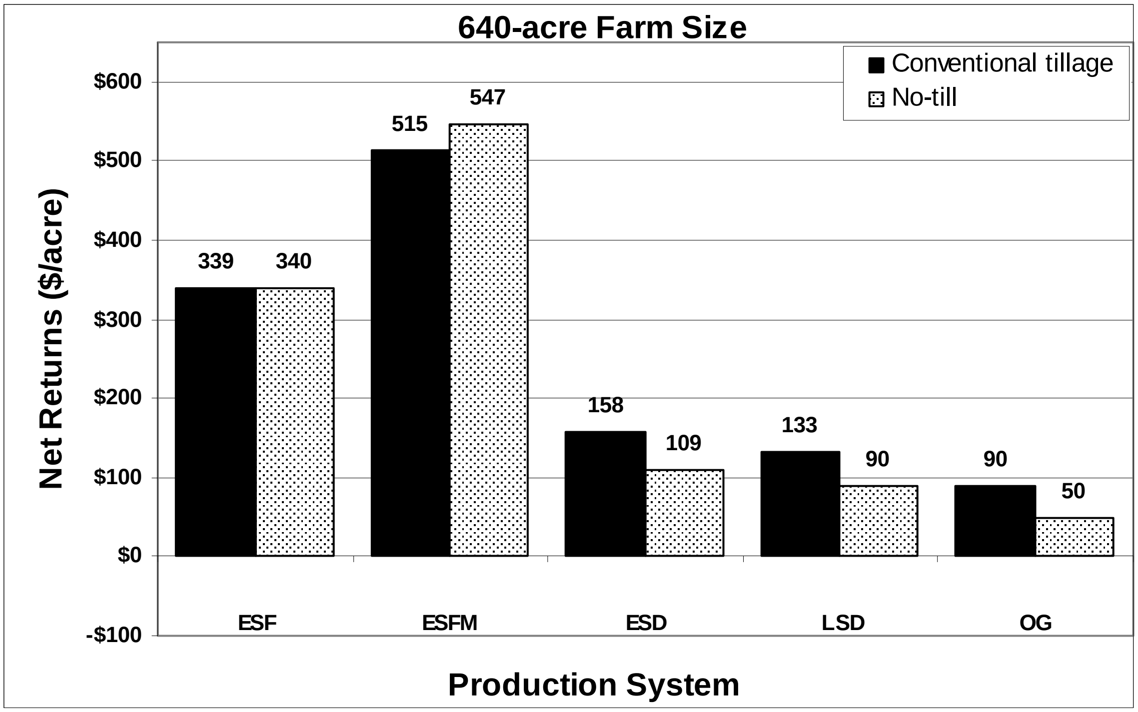


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Figure IV-20. Per Acre Net Returns for a 640-acre Farm with wheat grain price of $6/bu, forage price of $0.03/lbDM, wheat hay price of $0.075/lbDM, and millet hay price of $0.08/lbDM.

The range of returns under this set of prices is from $52 to $550, which shows that when the price of hay increases by $50 per ton, the net returns for the ESFM and the ESF systems increase and producers would want to switch to this type of production system.

Increasing the price of wheat to $9 per bushel and increasing hay prices shows a change in the net returns and the optimal production system. Recall that with only an increase in the wheat price to $9 per bushel, the optimal system was still ESD, which is also the case when hay price is increased to $0.05 and $0.055. The range of the returns was $6 to $286. When the price of hay increases to $0.05 and $0.055, as shown in Figure IV-25, the range of returns is from $158 to $286.

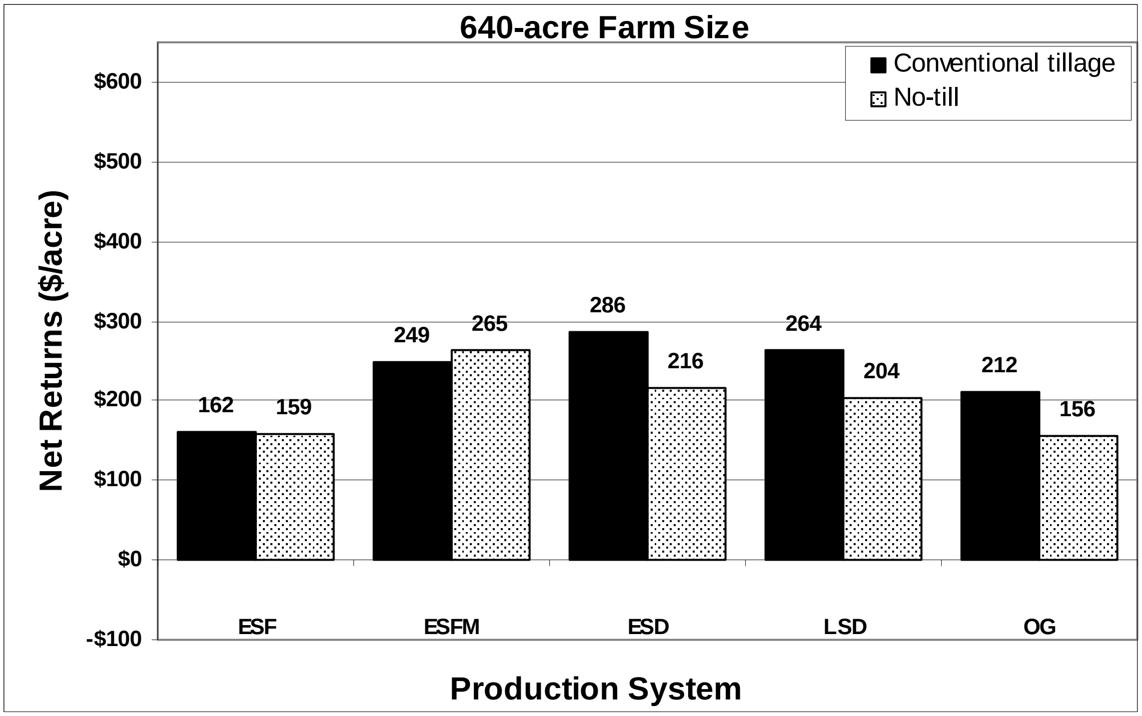

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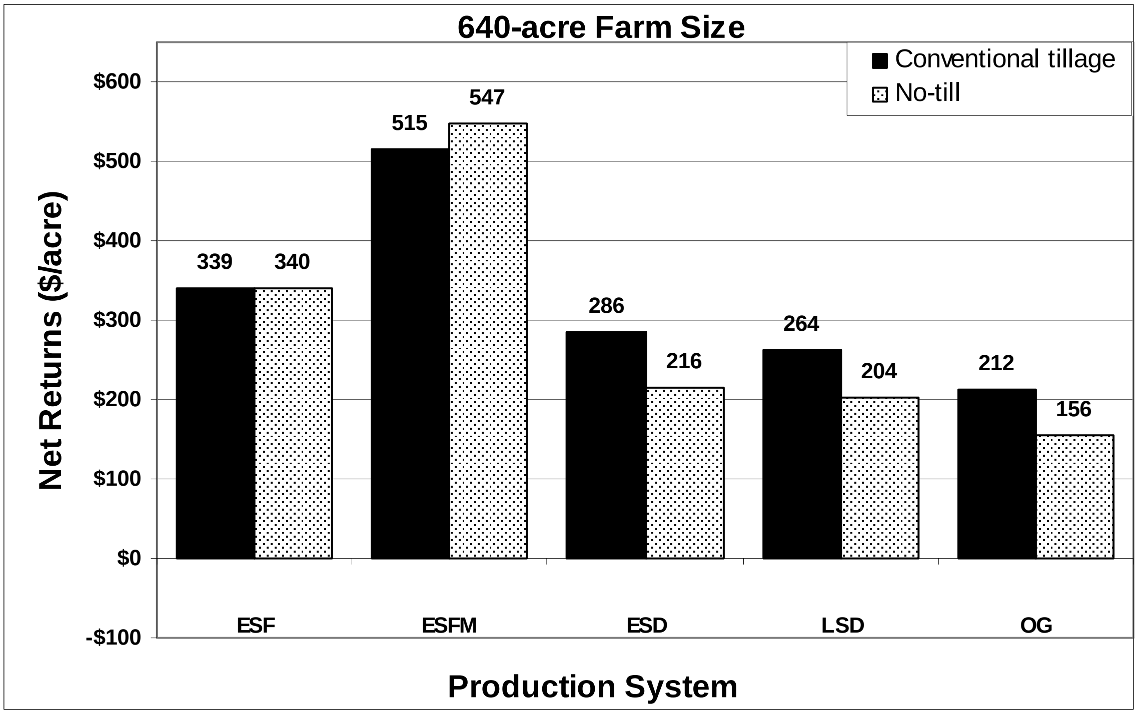
Figure IV-21. Per Acre Net Returns for a 640-acre Farm with wheat grain price of \$9/bu, forage price of \$0.03/lbDM, wheat hay price of \$0.05/lbDM, and millet hay price of \$0.055/lbDM.

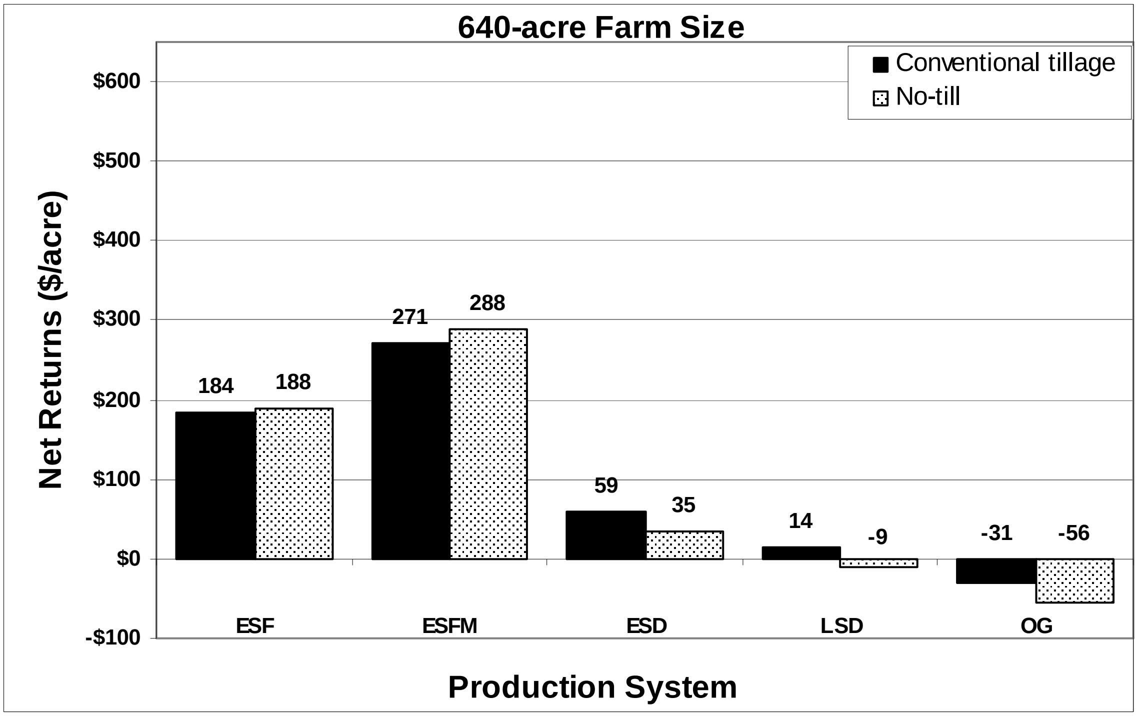
In Figure IV-25, the ESD system still generates the highest return given the set of prices, but if the price of hay is increased to \$0.075 and \$0.08, the results change. Figure IV-26 includes a chart of the returns with \$9 per bushel wheat, and increased hay prices.



ESF = wheat seeded in early September for forage-only, ESFM = wheat seeded in early September for forage-only with foxtail millet seeded as a summer forage double crop, ESD = wheat seeded in early September for dual-purpose (forage plus grain), LSD = wheat seeded in late September for dual-purpose (forage plus grain), OG = wheat seeded in mid October for grain-only

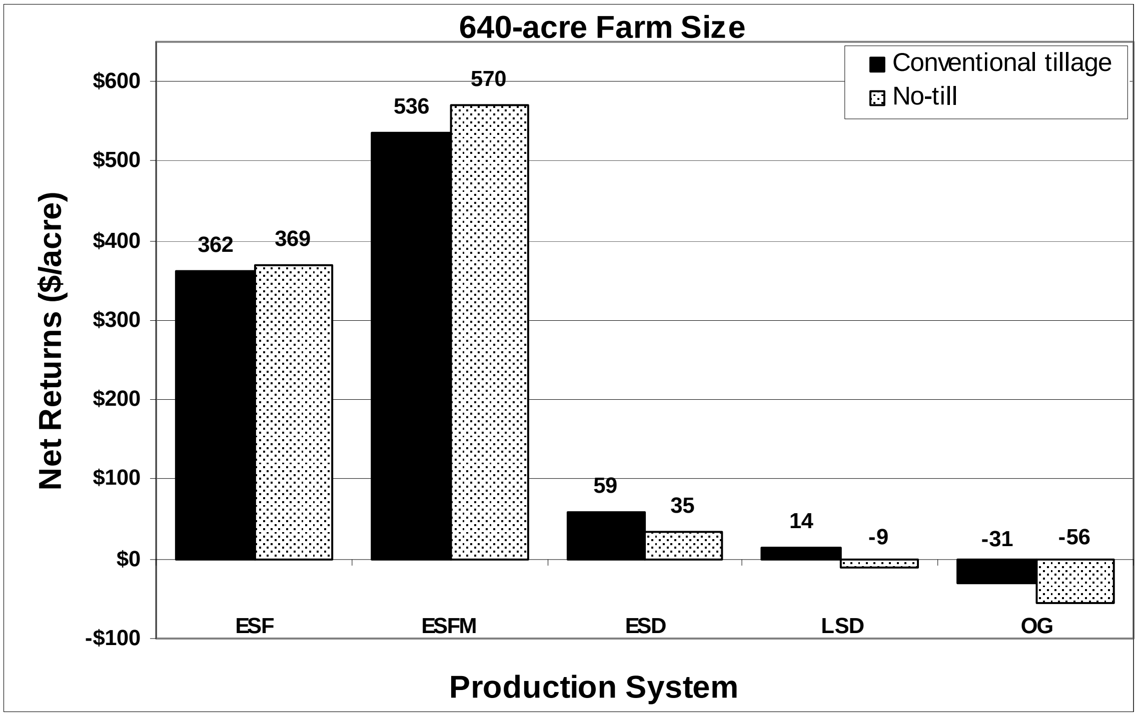
Figure IV-22. Per Acre Net Returns for a 640-acre Farm with wheat grain price of $9/bu, forage price of $0.03/lbDM, wheat hay price of $0.075/lbDM, and millet hay price of $0.08/lbDM.

