ECONOMICS OF ALTERNATIVE WHEAT HARVESTING METHODS FOR WEED-INFESTED OKLAHOMA FIELDS

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ECONOMICS OF ALTERNATIVE WHEAT

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CHAPTER I

INTRODUCTION

Problem Statement

Winter wheat is one of Oklahoma's major agricultural commodities, with approximately 6.8 million acres planted and 5.4 million acres harvested in 1997 (Oklahoma Agricultural Statistics, 1997). Wheat is also grown continuously on a large portion of the crop acreage in the Southern Great Plains of the United States, making it a primary crop in the U.S. as well. One of the major challenges of winter wheat production is dealing with the problems created by weed infestation. Not only are weeds a source of dockage at the market level during harvest, but they also reduce yields. This is true especially for weeds that mimic the natural biological cycle of the wheat crop, such as cheat and ryegrass. Cheat is one of the most difficult-to-control pests in winter wheat throughout Oklahoma and the U.S. In 1993, it infested more than 3.25 million acres in Oklahoma alone, and is ranked high among troublesome weeds in wheat in nine southern states (Driver et al., 1993).

This stubborn pest is rapidly increasing due to the added incentive from the Conservation Compliance Program for wheat and other small-grain producers to adopt conservation tillage methods. Due to the infestations of grass weeds and changing tillage methods, farmers may be relying more on herbicides to control the problem. However, use of selective cheat control herbicides, such as Sencor (metribuzin) and Finesse (chlorsulfuron plus metsulfuron), is only effective under certain circumstances (Driver, Peeper, and Koscelny, 1993). There is also the likelihood of weeds developing resistance to the chemicals after constant exposure. Besides this inefficacy, pesticides may cause environmental damage, such as ground water contamination. When pesticides fail, farmers must resort to cultural control practices, like burning or deep plowing. Both of these tactics have potentially damaging side-effects to the environment in the form of soil erosion, hence the need to adopt conservation tillage systems.

Since some weeds and wheat have similar biological cycles, weed seeds are harvested with grain combines (harvesters). Then, they either join the wheat in the grain tank and enter the marketing channel as dockage or return to the field to contaminate subsequent crops. Based on exploratory on-farm tests conducted by the Oklahoma State University (OSU) Plant and Soil Sciences Department, collecting these weed seeds during harvest may substantially lessen field reinfestations.

The current research advances harvesting technology by incorporating this possible weed control method into the harvesting process. This study will determine the profitability of four cultural approaches to removing and disposing of cheat and annual ryegrass seed during harvest. The four proposed systems are: (1) adjusting the combine to a low air setting to collect both grain and weed seed in the grain bin, followed by recleaning with a Kice aspirator cleaner; (2) adjusting the combine to a high air setting to clean the wheat as well as possible with the combine, followed by recleaning with a Kice aspirator cleaner; (3) equipping a normally set combine with a secondary cleaner (bin-unit cleaner) to separate the weed seed and remove it from the field, and (4) using a low combine air setting with the bin-unit cleaner. This research was done in conjunction with the OSU Plant and Soil Sciences Department and the OSU Biosystems and Agricultural Engineering Department. The field studies were performed during the wheat harvest of 1997.

Such a step in harvesting techniques may reduce price discounts and dockage in wheat and also provide a weed control method to reduce herbicide use, while still allowing the possibility of conservation tillage practices. This control method could be applicable to other crops that are harvested with a combine. For example, other crop species with biologically mimicking weed species include: morning-glory in soybeans, barnyardgrass in rice, and johnsongrass in grain sorghum. Also, small and large scale farmers might be interested in this technology as an alternative to conventional and herbicide control on their farms.

Objectives

The general objective of this research is to increase the profitability of Oklahoma wheat farms. The specific objective is to determine and compare the net returns from a conventional wheat harvesting system and the three experimental systems.