The next combination of prices observed were $3 per bushel wheat, with increasing forage and hay prices. When the price of hay increases from $0.025 and $0.03 to $0.05 and $0.055, and the forage price increases from $0.03 to $0.05, the ESF and the ESFM systems show much larger net returns. The ESD, LSD increase slightly due to the higher forage price, and the OG system remains the same. Figure IV-27 includes a chart of the results. Figure IV-28 shows the net returns using the second increase in the hay prices.



ESF = wheat seeded in early September for forage-only, ESFM = wheat seeded in early September for forage-only with foxtail millet seeded as a summer forage double crop, ESD = wheat seeded in early September for dual-purpose (forage plus grain), LSD = wheat seeded in late September for dual-purpose (forage plus grain), OG = wheat seeded in mid October for grain-only

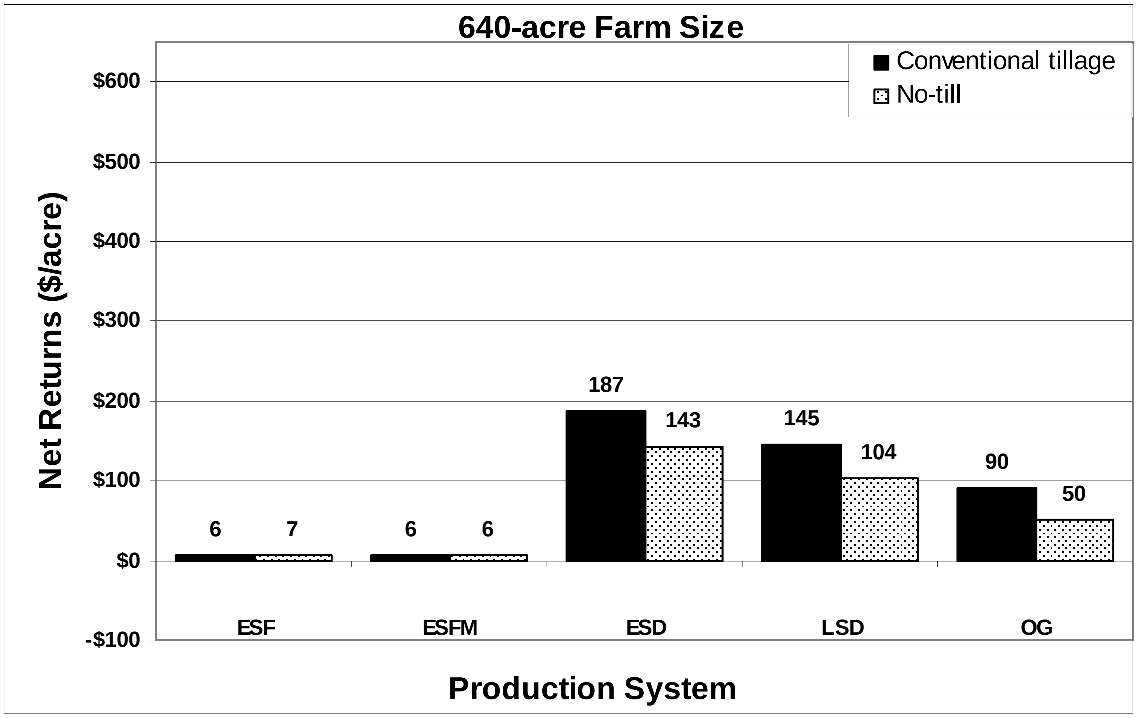
Figure IV-23. Per Acre Net Returns for a 640-acre Farm with wheat grain price of $3/bu, forage price of $0.05/lbDM, wheat hay price of $0.05/lbDM, and millet hay price of $0.055/lbDM.



ESF = wheat seeded in early September for forage-only, ESFM = wheat seeded in early September for forage-only with foxtail millet seeded as a summer forage double crop, ESD = wheat seeded in early September for dual-purpose (forage plus grain), LSD = wheat seeded in late September for dual-purpose (forage plus grain), OG = wheat seeded in mid October for grain-only

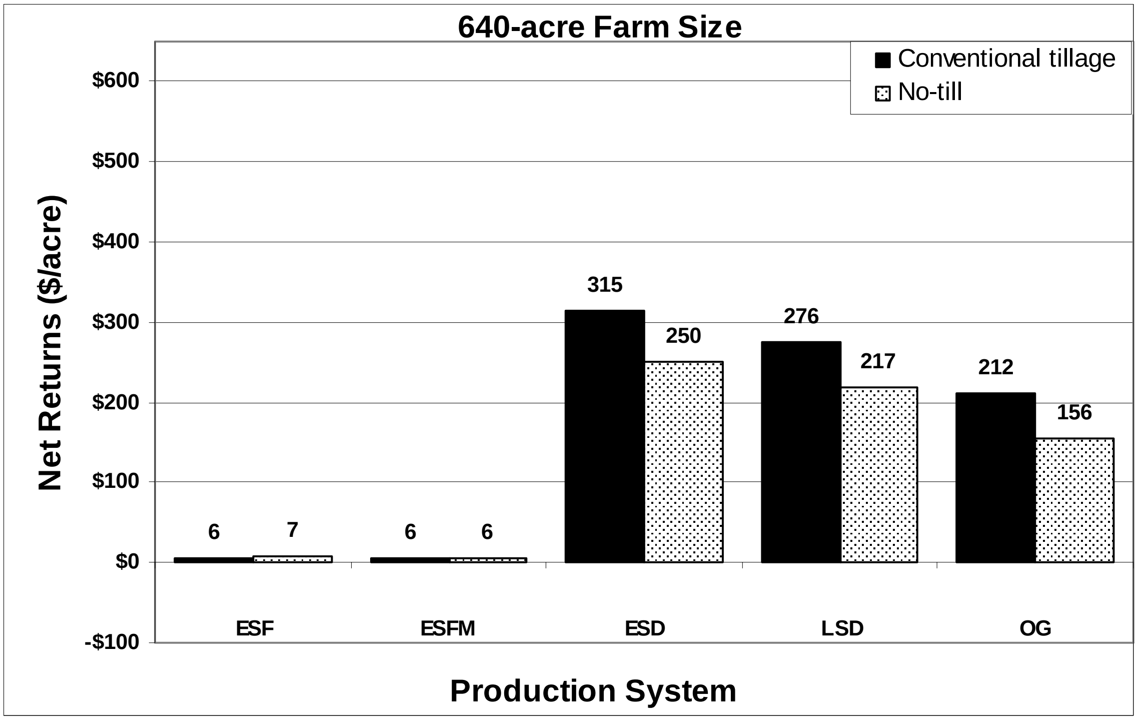
Figure IV-24. Per Acre Net Returns for a 640-acre Farm with wheat grain price of $3/bu, forage price of $0.05/lbDM, wheat hay price of $0.075/lbDM, and millet hay price of $0.08/lbDM.

The next price combination to evaluate is comparing rising wheat prices and rising forage prices. Figure IV-29 shows the net returns when the price of wheat is $6, and the forage price is $0.05. Figure IV-30 shows the returns when the price of wheat at $9, and the price of forage is $0.05. In both cases, the ESD and the LSD systems show the highest net returns compared to the other systems.



ESF = wheat seeded in early September for forage-only, ESFM = wheat seeded in early September for forage-only with foxtail millet seeded as a summer forage double crop, ESD = wheat seeded in early September for dual-purpose (forage plus grain), LSD = wheat seeded in late September for dual-purpose (forage plus grain), OG = wheat seeded in mid October for grain-only

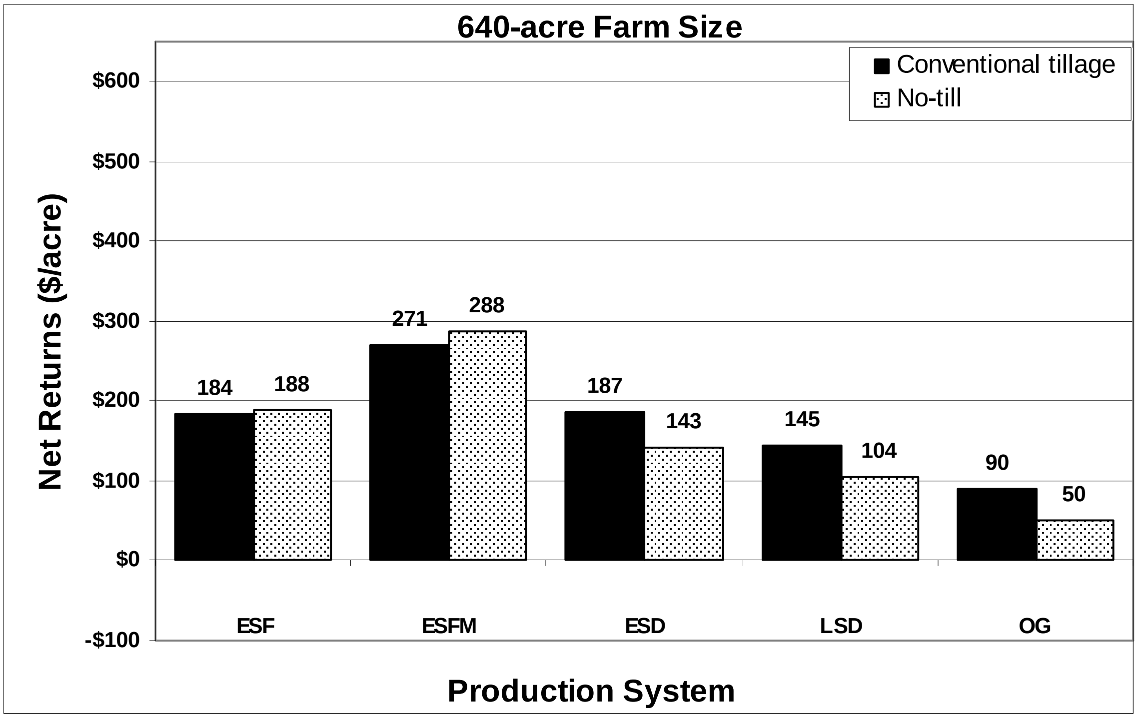
Figure IV-25. Per Acre Net Returns for a 640-acre Farm with wheat grain price of $6/bu, forage price of $0.05/lbDM, wheat hay price of $0.025/lbDM, and millet hay price of $0.03/lbDM.



ESF = wheat seeded in early September for forage-only, ESFM = wheat seeded in early September for forage-only with foxtail millet seeded as a summer forage double crop, ESD = wheat seeded in early September for dual-purpose (forage plus grain), LSD = wheat seeded in late September for dual-purpose (forage plus grain), OG = wheat seeded in mid October for grain-only

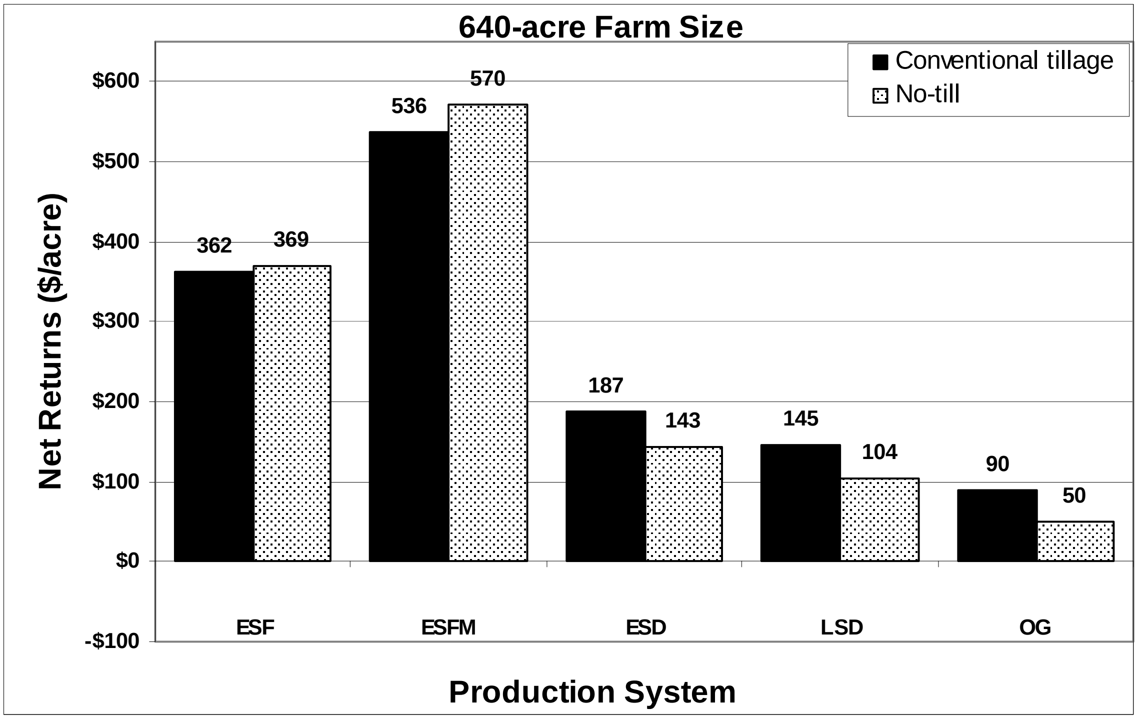
Figure IV-26. Per Acre Net Returns for a 640-acre Farm with wheat grain price of $9/bu, forage price of $0.05/lbDM, wheat hay price of $0.025/lbDM, and millet hay price of $0.03/lbDM.

The last piece of the price sensitivity analysis for these systems is to consider a combination of prices increasing at the same time at different levels. Figure IV-31 shows net returns when the price of wheat is $6, hay price is $0.05, and $0.055, and the forage price is $0.05. Due to the high hay prices, the ESFM system shows the highest net return. Figure IV-32 displays wheat prices of $6, hay prices of $0.075, and $0.08, and a forage price of $0.05. Given this set of prices the net returns are highest for the ESFM system followed by the ESF systems.



ESF = wheat seeded in early September for forage-only, ESFM = wheat seeded in early September for forage-only with foxtail millet seeded as a summer forage double crop, ESD = wheat seeded in early September for dual-purpose (forage plus grain), LSD = wheat seeded in late September for dual-purpose (forage plus grain), OG = wheat seeded in mid October for grain-only

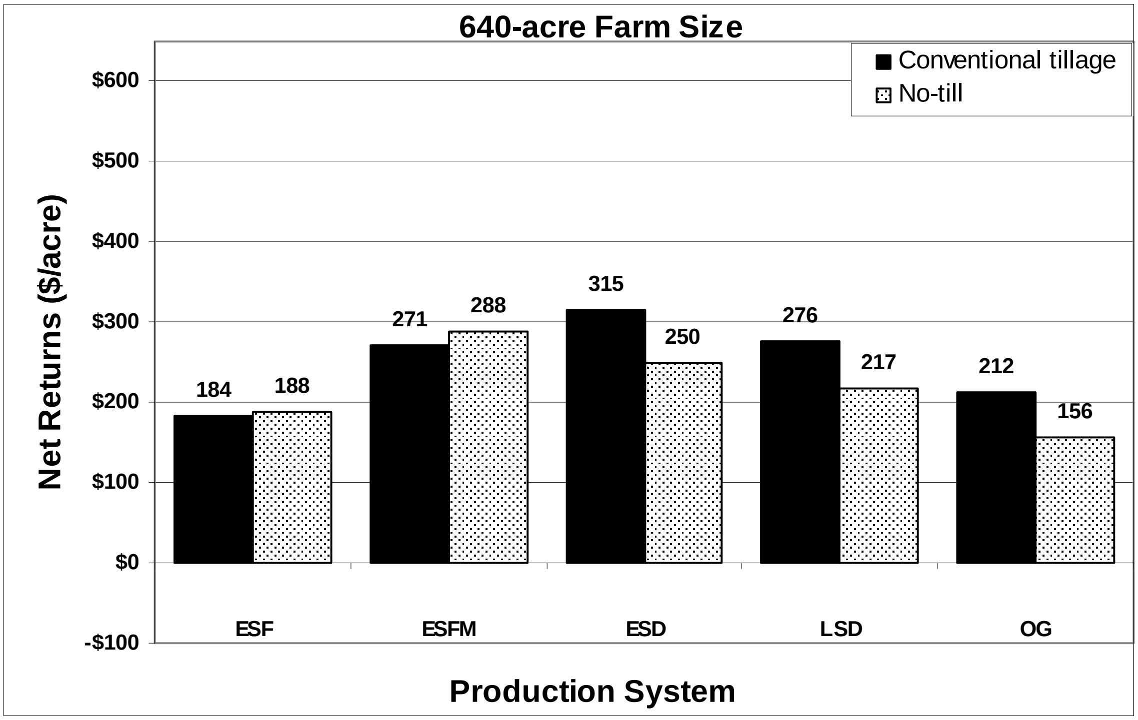
Figure IV-27. Per Acre Net Returns for a 640-acre Farm with wheat grain price of $6/bu, forage price of $0.05/lbDM, wheat hay price of $0.05/lbDM, and millet hay price of $0.055/lbDM.



ESF = wheat seeded in early September for forage-only, ESFM = wheat seeded in early September for forage-only with foxtail millet seeded as a summer forage double crop, ESD = wheat seeded in early September for dual-purpose (forage plus grain), LSD = wheat seeded in late September for dual-purpose (forage plus grain), OG = wheat seeded in mid October for grain-only

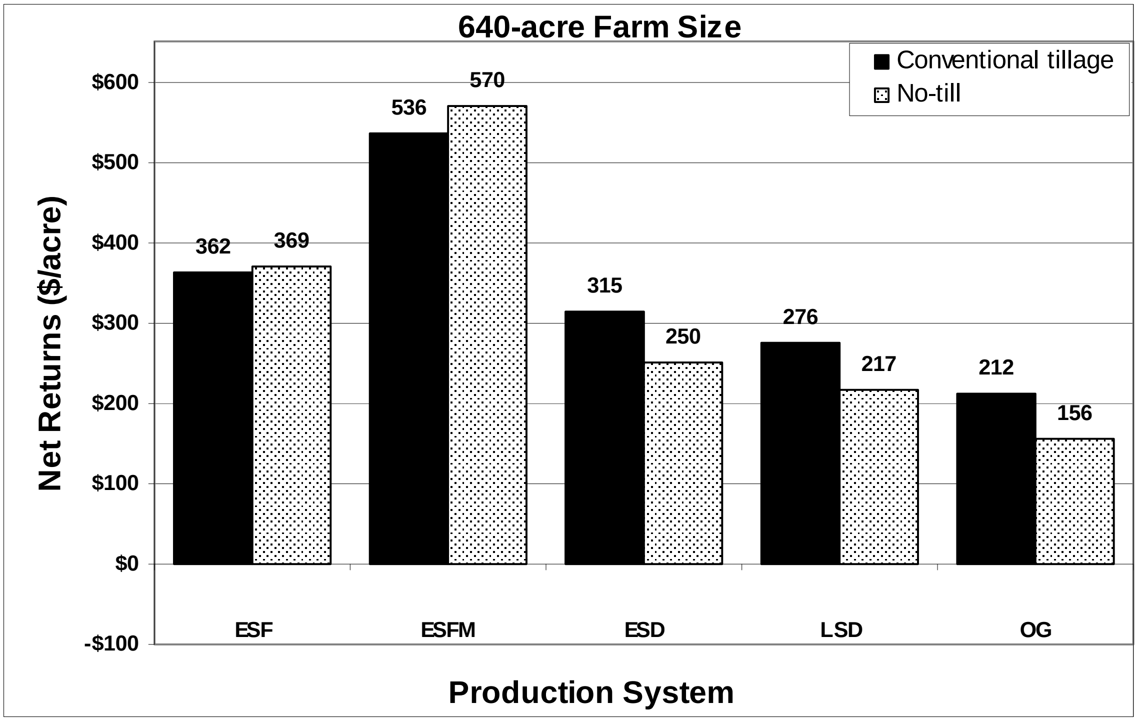
Figure IV-28. Per Acre Net Returns for a 640-acre Farm with wheat grain price of $6/bu, forage price of $0.05/lbDM, wheat hay price of $0.075/lbDM, and millet hay price of $0.08/lbDM.

The last set of charts shows the changes when the price of wheat is $9, the hay prices increase, and the forage price is $0.05. Figure IV-33 shows hay prices at $0.05, and $0.055. Figure IV-34 shows the hay prices of $0.075, and $0.08.



ESF = wheat seeded in early September for forage-only, ESFM = wheat seeded in early September for forage-only with foxtail millet seeded as a summer forage double crop, ESD = wheat seeded in early September for dual-purpose (forage plus grain), LSD = wheat seeded in late September for dual-purpose (forage plus grain), OG = wheat seeded in mid October for grain-only

Figure IV-29. Per Acre Net Returns for a 640-acre Farm with wheat grain price of $9/bu, forage price of $0.05/lbDM, wheat hay price of $0.05/lbDM, and millet hay price of $0.055/lbDM.

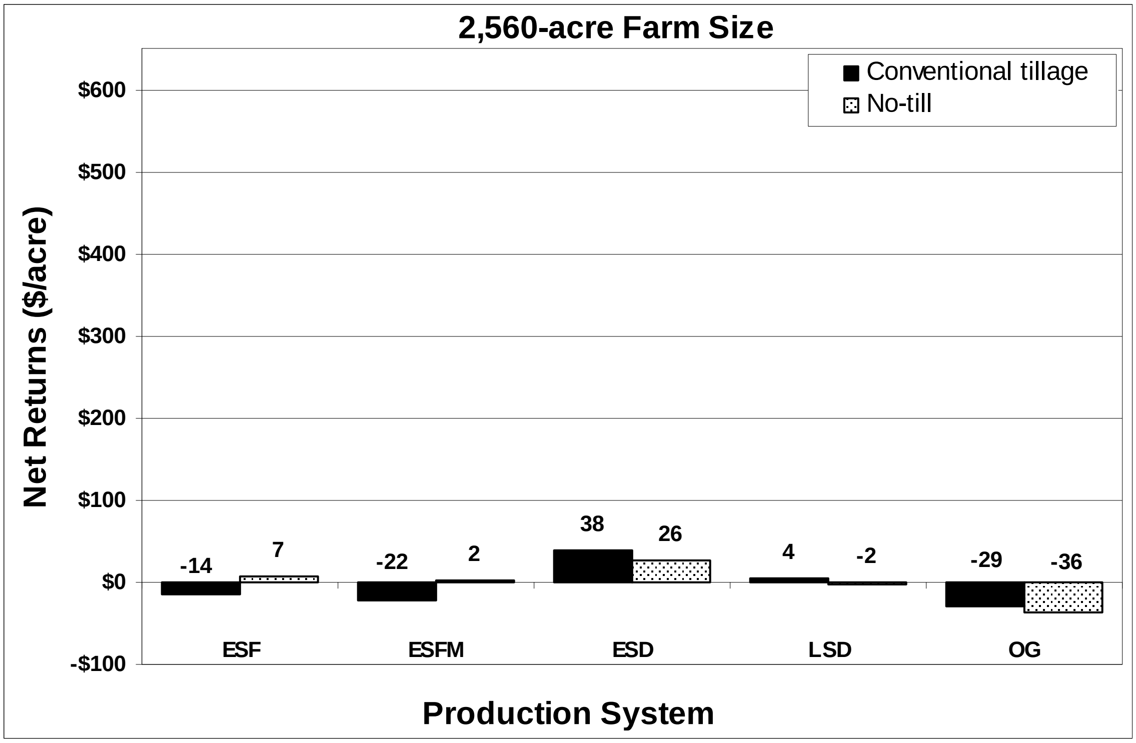


ESF = wheat seeded in early September for forage-only, ESFM = wheat seeded in early September for forage-only with foxtail millet seeded as a summer forage double crop, ESD = wheat seeded in early September for dual-purpose (forage plus grain), LSD = wheat seeded in late September for dual-purpose (forage plus grain), OG = wheat seeded in mid October for grain-only

Figure IV-30. Per Acre Net Returns for a 640-acre Farm with wheat grain price of $9/bu, forage price of $0.05/lbDM, wheat hay price of $0.075/lbDM, and millet hay price of $0.08/lbDM.

The price increase in wheat grain shows that wheat and millet hay prices would have to increase to $0.075 and $0.08 respectively before ESF and ESFM would have higher net returns than the ESD system.

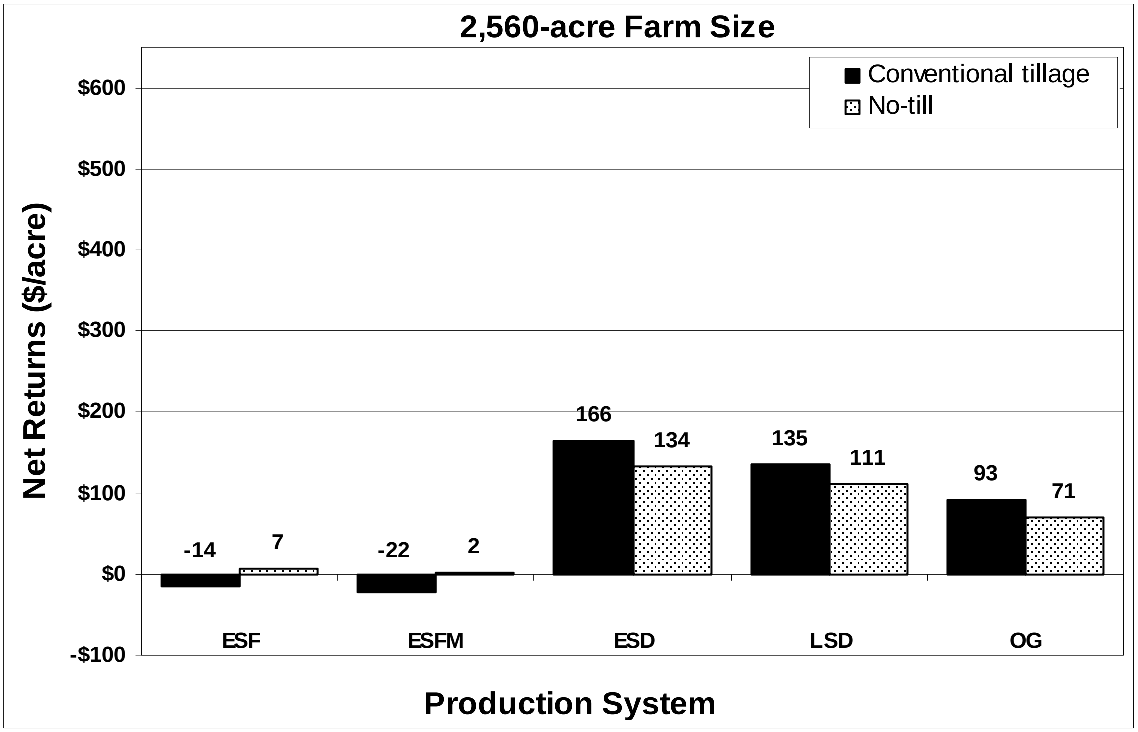
<u>2,560-acre Farm</u>. Figure IV-35 shows the net returns for the 2,560-acre farm using the base prices.