Literature Review

Prelude. There have been numerous studies and research projects completed over the topic of cheat and weed control. Some of these reports will be reviewed in this paper. They are broken into two main approaches, cultural and chemical approaches. The cultural approach can be further divided into three categories: 1) accepted cultural and mechanical practices, 2) proposed cultural and mechanical practices, and 3) harvest practices. The first category contains such methods as crop rotation, delayed planting, and deep plowing to reduce cheat. The second group has techniques like row spacing, seeding rate reduction, cultivar selection, and placement selectivity. The third section includes modified harvesting systems, such as a sprayer-equipped combine, strip control, and alternative combine settings (Garrison, 1991). Although not all of these procedures are applicable to conservation tillage, most of them have been studied as wheat production methods. Chemical control mechanisms for weeds in general have been studied extensively. They are currently used in a conservation tillage alternative known as no-tillage or no-till (Swenson and Johnson, 1982).

Oklahoma Herbicide Control Research. Herbicides are currently one of the most widely used methods for broadleaf weed control. Nevertheless, specific cheat control herbicides are not used extensively (Agricultural Chemical Usage 1996 Field Crops Summary, 1997). One reason for this hesitation might be the lack of registered chemicals for this purpose. At the time Driver, Peeper, and Koscelny (1993) were conducting research on cheat control, only metribuzin was registered as a cheat control herbicide for winter wheat in Oklahoma. The use of metribuzin was limited because of different cultivar tolerances and restrictions on the Environmental Protection Agency (E.P.A.) registration label. Therefore, ten experiments were performed during the 1988-89, 1989-90, 1990-91, and 1991-92 winter wheat growing seasons to evaluate the efficacy of chlorsulfuron plus metsulfuron (with a ratio of 5:1) and triasulfuron applied preemergence for control of this invader. The triasulfuron was used at rates of 0.25 and 0.42 ounces per acre (oz/ac). The chlorsulfuron metsulfuron combination was applied at rates of .21 + .04 and .30 + .06 oz/ac immediately after seeding. The cheat infestations at the experiment sites were artificially established prior to wheat seeding. Cheat control was visually evaluated after heading.

The treatment effects for 1988 were pooled across the three locations because there were no significant treatment by location interactions. Treatments in 1989 and 1990 varied with location which precluded pooling. Cheat control with chlorsulfuron plus metsulfuron in 1988 varied from 49 to 60%. Control was variable among locations during the 1989-90 growing season with none of the treatments controlling cheat over 38%. In 1990-91, control was near zero at one location, but about 50% at another. Although no rate response was found with chlorsulfuron plus metsulfuron, control was greater with the low rate of 0.25 oz/ac of triasulfuron than with the high rate of 0.42 oz/ac.

Grain yield was also assessed by Driver, Peeper, Koscelny (1993). In 1988 initiated experiments, that were pooled across locations, yield was increased 28 to 37% by chlorsulfuron plus metsulfuron at both application rates. At one location in 1989, yield increased by 54 to 61%. Triasulfuron at 0.25 oz/ac increased grain yield in a 1990 experiment even though top cheat growth was not visibly controlled.

These experiments indicated that triasulfuron and chlorsulfuron plus metsulfuron could reduce cheat in wheat while simultaneously controlling broadleaf weeds, but the results were variable.

Oklahoma Cultural Control Research. The move from uncertain herbicides to improved cultural methods of cheat control was the basis for several research topics. The highly selective herbicides were not always effective, and the previously accepted forms of cultural control, such as moldboard plowing or stubble burning followed by plowing, tend to lead to soil erosion and have become less environmentally tolerable. Therefore, techniques like changing planting dates, increasing seeding rates, reducing row spacing, and cultivar selection have become the subject of many studies.

One such investigation by Koscelny et al. (1990) was to determine whether wheat competitiveness with cheat could be increased by decreasing row spacing or increasing seeding rate. Wheat cultivars were also compared for their competitiveness with cheat. The experiments included in this study were artificially infested with cheat.