ESF = wheat seeded in early September for forage-only, ESFM = wheat seeded in early September for forage-only with foxtail millet seeded as a summer forage double crop, ESD = wheat seeded in early September for dual-purpose (forage plus grain), LSD = wheat seeded in late September for dual-purpose (forage plus grain), OG = wheat seeded in mid October for grain-only

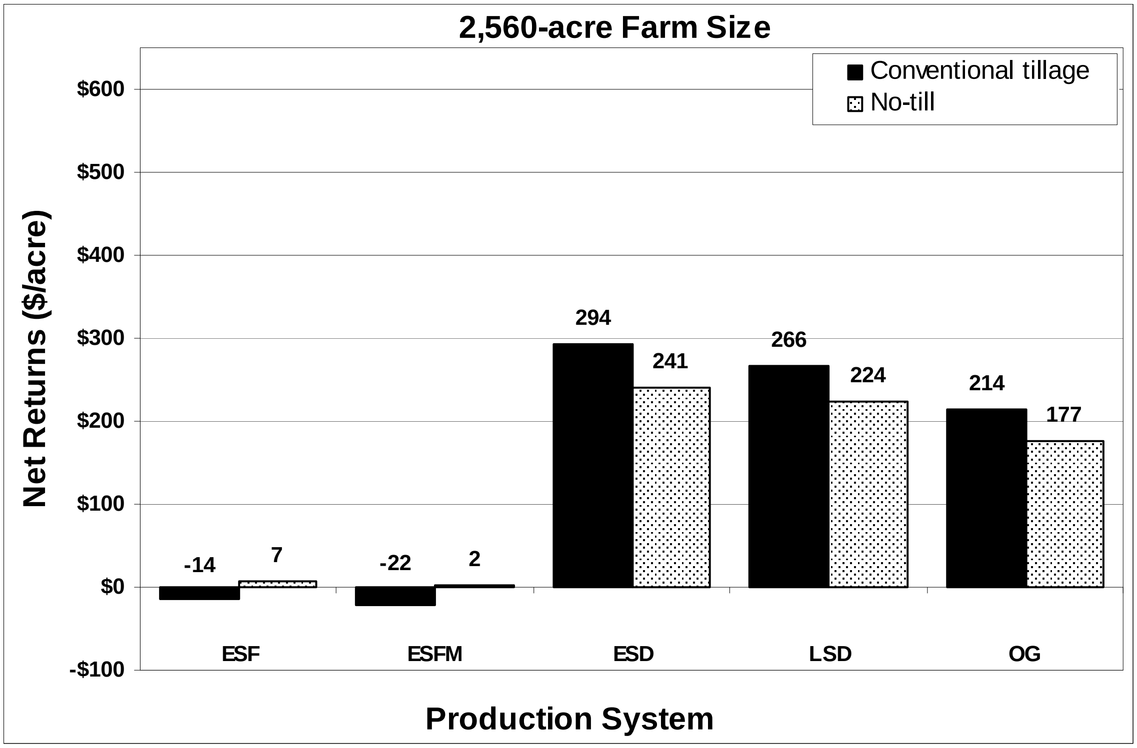
Figure IV-31. Net Returns for a 2,560-acre Farm Using Base Prices

If the price of wheat increases from $3 per bushel to $6 and $9 per bushel, the net returns for the ESD, LSD and the OG systems increases. Given the set of prices, ESD continues to have the highest net returns for conventional till and no-till operations. Figure IV-36 includes a chart of the net returns for each system with a wheat price of $6 per bushel, forage price of $0.03, and hay prices of $0.025, and $0.03. Figure IV-37 includes a chart of the net returns when the price of wheat is $9 per bushel, and the forage and hay prices are the same as above.



ESF = wheat seeded in early September for forage-only, ESFM = wheat seeded in early September for forage-only with foxtail millet seeded as a summer forage double crop, ESD = wheat seeded in early September for dual-purpose (forage plus grain), LSD = wheat seeded in late September for dual-purpose (forage plus grain), OG = wheat seeded in mid October for grain-only

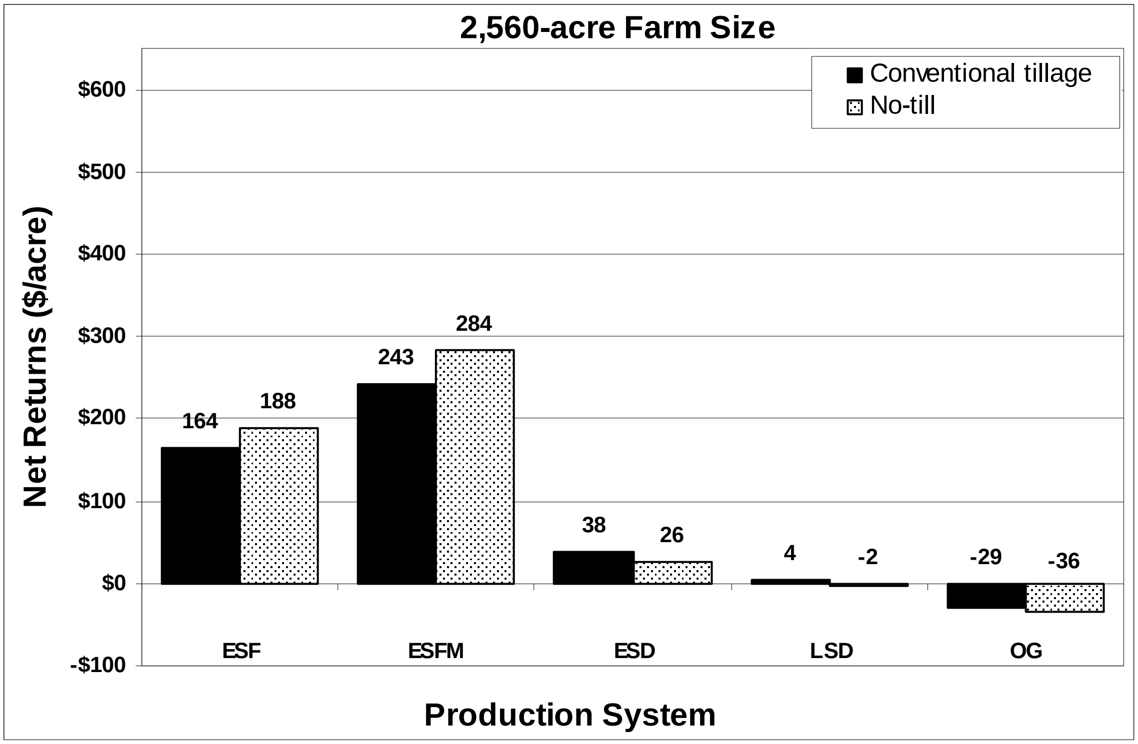
Figure IV-32. Per Acre Net Returns for a 2,560-acre Farm with wheat grain price of $6/bu, forage price of $0.03/lbDM, wheat hay price of $0.025/lbDM, and millet hay price of $0.03/lbDM.



ESF = wheat seeded in early September for forage-only, ESFM = wheat seeded in early September for forage-only with foxtail millet seeded as a summer forage double crop, ESD = wheat seeded in early September for dual-purpose (forage plus grain), LSD = wheat seeded in late September for dual-purpose (forage plus grain), OG = wheat seeded in mid October for grain-only

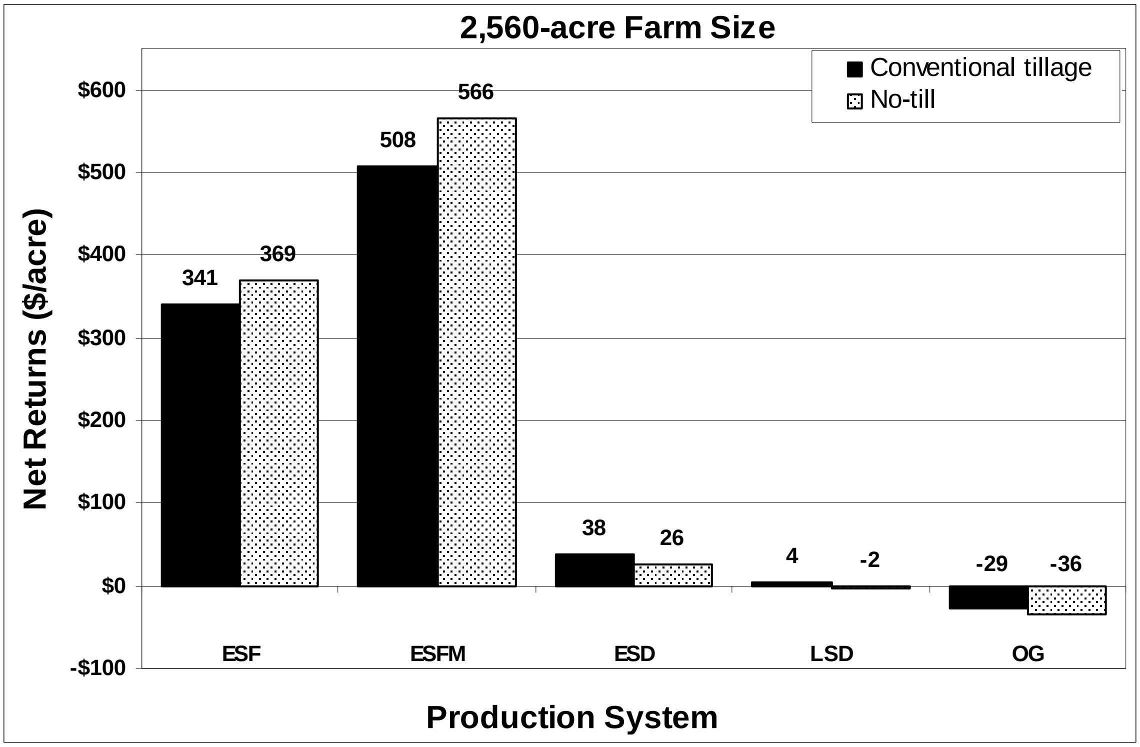
Figure IV-33. Per Acre Net Returns for a 2,560-acre Farm with wheat grain price of $9/bu, forage price of $0.03/lbDM, wheat hay price of $0.025/lbDM, and millet hay price of $0.03/lbDM.

Figure IV-38 includes a chart of the net returns when hay prices are $0.05 per pound for wheat hay, and $0.055 for millet hay. Figure IV-39 includes a chart of the net returns with an even larger increase in hay prices with wheat hay at $0.075 per pound and $0.08 per pound for millet hay.



ESF = wheat seeded in early September for forage-only, ESFM = wheat seeded in early September for forage-only with foxtail millet seeded as a summer forage double crop, ESD = wheat seeded in early September for dual-purpose (forage plus grain), LSD = wheat seeded in late September for dual-purpose (forage plus grain), OG = wheat seeded in mid October for grain-only

Figure IV-34. Per Acre Net Returns for a 2,560-acre Farm with wheat grain price of $3/bu, forage price of $0.03/lbDM, wheat hay price of $0.05/lbDM, and millet hay price of $0.055/lbDM.

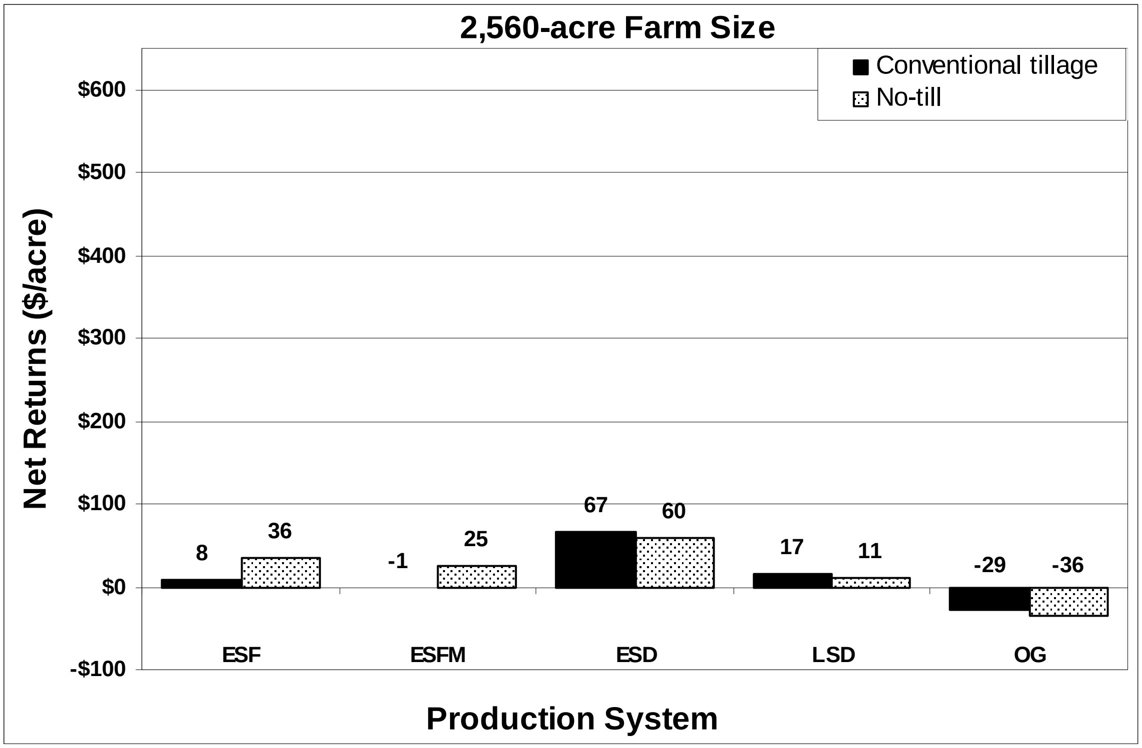


ESF = wheat seeded in early September for forage-only, ESFM = wheat seeded in early September for forage-only with foxtail millet seeded as a summer forage double crop, ESD = wheat seeded in early September for dual-purpose (forage plus grain), LSD = wheat seeded in late September for dual-purpose (forage plus grain), OG = wheat seeded in mid October for grain-only

Figure IV-35. Per Acre Net Returns for a 2,560-acre Farm with wheat grain price of $3/bu, forage price of $0.03/lbDM, wheat hay price of $0.075/lbDM, and millet hay price of $0.08/lbDM.

Given the increased prices in hay, the highest net return would be obtained from the ESFM system, followed by the ESF system. The systems producing forage and grain only would no longer have the highest net returns.

When forage price is increased from $0.03 to $0.05, the systems favored are the same as the base budget showing ESD with the highest net returns. Figure IV-40 is a chart showing the net returns when forage prices increase, and wheat grain and hay prices are held constant.

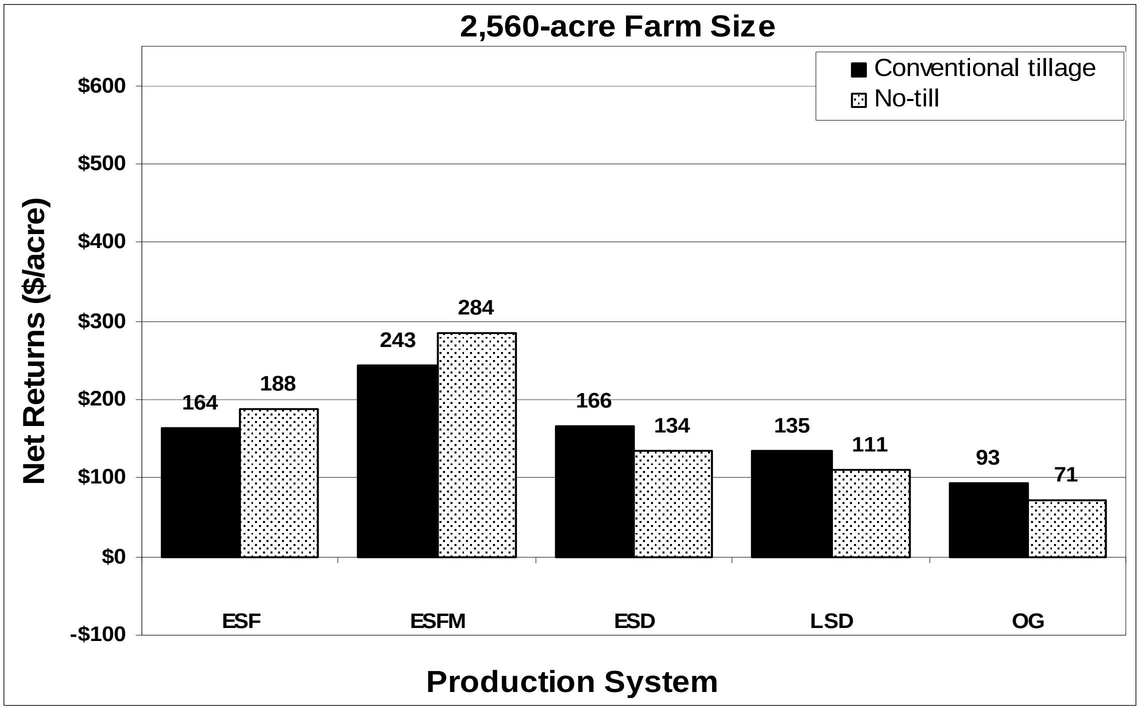


ESF = wheat seeded in early September for forage-only, ESFM = wheat seeded in early September for forage-only with foxtail millet seeded as a summer forage double crop, ESD = wheat seeded in early September for dual-purpose (forage plus grain), LSD = wheat seeded in late September for dual-purpose (forage plus grain), OG = wheat seeded in mid October for grain-only

Figure IV-36. Per Acre Net Returns for a 2,560-acre Farm with wheat grain price of $3/bu, forage price of $0.05/lbDM, wheat hay price of $0.025/lbDM, and millet hay price of $0.03/lbDM.

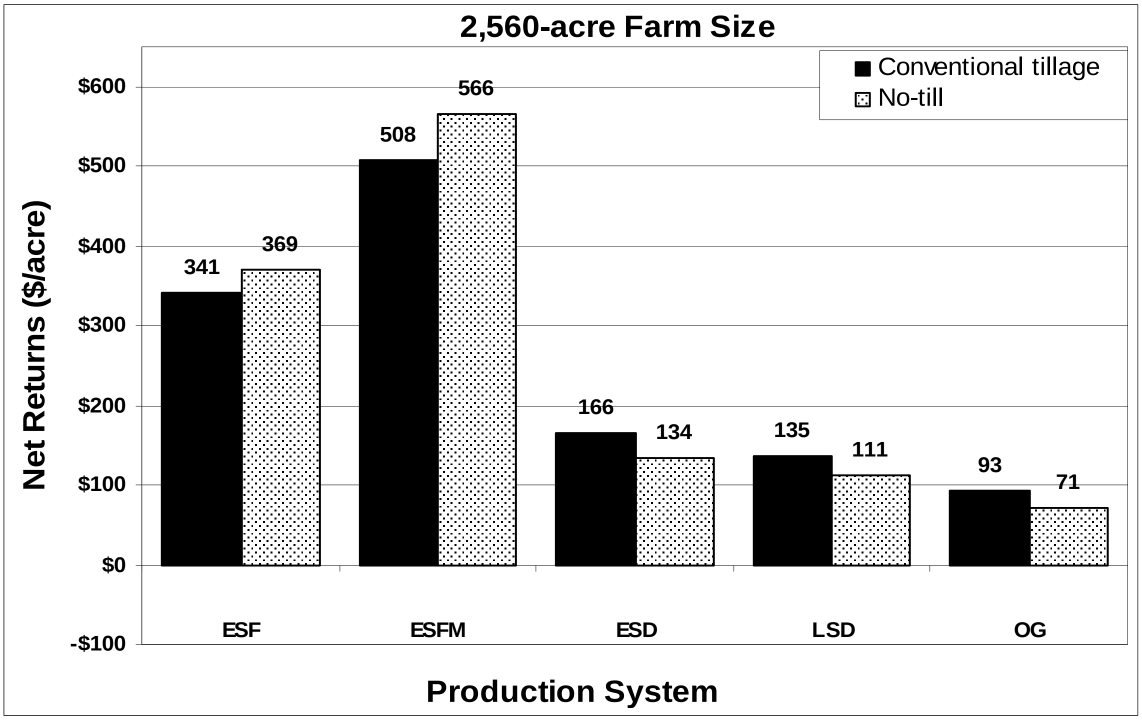
The next step in the price analysis is to evaluate the results if the price of wheat grain and hay increase at the same time, while holding forage prices constant. Figure IV-41 is a chart showing net returns for each system when the price of wheat is increased to $6 and the prices of hay to $0.05 and $0.055. Given the increased price of wheat grain and hay, the system showing the highest net returns is the ESFM system followed by the ESF system.

When the price of hay increases even more to $0.075 and $0.08, the returns for ESFM and ESF increase. Figure IV-42 is a chart of the results.



ESF = wheat seeded in early September for forage-only, ESFM = wheat seeded in early September for forage-only with foxtail millet seeded as a summer forage double crop, ESD = wheat seeded in early September for dual-purpose (forage plus grain), LSD = wheat seeded in late September for dual-purpose (forage plus grain), OG = wheat seeded in mid October for grain-only

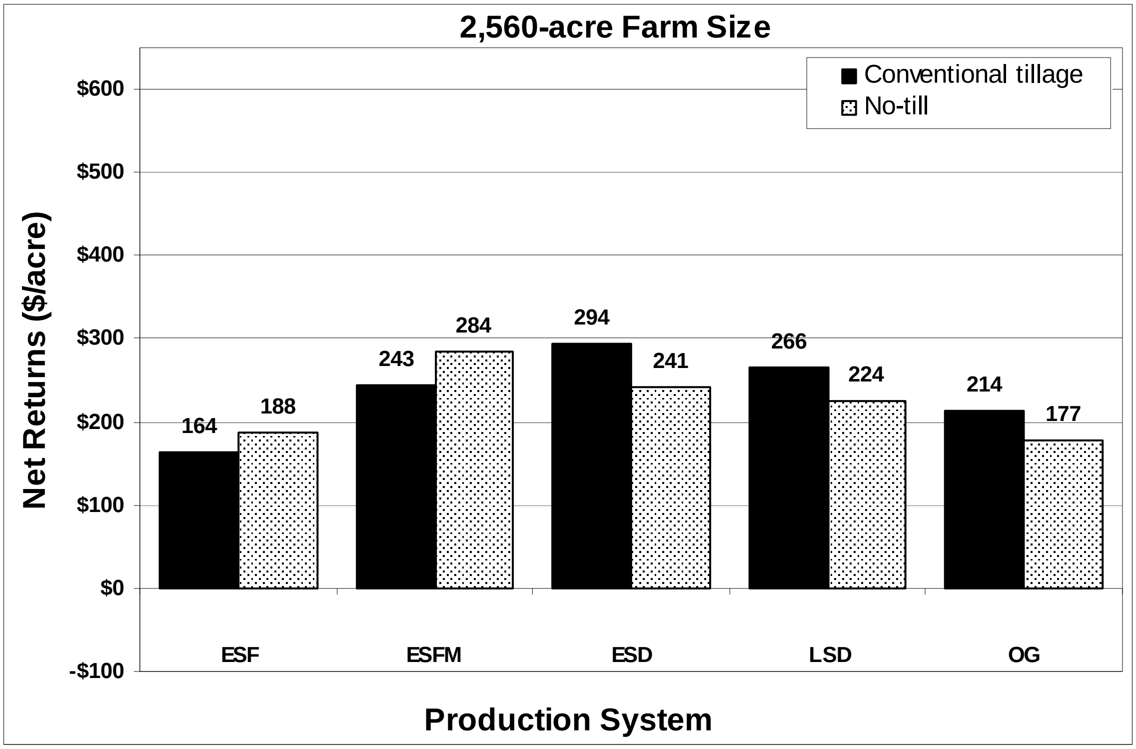
Figure IV-37. Per Acre Net Returns for a 2,560-acre Farm with wheat grain price of $6/bu, forage price of $0.03/lbDM, wheat hay price of $0.05/lbDM, and millet hay price of $0.055/lbDM.



ESF = wheat seeded in early September for forage-only, ESFM = wheat seeded in early September for forage-only with foxtail millet seeded as a summer forage double crop, ESD = wheat seeded in early September for dual-purpose (forage plus grain), LSD = wheat seeded in late September for dual-purpose (forage plus grain), OG = wheat seeded in mid October for grain-only

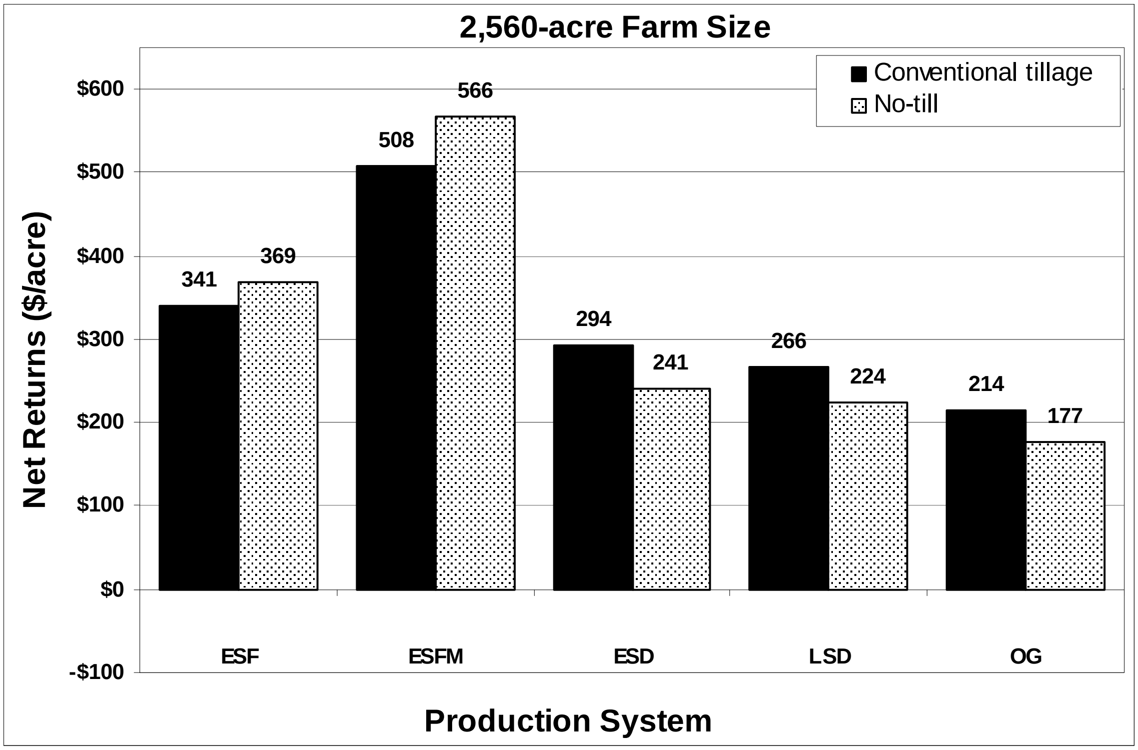
Figure IV-38. Per Acre Net Returns for a 2,560-acre Farm with wheat grain price of $6/bu, forage price of $0.03/lbDM, wheat hay price of $0.075/lbDM, and millet hay price of $0.08/lbDM.

By increasing the price of wheat grain to $9 per bushel, the hay price would have to increase to $0.075 and $0.08 in order for the ESFM system to be favored over the ESD system. Figure IV-43 shows the net returns with wheat grain price of $9 per bushel and hay prices of $0.05 per pound and $0.055 per pound. The ESD system has the highest net returns. Figure IV-44 shows the returns when the price of wheat is $9, and the hay prices are $0.075 and $0.08 per pound. In Figure IV-44, the ESFM and ESF systems are favored over the ESD, LSD and OG systems.