Three experiments were conducted to compare the effects of seeding wheat in 3-, 6-, and 9-in. rows on cheat seed yield and yield of weed-free and cheat-infested wheat. Cheat-free wheat in two locations had higher yields when seeded in 3 in. rows relative to 9 in. rows. But, with cheat present, decreasing row spacing did not increase wheat yield. At a third location, row spacing did not affect yield of weed-free or cheat-infested wheat. Effects of row spacing on cheat seed production varied with location. Location one had 11% less cheat seed harvested in rows spaced 6-in. than 3- or 9-in. apart. At location two, more cheat was produced in wheat seeded in 3-in. rows than in 9-in. rows. And at location three, row spacing did not affect cheat seed production.

Two experiments were conducted to compare the effects of seeding wheat at 24.6, 37.0, and 49.2 seeds per square foot (seeds/ft^2) in 3-in. rows on cheat seed yield and yield of weed-free and cheat-infested wheat. Averaged over seeding rates, at location one, cheat reduced wheat yield from 57.8 to 35.5 bushels per acre (bu/ac). Averaged over cheat presence, each increase in seeding rate increased wheat yield. Although wheat seeded at 49.2 seeds/ft^2 produced only 15% more yield than wheat seeded at 24.6 seeds/ft^2, 25% less cheat seed was produced in plots seeded at the highest vs. lowest seeding rates. Also, averaged over seeding rates at location two, cheat reduced wheat yields from 44.6 to 25.8 bu/ac. Averaged across cheat presence, increasing seeding rate from 24.6 to 49.2 seeds/ft^2 increased wheat yield by 21%, but no significant differences were found in cheat seed production.

Seven hard red winter wheat cultivars were compared to determine their ability to compete with cheat in five field experiments. Wheat yield differences among cultivars occurred at all locations, but the magnitude of the differences varied. Cheat seed production was also affected by cultivar selection at all locations. However, no cultivar consistently suppressed cheat production more than another (Koscelny et al., 1990).

In following the previous study, Koscelny et al. (1991) continued research in this area with this next project that was to better define the relationship between wheat seeding date, rate, and row spacing on cheat suppression and hard red winter wheat yield. As before, all the experiments were artificially infested with cheat for test purposes.

Three field experiments were conducted in Oklahoma to examine the effects of seeding date, seeding rate, and row spacing on wheat and cheat growth and yield. Wheat seeding dates were September 28, October 11, and November 3, 1989 at Chickasha; September 22, October 11, and November 1, 1989 at Lahoma; and September 21, October 10, and November 2, 1989 at Perkins. Each plot contained 3-, 6-, and 9-in. rows, with seeding rates of 1.0, 1.5, and 2.0 bu/ac in each of the row spacings.

Results from Chickasha showed that the cheat was not very competitive with wheat and there were no wheat seeding date, seeding rate, or row spacing effects on density, tillers, or biomass of cheat. At Lahoma, plots seeded in 3- and 9-in. rows in September and October at 2.0 bu/ac had fewer cheat plants present in April than plots seeded at 1.0 bu/ac. There were no interactions for cheat density and cheat biomass at Perkins. Wheat biomass at Lahoma was reduced by delaying seeding from September to

October. The presence of cheat also reduced wheat biomass and increasing wheat seeding rate increased wheat biomass. At Perkins, each delay in seeding reduced wheat biomass. Seeding date did not affect wheat biomass at Chickasha. Besides wheat biomass, Koscelny et al. (1991) evaluated grain yield during this research. Increasing the wheat seeding rate of cheat-free plots did not increase wheat yield at any site. However, in cheat-infested plots, increasing the wheat seeding rate reduced wheat yield loss attributed to cheat. Each decrease in row spacing increased grain yields of wheat seeded in September and November. It was also found that dockage was higher in wheat seeded at 1.0 bu/ac in 3- and 6-in. rows than in wheat seeded at 2.0 bu/ac in 3- and 6-in. rows. This study indicated no advantage from increasing the seeding rate of winter wheat seeded in late September or early October under cheat-free conditions, but winter wheat yields increased with increasing seeding rate in the presence of cheat.

Oklahoma Combination Research. Instead of researching herbicide treatments or new cultural methods, some studies were done on the combination between the two control practices. Ferreira, Peeper, and Epplin's (1990) objective was to define the interaction between wheat seeding date and cheat control herbicide treatment on wheat forage production, grain yields, and net returns associated with each combination.