ESF = wheat seeded in early September for forage-only, ESFM = wheat seeded in early September for forage-only with foxtail millet seeded as a summer forage double crop, ESD = wheat seeded in early September for dual-purpose (forage plus grain), LSD = wheat seeded in late September for dual-purpose (forage plus grain), OG = wheat seeded in mid October for grain-only

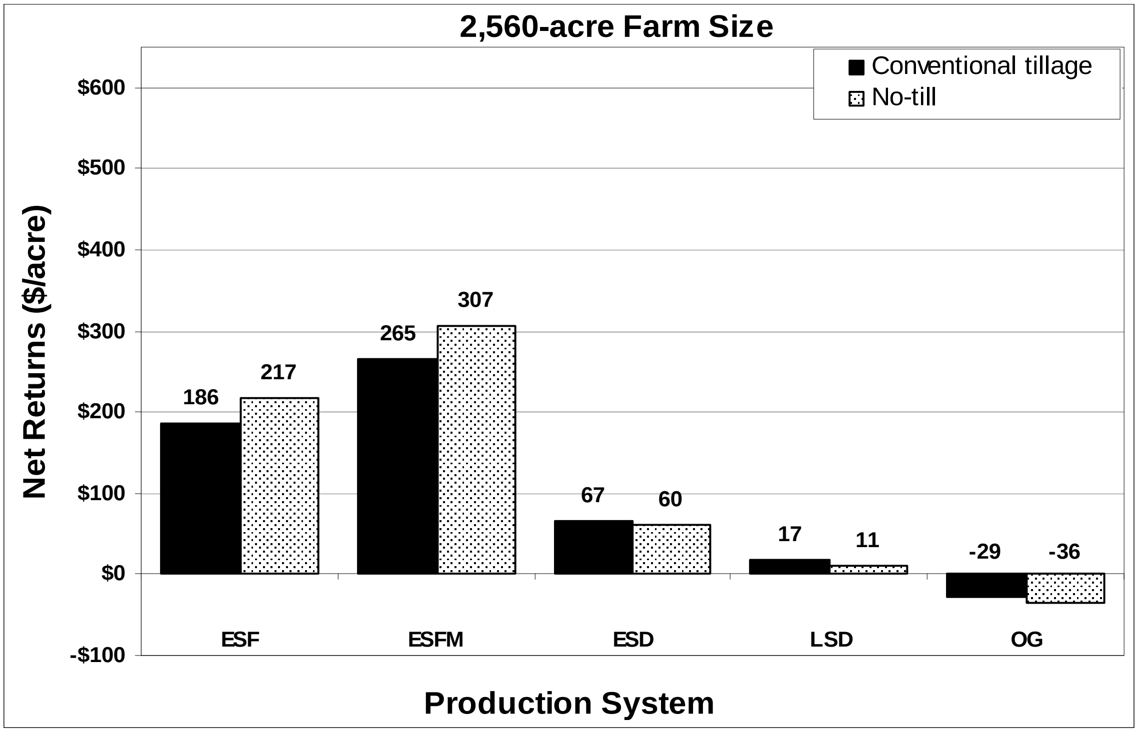
Figure IV-39. Per Acre Net Returns for a 2,560-acre Farm with wheat grain price of $9/bu, forage price of $0.03/lbDM, wheat hay price of $0.05/lbDM, and millet hay price of $0.055/lbDM.



ESF = wheat seeded in early September for forage-only, ESFM = wheat seeded in early September for forage-only with foxtail millet seeded as a summer forage double crop, ESD = wheat seeded in early September for dual-purpose (forage plus grain), LSD = wheat seeded in late September for dual-purpose (forage plus grain), OG = wheat seeded in mid October for grain-only

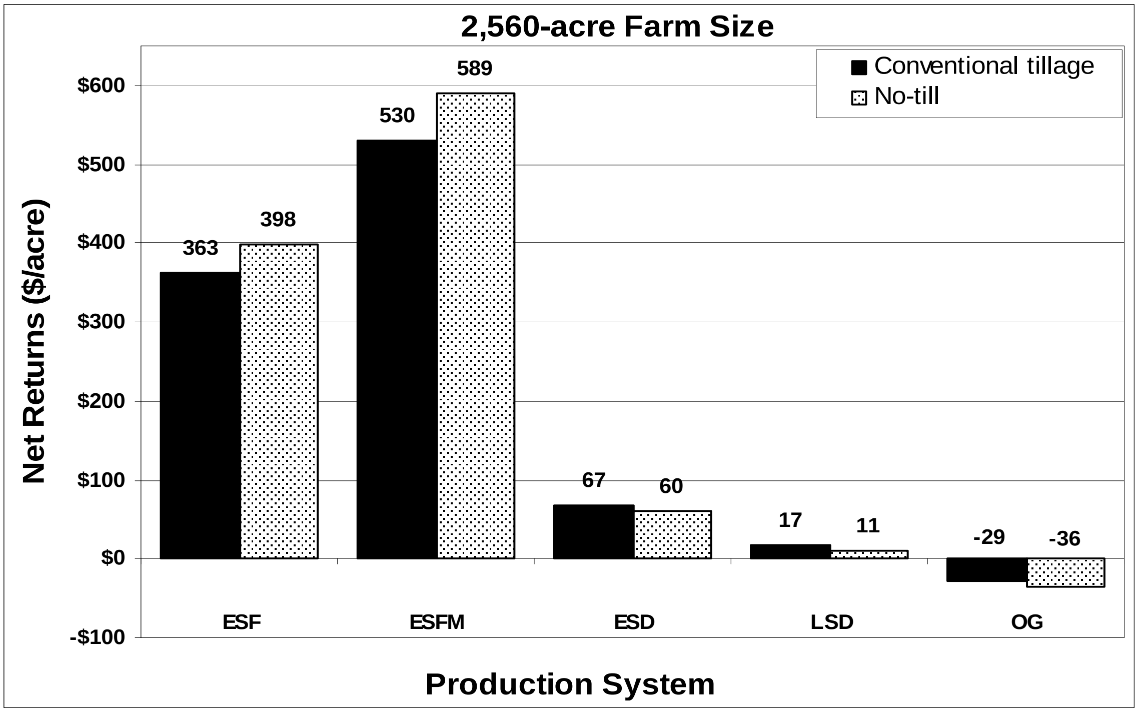
Figure IV-40. Per Acre Net Returns for a 2,560-acre Farm with wheat grain price of $9/bu, forage price of $0.03/lbDM, wheat hay price of $0.075/lbDM, and millet hay price of $0.08/lbDM.

The next set of charts compares net returns when the price of wheat remains constant and the price of forage and hay increase. Figure IV-45 is a chart showing the net returns when the price of forage is $0.05 and the price of hay is $0.05 for wheat hay and $0.055 for millet hay. Figure IV-46 shows the returns when the price of forage is $0.05 and the price of hay is $0.075 for wheat hay and $0.08 for millet hay.



ESF = wheat seeded in early September for forage-only, ESFM = wheat seeded in early September for forage-only with foxtail millet seeded as a summer forage double crop, ESD = wheat seeded in early September for dual-purpose (forage plus grain), LSD = wheat seeded in late September for dual-purpose (forage plus grain), OG = wheat seeded in mid October for grain-only

Figure IV-41. Per Acre Net Returns for a 2,560-acre Farm with wheat grain price of $3/bu, forage price of $0.05/lbDM, wheat hay price of $0.05/lbDM, and millet hay price of $0.055/lbDM.

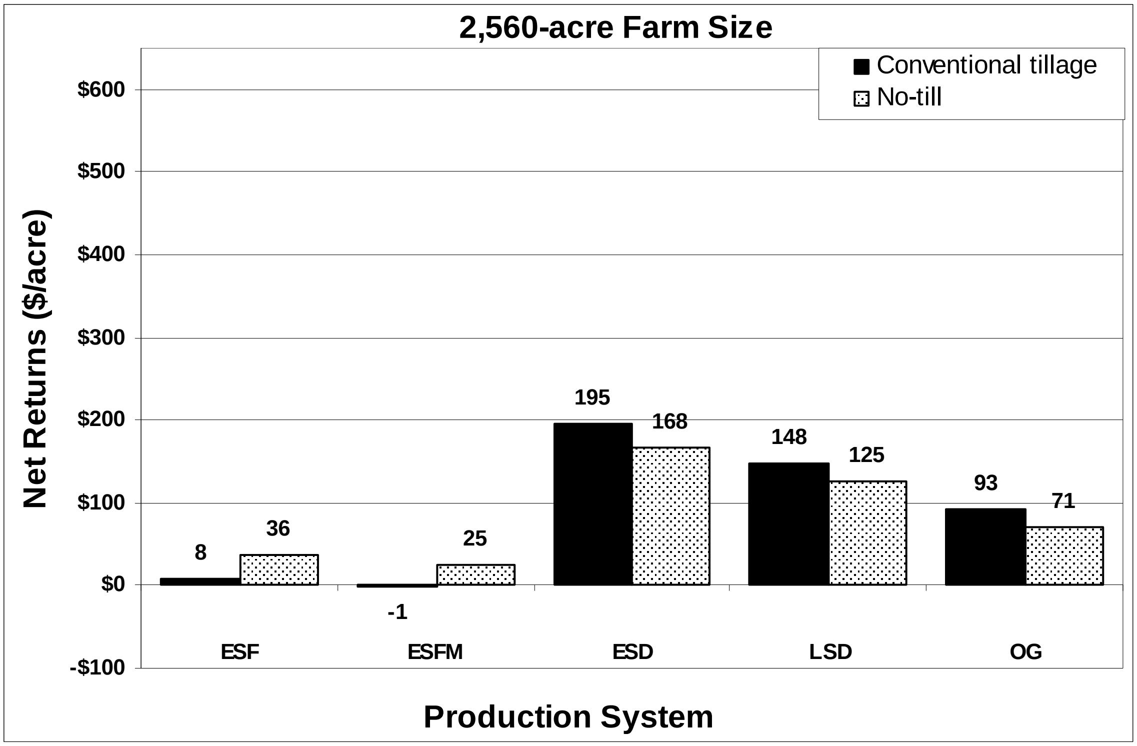


ESF = wheat seeded in early September for forage-only, ESFM = wheat seeded in early September for forage-only with foxtail millet seeded as a summer forage double crop, ESD = wheat seeded in early September for dual-purpose (forage plus grain), LSD = wheat seeded in late September for dual-purpose (forage plus grain), OG = wheat seeded in mid October for grain-only

Figure IV-42. Per Acre Net Returns for a 2,560-acre Farm with wheat grain price of $3/bu, forage price of $0.05/lbDM, wheat hay price of $0.075/lbDM, and millet hay price of $0.08/lbDM.

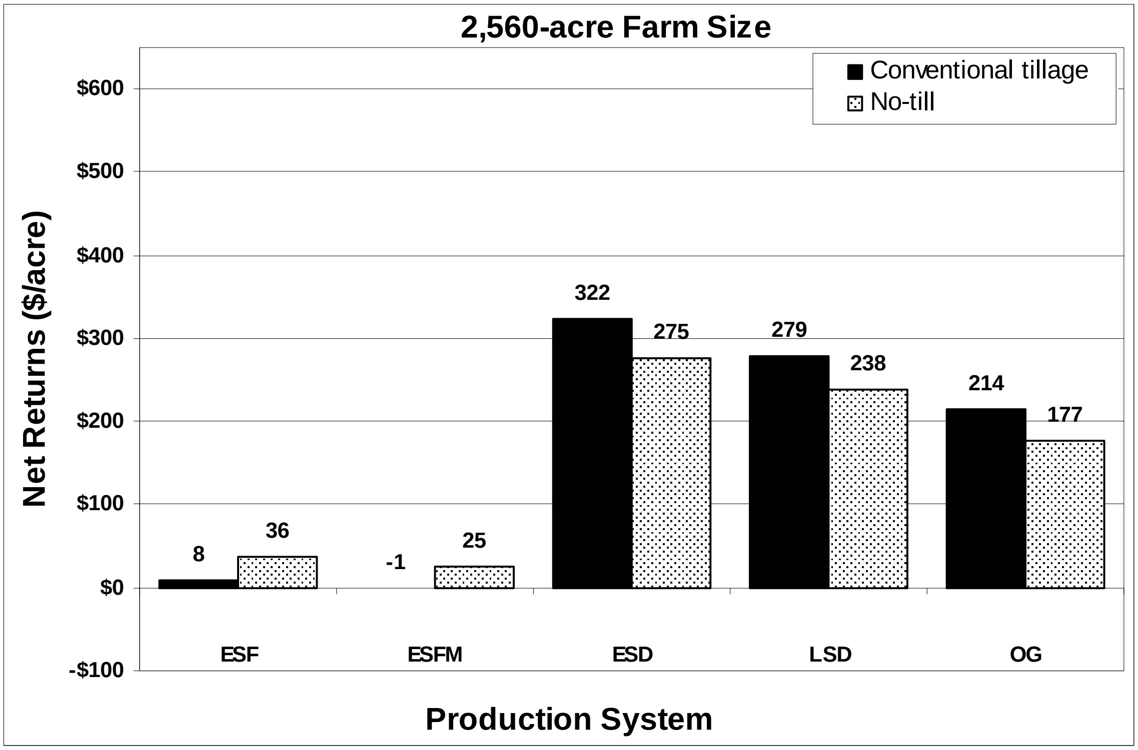
The increase in forage price increases the net returns for ESD and LSD, however the increase of hay prices makes the ESFM and ESF systems more favorable.

Figure IV-47 and Figure IV-48 show the net returns when there is an increase in forage price from $0.03 to $0.05, and an increase in wheat grain price from $3 to $6 and $9 per bushel. The results show highest net returns for the ESD and LSD systems, which can be expected because there is not an increase in hay prices.



ESF = wheat seeded in early September for forage-only, ESFM = wheat seeded in early September for forage-only with foxtail millet seeded as a summer forage double crop, ESD = wheat seeded in early September for dual-purpose (forage plus grain), LSD = wheat seeded in late September for dual-purpose (forage plus grain), OG = wheat seeded in mid October for grain-only

Figure IV-43. Per Acre Net Returns for a 2,560-acre Farm with wheat grain price of $6/bu, forage price of $0.05/lbDM, wheat hay price of $0.025/lbDM, and millet hay price of $0.03/lbDM.