Field experiments, with man-made cheat infestations, were conducted using planting dates of September 2 or 3 (early seeding), September 30 or October 11 (traditional seeding period), and November 1 or 3 (delayed seeding). The herbicide treatments studied included ethyl-metribuzin and cyanazine applied when the wheat had 3 to 4 tillers. Thus, the herbicide application dates differed for each seeding date. The net return to land, overhead, risk, and management was determined for each seeding date by herbicide-treatment by forage-removal-treatment combination at all locations with enterprise budgets.

Results from this project determined that wheat plant density in the untreated checks was unaffected by seeding date, but cheat density declined in all locations as seeding was delayed. They also indicated that forage removal may not affect cheat reproduction in traditionally seeded wheat but increase the cheat seed content of early seeded wheat. With herbicide treatment, it was found that at one location the ethyl-metribuzin and metribuzin treatments reduced dockage in the traditionally seeded wheat, and no treatment reduced dockage in early seeded wheat.

In the grain yield data, 2 of the 3 locations had yields highest in the traditionally seeded wheat and lowest in the early seeded wheat. At the first location, where cheat population was low, all of the herbicide treatments reduced the yield of wheat with delayed seeding, but metribuzin treatments reduced the yield more than other treatments, because it reduced stand severely. In the second location where cheat population was high, all ethyl-metribuzin and metribuzin treatments applied increased grain yields. The herbicide treatments only increased the yields of the unforaged wheat plots at the third location.

Ferreira, Peeper, and Epplin (1990) also analyzed the economic benefits of the methods of control. Net returns were negative for early seeded wheat despite use of forage. However, at location one, forage removal did increase returns from the traditionally seeded wheat. In the traditionally seeded wheat of location three, none of the herbicide treatments increased net returns in either foraged or unforaged, but several treatments decreased the net losses in the early seeded, foraged wheat. At location two, ethyl-metribuzin reduced the net losses of early seeded, foraged wheat, and in the traditionally seeded wheat ethyl-metribuzin and metribuzin both increased net returns. Although it was found that delaying seeding until November reduced cheat populations at all sites, the economic penalties for delaying were severe and therefore economically unfeasible.

There was another study conducted that combined both cultural and herbicide control methods. Justice et al. (1993) attempted to determine whether decreasing row spacing and increasing wheat seeding rates would improve cheat control obtained with herbicides and to determine whether herbicide rates could be reduced without reducing cheat control if the wheat seeding rates were increased and row spacing narrowed. Wheat seeding dates were October 1, 4, and 15, 1990 at location one, two, and three, respectively. The plots contained 3-, 6-, and 9-in. rows, with seeding rates of 1.25 or 2.0 bu/ac in each of the row spacings. The herbicide treatments included chlorsulfuron plus metsulfuron applied preemergence and metribuzin applied postemergence when the wheat had three to four tillers. Production cost and net returns to land, labor, overhead, risk, and management were computed for each treatment combination at all locations by using an appropriate enterprise budget.

Results indicated that at location one increasing herbicide rate, reducing row spacing, or increasing the wheat seeding rate reduced cheat seed. Increasing wheat seeding rate at location two and three also reduced cheat seed content. The data showed that no seeding rate by row width by herbicide treatment interaction was found in the wheat yield figures. However, averaged over herbicide treatments and row spacing, increasing the seeding rate increased wheat yield at location three, and at location two each decrease in row spacing increased wheat yield, but these factors did not affect yield at other locations.

It was determined by Justice et al. (1993) that no individual practice or combination consistently increased net returns. However, net returns were frequently increased by applying the high rate of either herbicide or by increasing seeding rate. Thus in conclusion, to maximize the potential for positive returns, combinations of practices were recommended, including seeding at a higher rate.

Additional Oklahoma Control Research. In addition to the herbicide and cultural methods research, there have also been studies that propose biological control practices. Koscelny and Peeper (1990) have two papers that relate grazing winter wheat as a possible cheat control technique. One paper measured the interaction of grazing winter wheat and herbicide treatments on cheat control, and the other examined the influence of grazing cheat-infested wheat on growth and reproduction of both species when no herbicides were used. The experiments conducted in these papers contained both naturally occurring and man-made cheat infestations.

In combined data analyses, grazing had no effect on herbicide efficacy or influenced wheat yield at any location. There were no grazing by herbicide treatment interactions with grain yield, but all herbicide treatments increased wheat grain yield at all locations. Thus, the herbicides controlled cheat in both grazed and ungrazed wheat. In the non-herbicide experiments, grazing reduced wheat leaf area/plant by 52%, while cheat leaf area/plant was reduced 28%. Grazing increased wheat tillering per plant, but had no affect in the tillering of cheat. The results indicated that cattle grazing cheat-infested wheat defoliate wheat plants more than cheat plants. The dockage data, the best measure of cheat yield, suggested that grazing favored cheat over wheat. The conclusions drawn here eliminated grazing as a control procedure and leaned toward the need for some other form of cheat control when grazing wheat.

Relevant U.S. Control Research. There have been numerous projects conducted in Oklahoma to evaluate different cheat control methods in winter wheat, but there has also been additional studies completed throughout the U.S. on this topic. One such study by Griffin (1985) evaluated ryegrass control in the Gulf Coast area of Louisiana using chlorsulfuron, metribuzin, and diclofop to measure the effect of the herbicide treatment on wheat injury and yield. This study is relevant because ryegrass is very similar to cheat in many aspects, especially in its control. His findings showed that diclofop at 7.84 oz/ac and metribuzin at 5.88 oz/ac applied early postemergence controlled significantly more ryegrass than other herbicide treatments except chlorsulfuron applied preemergence at 0.49 oz/ac. Results of this research indicated that ryegrass can be selectively controlled in wheat, but that the wheat injury may be much less severe in the coastal area of Louisiana compared to more northern areas of the state due to differing temperature/rainfall regimes.

Goldstein and Young (1987) performed a study in the cropping region of the Washington-Idaho Palouse. Winter wheat, barley, and peas are commonly grown there. They showed how herbicides have become a large percentage of the conventional tillage system. When comparing the variable costs of an experimental, low-input, legume-based system (PALS) to a conventional system, it was found that variable costs for PALS were only 44% of those for the conventional system. Fertilizers, pesticides, and application accounted for 56% of the costs for the conventional system, but only 26% for PALS.

Chemical inputs designate a large portion of the variable production costs for conventional cropping in the Palouse.

Taylor and Burt (1984) examined alternative strategies for management of wild oats in spring wheat in north central Montana. The wild oats problem in Montana is similar to the cheat problem in Oklahoma. The alternative strategies were obtained from a partially decomposed stochastic dynamic programming model. The decision alternatives considered were fallow, use of a preemergence herbicide, use of a postemergence herbicide, and crop without use of herbicide.

The results of the first of two components were found to be sensitive to yield and cost data and could not be extrapolated to many other areas. The conclusions drawn from the second component dealt with the wild oats density thresholds for application of a postemergence herbicide, which appeared to be at a rather high density. In the authors' opinion the missing link in the model is that it does not consider planting time relative to wild oats emergence. With regards to implementation of the decision rules, it is impractical for producers to annually measure the wild oats seed reserve in the plow layer. Implementation of the postemergent herbicide strategy, however, was not difficult because of the relative ease of establishing the density of wild oat plants.

Springer et al. (1992) conducted tests in Hayes, Kansas to establish a preference of the Russian wheat aphid for cheat, downy brome, Japanese brome, or wheat. This might have been a form of biological control if the aphid preferred cheat to winter wheat. Unfortunately, the study established the order of decreasing acceptability to the Russian wheat aphid as: wheat, downy brome, cheat, and Japanese brome. The preference for wheat over the annual brome species is consistent with the fact that wheat is a more suitable host. Given that life cycles of wheat and the annual *Bromus* species are similar, the likelihood of annual *Bromus* species serving as alternate hosts of aphids was small.