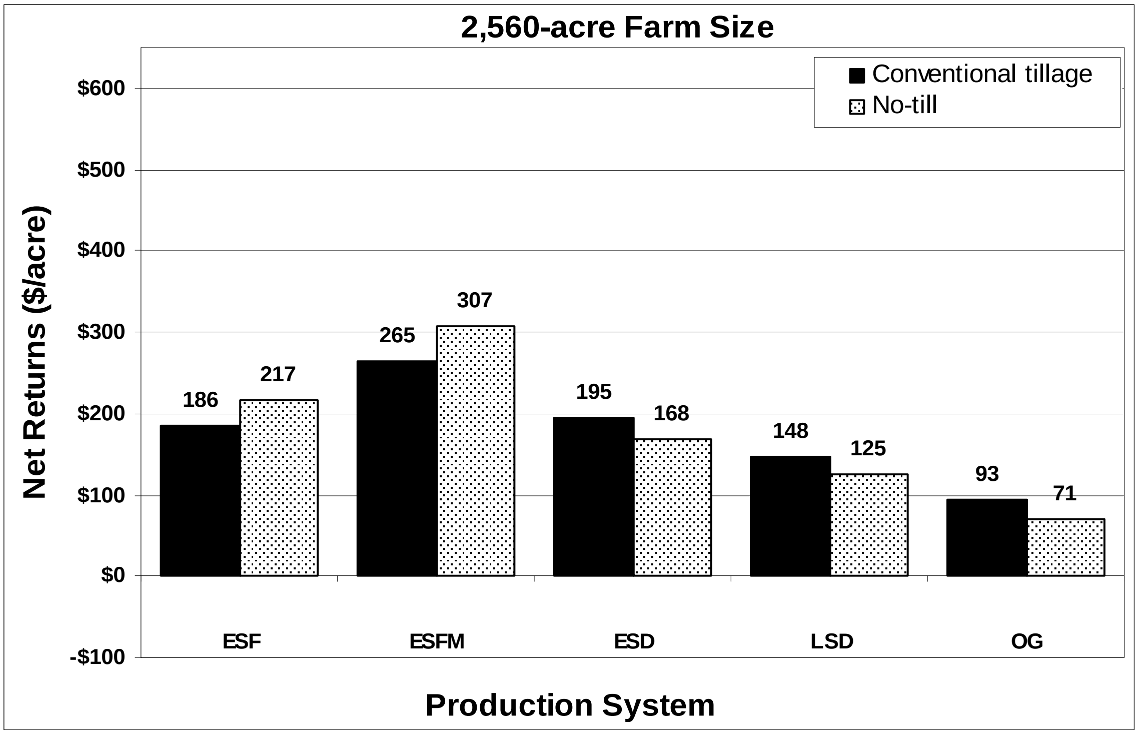


ESF = wheat seeded in early September for forage-only, ESFM = wheat seeded in early September for forage-only with foxtail millet seeded as a summer forage double crop, ESD = wheat seeded in early September for dual-purpose (forage plus grain), LSD = wheat seeded in late September for dual-purpose (forage plus grain), OG = wheat seeded in mid October for grain-only

Figure IV-44. Per Acre Net Returns for a 2,560-acre Farm with wheat grain price of $9/bu, forage price of $0.05/lbDM, wheat hay price of $0.025/lbDM, and millet hay price of $0.03/lbDM.

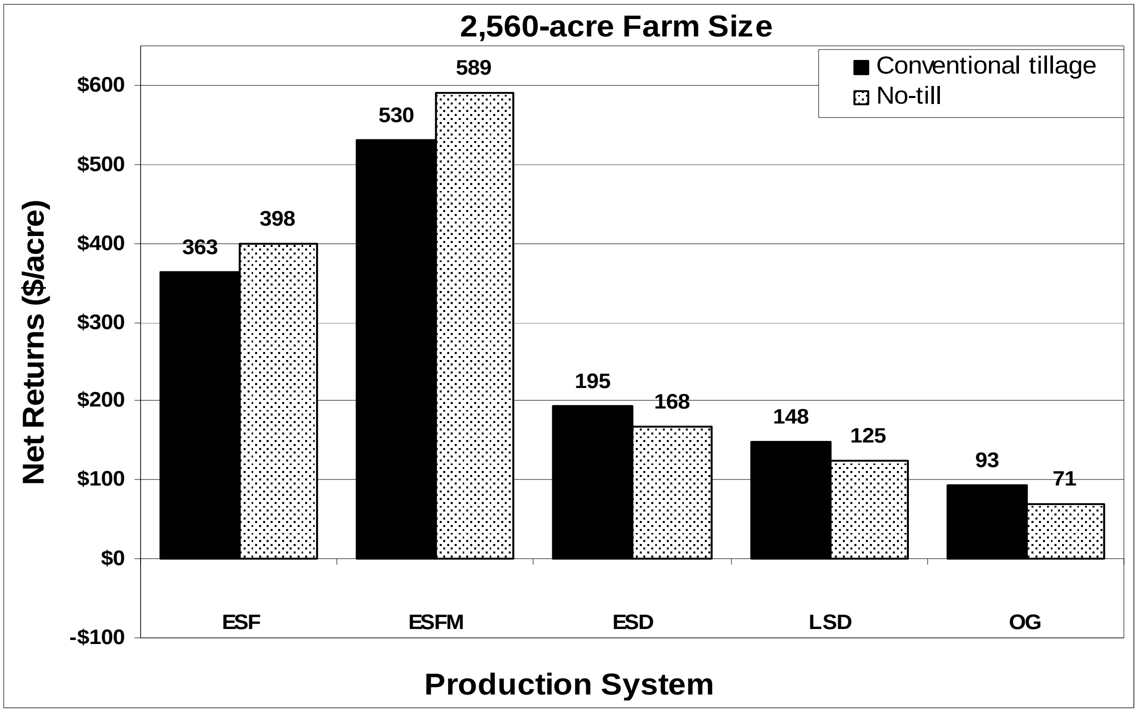
The last step is to evaluate net returns when prices for wheat grain, hay, forage, and millet hay increase at different levels. Figure IV-49 compares net returns when the price of wheat grain is $6, the price of wheat forage is $0.05, and the price of wheat hay is $0.05. The price of millet hay is $0.055. Given this set of prices, the ESFM system has the highest net returns.

Figure IV-50 shows the net returns when the price of wheat grain is $6, the price of forage is $0.05, and the price of hay is $0.075 and $0.08 respectively. The net returns in this case favor the ESFM and ESF system over the other three systems.



ESF = wheat seeded in early September for forage-only, ESFM = wheat seeded in early September for forage-only with foxtail millet seeded as a summer forage double crop, ESD = wheat seeded in early September for dual-purpose (forage plus grain), LSD = wheat seeded in late September for dual-purpose (forage plus grain), OG = wheat seeded in mid October for grain-only

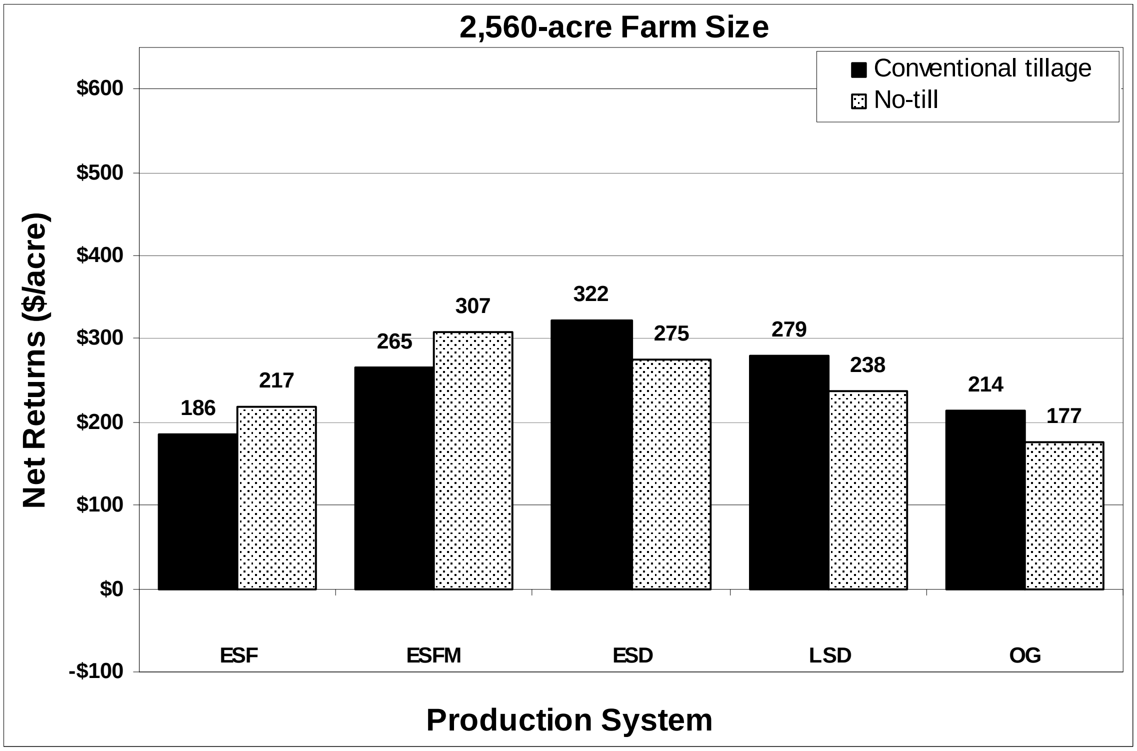
Figure IV-45. Per Acre Net Returns for a 2,560-acre Farm with wheat grain price of $6/bu, forage price of $0.05/lbDM, wheat hay price of $0.05/lbDM, and millet hay price of $0.055/lbDM.



ESF = wheat seeded in early September for forage-only, ESFM = wheat seeded in early September for forage-only with foxtail millet seeded as a summer forage double crop, ESD = wheat seeded in early September for dual-purpose (forage plus grain), LSD = wheat seeded in late September for dual-purpose (forage plus grain), OG = wheat seeded in mid October for grain-only

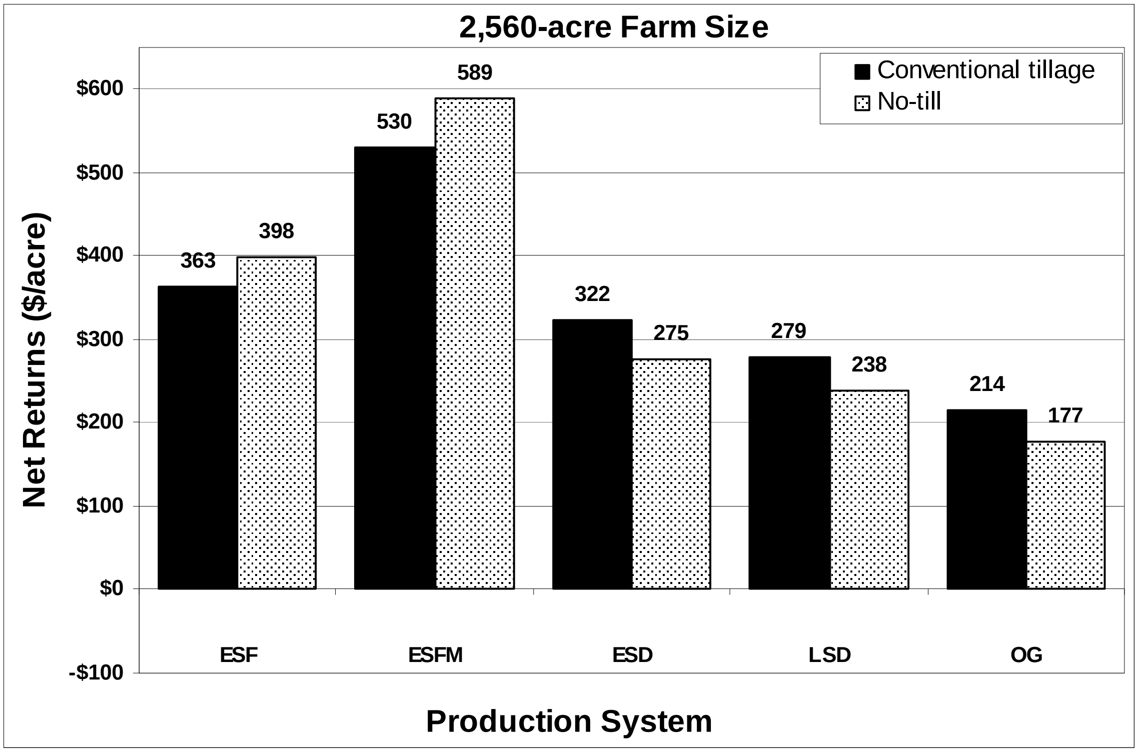
Figure IV-46. Per Acre Net Returns for a 2,560-acre Farm with wheat grain price of $6/bu, forage price of $0.05/lbDM, wheat hay price of $0.075/lbDM, and millet hay price of $0.08/lbDM.

The last set of prices to consider are $9 per bushel wheat grain prices, $0.05 per pound forage prices, and changing hay prices. Figure IV-51 shows the returns when the wheat hay price is $0.05 and the millet hay price is $0.055. Figure IV-52 shows the returns when the hay price is $0.075 and $0.08 respectively. The ESD system is favored when the hay prices increase to $0.05 and $0.055, however when the price of hay increases to $0.075, and $0.08, ESFM and ESF generate the highest net returns.



ESF = wheat seeded in early September for forage-only, ESFM = wheat seeded in early September for forage-only with foxtail millet seeded as a summer forage double crop, ESD = wheat seeded in early September for dual-purpose (forage plus grain), LSD = wheat seeded in late September for dual-purpose (forage plus grain), OG = wheat seeded in mid October for grain-only

Figure IV-47. Per Acre Net Returns for a 2,560-acre Farm with wheat grain price of $9/bu, forage price of $0.05/lbDM, wheat hay price of $0.05/lbDM, and millet hay price of $0.055/lbDM.



ESF = wheat seeded in early September for forage-only, ESFM = wheat seeded in early September for forage-only with foxtail millet seeded as a summer forage double crop, ESD = wheat seeded in early September for dual-purpose (forage plus grain), LSD = wheat seeded in late September for dual-purpose (forage plus grain), OG = wheat seeded in mid October for grain-only

Figure IV-48. Per Acre Net Returns for a 2,560-acre Farm with wheat grain price of $9/bu, forage price of $0.05/lbDM, wheat hay price of $0.075/lbDM, and millet hay price of $0.08/lbDM.

CHAPTER V

CONCLUSION

Wheat is the primary crop grown in the Southern Plains. It is not typically rotated with other crops. Wheat is often grown for two (dual) purposes in Oklahoma: fall-winter forage for livestock gazing and grain. Dual purpose wheat is grazed by cattle during the winter months, and then allowed to mature in the spring and produce a grain crop. Research was conducted to determine the economics of conventional tillage and no-till, for five different cropping systems and two different farm sizes. The five cropping systems included: early September planted wheat for dual-purpose (fall forage for grazing plus wheat grain) (ESD); early September planted wheat for forage-only (fall forage for grazing plus wheat hay harvested in the spring) (ESF); early September planted forage-only double cropped with foxtail millet (fall forage for grazing plus wheat hay harvested in the spring plus millet hay harvested in the summer) (ESFM); late September planted wheat for dual-purpose (fall forage for grazing plus wheat grain) (LSD); and October planted wheat for grain-only (OG).

Field operations, operating inputs, and yields were obtained from an agronomy experiment completed from 2002-2005 at three Oklahoma locations. The experiment was set up in a complete randomized block design, and each production system and tillage method was replicated four times.

Analysis of variance was completed for wheat grain, forage, and hay yields, and foxtail millet hay yields. The wheat grain analysis showed that conventional tillage yields were statistically significantly greater than no-till yields across all production systems. The grain yield reductions associated with the no-till treatments are consistent with findings of other studies of continuous monoculture winter wheat conducted in the region. The reasons for the reduction in grain yields for no-till relative to conventional tillage are not clear. One hypothesis is that it is easier for wheat pathogens to move from the old crop to the new crop under a no-till system.

The forage yields for the no-till plots were found to be statistically significantly greater than fall forage yields obtained from conventional tillage plots. Also, when pooled across location and tillage method, fall forage yields from the ESD system were statistically significantly greater than fall forage yield obtained from other production systems which produced forage. The cause of the increase in fall forage yield for the no-till system relative to the conventional tillage system is not known. One hypothesis is that the no-till system retains more moisture during the summer fallow months that is then available for fall forage production (Heer and Krenzer, 1989). However, measurements of soil moisture were not taken in the current study. The increase in fall forage yield from the ESD system relative to the ESF system could be a result of differences in surface residue during the summer. For the ESD system the wheat grain was harvested and the wheat straw was returned to the soil surface. However, for the ESF system the wheat hay was baled and removed and little residue was left on the soil during the summer fallow period. It is likely that more moisture was retained with the ESD system and that could explain the increase in fall forage yield for the ESD system relative to the ESF system.

The wheat hay and millet hay yields were not statistically significantly different across tillage method, or production system.

The economic procedures included enterprise budgets, a price sensitivity analysis for wheat grain, hay, and forage prices, and foxtail millet price, and a comparison of 2002-2005 average prices and 2008 prices. The enterprise budgets were created for each tillage method, each production system and for each farm size, with a total of 20 budgets. For both farm sizes and both tillage systems, the ESD production system generated the greatest net returns. This is not surprising since it is the most common cropping system in the region. For the 640-acre farm, conventional tillage generated greater net returns than no-till across all five production systems. For the 2,560-acre farm, conventional tillage generated greater net returns than no-till for each of the three systems that include wheat grain harvest (ESD, LSD, OG). However, for the 2,560-acre farm, no-till generated greater net returns for both total forage systems (ESF, ESFM). For both farm sizes adding a foxtail millet double crop during the traditional wheat summer fallow time period generated small positive net returns.

The no-till system is relatively more economical for the 2,560-acre farm. Differences across farm size are largely the result of the relative difference in the cost of no-till seeders relative to the cost of conventional seeders. The list price of a 20-foot no-till drill is around $43,000, which is almost twice that of a 20 foot conventional drill at around $24,000. Whereas the list price of $137,500 for a 36-foot no-till air seeder is only about 20% more than the list price of $105,000 for a conventional tillage air seeder.

The reduction in the price of glyphosate after the patent expired and the increase in the price of diesel fuel has clearly improved the relative economics of no-till. For large farms that intend to seed wheat for use as a forage-only crop, no-till is more economical. However, for farms that intend to harvest the wheat grain, since conventional tillage produces on the average 16 percent greater yield, no-till is not the most economical choice for continuous monoculture wheat in the region.

The objective of this study was to determine the net returns of five different cropping systems for conventional tillage and no-till methods for a 2,560-acre farm, and a 640-acre farm. The results of the research show that the Early September Dual Purpose Wheat using conventional tillage is the preferred production system for both farm sizes. The price sensitivity analysis completed also considered higher commodity prices and whether or not the preferred production system would continue to be ESD using conventional tillage. The results show that given higher prices across the board with grain prices at $9 per bushel, forage price at $0.05 per pound, wheat hay price at $0.075 per lb DM, and millet hay at $0.08 per lb DM, the preferred production system is ESFM for the 640-acre farm and the 2,560-acre farm. This is due to the high price of hay. When the price of hay is dropped to $0.05 for wheat hay and $.055 for millet hay, the preferred system is ESD for both farm sizes, however the range of net returns for the small farm is $158 to $315. The large farm shows a net returns range of $181 for OG to $322 for ESD. Given this set of prices, the range of net returns for the systems is smaller than with the original set of prices. Overall, when the price of wheat increases, the ESD, LSD, and OG systems benefit. When the price of forage increases, all systems except the OG system benefit, and when the price of hay increases, the ESF and ESFM systems benefit.

The overall result of the study shows that conventional tillage methods produce higher net returns than no-till, and that the ESD system produces the highest net returns across farm size in the Southern Plains region. These findings are consistent with the current production method in the state of Oklahoma given that most wheat producers are using conventional tillage and a dual purpose production system. The major limitation of this study is that each of the five cropping systems included continuous wheat, and four included only wheat. Because of the climate and soil types, cropping alternatives in the region are limited. However, additional research is warranted to identify alternative crops for the region that might fit in a rotation with winter wheat.

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APPENDIX

A. Machinery Complements for Conventional Tillage and No-till Wheat Production Systems for Two Farm Sizes

Machine	List Price ($)	Width (Feet)	Speed (mph)	Draft (lbs)	Field Efficiency	Repair Cost 1	Repair Cost 2	Repair Cost 3	Years Owned	RV 1	RV 2	Purchase Price ($)	Hours of Life	Ac/ Hr
640-acre Farm No-till														
155 hp Tractor	81707		4.5		0.88	1	0.0001	2	12	0.68	0.92	69451	12000	
No-Till Drill	51992	20	5	400	0.7	0.75	0.000063	2.1	10	0.6	0.885	46793	1500	8.48
640-acre Farm Conventional Tillage														
155 hp Tractor	81707		4.5		0.88	1	0.0001	2	12	0.68	0.92	69451	12000	
Moldboard Plow	15812	7.75	4.5	1250	0.85	1	0.00025	1.8	12	0.6	0.885	14231	2000	3.59
Chisel	9673	18.6	5	625	0.85	0.75	0.00016	1.4	10	0.6	0.885	8706	2000	9.58
Disk	20231	17.1	6	425	0.8	0.6	0.0004	1.7	12	0.6	0.885	18208	2000	9.95
Conventional Till Drill	23957	20	5	225	0.7	0.75	0.000063	2.1	10	0.6	0.885	21561	1500	8.48
2560-acre Farm No-Till														
95 hp Tractor	58167		4.5		0.88	1	0.0001	2	12	0.68	0.92	49442	12000	
Sprayer	5564	40	6.5	200	0.65	0.7	0.00251	1.3	20	0.6	0.885	5008	1500	20.48
255 hp Tractor	156404		4.5		0.88	1	0.0001	2	12	0.68	0.92	132943	12000	
No-Till Air Seeder	137500	36	5	400	0.7	0.75	0.000063	2.1	10	0.6	0.885	123750	1500	16.97
NT Anhydrous Applicator	24800	32	5.5	360	0.78	0.65	0.000025	1.8	10	0.6	0.885	22320	2000	16
2560-acre Farm Conventional Tillage														
95 hp Tractor	58167		4.5		0.88	1	0.0001	2	12	0.68	0.92	49442	12000	
Sprayer	5564	40	6.5	200	0.65	0.7	0.00251	1.3	20	0.6	0.885	5008	1500	20.48
255 hp Tractor	156404		4.5		0.88	1	0.0001	2	12	0.68	0.92	132943	12000	
Disk	29022	28.13	6	425	0.8	0.6	0.0004	1.7	12	0.6	0.885	26120	2000	16.35
Chisel	21982	30.6	5	625	0.85	0.75	0.00158	1.4	10	0.6	0.885	19784	2000	15.76
CT Air Seeder	105000	36	5	225	0.7	0.75	0.000063	2.1	10	0.6	0.885	94500	1500	15.27
255 hp Tractor	156404		4.5		0.88	1	0.0001	2	12	0.68	0.92	132943	12000	
Moldboard Plow	24516	12.75	4.5	1250	0.85	1	0.00025	1.8	12	0.6	0.885	22064	2000	5.91
Chisel	21982	30.6	5	625	0.85	0.75	0.00158	1.4	10	0.6	0.885	19784	2000	15.76
Disk	29022	28.13	6	425	0.8	0.6	0.0004	1.7	12	0.6	0.885	26120	2000	16.35
Cultivator w/ Anhydrous	19500	23	7	320	0.85	0.7	0.00158	1.4	20	0.6	0.885	17550	2000	16.59

B. MachSel Results for a 640-acre farm and a 2,560-acre farm

MachSel Results for a 640-acre Farm

Parameter*	Production System									
	ESFC	ESFMC	ESDC	LSDC	OGC	ESFN	ESFMN	ESDN	LSDN	OGN
Interest Expense	11.50	10.34	11.50	11.50	11.50	10.26	10.26	10.26	10.26	10.26
Taxes Expense	2.06	1.84	2.06	2.06	2.06	1.82	1.82	1.82	1.82	1.82
Insurance Expense	0.77	0.69	0.77	0.77	0.77	0.68	0.68	0.68	0.68	0.68
Annual Depreciation Cost	13.76	12.19	13.76	13.76	13.76	12.26	12.26	12.26	12.26	12.26
Total Fixed Cost	28.09	25.06	28.09	28.09	28.09	25.01	25.01	25.01	25.01	25.01
Repair Cost	7.73	7.29	3.09	4.64	4.64	1.51	6.46	1.51	1.51	1.51
Lube Cost	0.94	0.79	0.56	0.69	0.69	0.14	0.29	0.14	0.14	0.14
Fuel in gallons	6.25	5.25	3.75	4.57	4.57	0.96	1.93	0.96	0.96	0.96
Labor Hours Required	0.92	0.78	0.55	0.68	0.68	0.14	0.29	0.14	0.14	0.14

*Annual Interest is calculated at 9% per year, taxes are calculated as 1% of the purchase price, insurance is calculated as 1% of the average investment of the machinery. For additional Mach Sel information and calculations see Kletke and Sestak (1991).

MachSel Results for a 2,560-acre Farm

Parameter*	Production System									
	ESFC	ESFMC	ESDC	LSDC	OGC	ESFN	ESFMN	ESDN	LSDN	OGN
Interest Expense	11.92	11.47	11.92	11.92	11.92	7.31	7.31	7.31	7.31	7.31
Taxes Expense	2.13	2.05	2.13	2.13	2.13	1.30	1.30	1.30	1.30	1.30
Insurance Expense	0.79	0.76	0.79	0.79	0.79	0.49	0.49	0.49	0.49	0.49
Annual Depreciation Cost	13.92	13.31	13.92	13.92	13.92	8.87	8.87	8.87	8.87	8.87
Total Fixed Cost	28.76	27.59	28.76	28.76	28.76	17.97	17.97	17.97	17.97	17.97
Repair Cost	14.38	25.53	8.34	10.24	10.24	7.64	22.26	7.64	7.64	7.64
Lube Cost	1.08	1.04	0.71	0.83	0.83	0.41	0.60	0.41	0.41	0.41
Fuel in gallons	7.22	6.95	4.72	5.55	5.55	2.70	4.00	2.70	2.70	2.70
Labor Hours Required	0.69	0.66	0.46	0.54	0.54	0.39	0.47	0.39	0.39	0.39

*Annual Interest is calculated at 9% per year, taxes are calculated as 1% of the purchase price, insurance is calculated as 1% of the average investment of the machinery. For additional Mach Sel information and calculations see Kletke and Sestak (1991).

VITA

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Pages in Study: 89 Candidate for the Degree of Master of Science

Major Field: Agricultural Economics

Scope and Method of Study: The net returns of five alternative cropping systems, for conventional tillage and no-till, for two farm sizes; 640-acres and 2,560-acres were determined. The five cropping systems included: early September wheat for dual-purpose (ESD); early September wheat for forage-only (ESF); early September wheat for forage-only double cropped with foxtail millet (ESFM); late September wheat for dual-purpose (LSD); October wheat for grain-only (OG).

Findings and Conclusions: Average wheat grain yields were significantly lower on the no-till plots. However, fall-winter wheat forage yields were significantly greater on the no-till plots. For both farm sizes and both tillage systems, the early planted dual purpose wheat produced the greatest expected net returns on average. For the small farm, the expected net returns for each of the five production systems were greatest for conventional tillage. The expected net returns for four of the production systems were greater for the no-till system for the large farm.

ADVISER'S APPROVAL: Dr. Francis Epplin