Relevant World Control Research. Grass control in small grains is a subject not only for the U.S. but the rest of the world as well. Italy, Australia, and Spain have conducted research in the area of weed control, in Australia more specifically wild oat control. Berti and Zanin (1997) organized a study to assess the validity of a decision making system, known as GESTINF, through soybean field experiments in north-eastern Italy. This program was developed to assist in the selection of weed control options in soybeans and winter wheat, using observed weed densities, crop weed-free yield, and grain price as input data. The program estimates potential crop damage from multispecies weed complexes and ranks the different weed control options according to expected net returns. The system also gives estimates of yield loss due to weeds surviving the treatment and an environmental index indicating how hazardous the treatment is for the water-table, thus allowing a selection of treatments on an economic and an environmental basis.

The yield loss estimations, without weed control, due to competition of the weeds were calculated using the 'density equivalent' method. The program determines the yield loss after treatments by computing the weed density remaining after treatment and applying that to the same procedure as untreated weed populations. The economic output from the model was net margin for the treatment. It was achieved by subtracting total treatment cost from the monetary loss caused by the weeds in the absence of control.

The results of the experiments indicated that the system forecasted the yield losses observed in the field fairly accurately and proved capable of selecting appropriate interventions on the basis of type of flora and weed growth stage. Since the system bases the estimation of yield losses on weed densities, a major limitation lies in the different competitiveness of weeds with different emergence times. Overall GESTINF demonstrated good flexibility allowing even very different weed communities to be compared.

A major grass weed of winter cereals, wild oats, is primarily controlled by killing plants, either prior to sowing a crop or within the crop. An array of technology exists for managing wild oats. There is a collection of ways to directly kill wild oat plants, various crop rotations, pre-crop tillage systems, and several pre- and post-emergence herbicides. But the weed problem persists on most farms from year to year.

Pandey and Medd (1990) estimated the economic feasibility of killing wild oat seeds for control in wheat in the context of a farm in the southern Australian wheat belt. The evaluation used a dynamic programming model linked to a bioeconomic simulation model. This control tactic of killing wild oat seeds was found to be economically viable under some conditions when combined with existing weed management practices. The two critical parameters which determine the viability of the seed kill option are the effectiveness of the control agent and the cost of the treatment. The feasibility of seed kill indicated the potential Australian market for seed kill technology. Also, farmers could reduce their dependence on post-emergence herbicides in the long run.

Martin, Felton, and Somervaille (1989) reported experiments that were aimed at determining the effects of fallow management and the presence of crop residues on the efficacy of liquid and granular formulations of tri-allate for control of wild oats in wheat. Three field trials and a glasshouse experiment were carried out in northern New South

Wales of Australia. The first trial was conducted in 1981 to compare three tri-allate formulations. The second and third field studies were directed at evaluating the performance of tri-allate formulations and mixtures with other herbicides and the effect of varying fallow management on herbicide performance. The glasshouse experiment was set up to examine the effect of time between application and watering, soil incorporation and rate of application on the efficacy of liquid and granular formulations of tri-allate.

In the field experiments, fallow management practices with surface crop residues ranging from nothing to complete retention, did not affect the performance of tri-allate in terms of control of wild oats and wheat grain yield response. Application of a granular formulation resulted in lower than expected wheat grain yields in two of the field experiments. Although soil incorporation improved the performance of tri-allate at the recommended rate of 0.7 lb/ac, satisfactory control of wild oats and profitable increases in wheat grain yield were obtained with tri-allate at 1.07 lb/ac. In conclusion, tri-allate as the liquid formulation at 1.07 lb/ac gives economic control of wild oats in no-tillage and stubble-mulched seedbeds when incorporated by sowing. Results from the glasshouse experiment, farmer experience, and published literature support the practice of incorporating tri-allate into dry soil with subsequent activation by rain.

Martin and Felton (1993) conducted a study, through field experiments from 1983 to 1986 in northern New South Wales, Australia, to determine the effect of reduced tillage practices on the efficacy of existing practices for the control of wild oats, namely a rotation of wheat and sorghum and use of selective herbicides. Emphasis was placed on determining the effect of herbicides, tillage, and rotation on the survival of wild oat seeds in the soil. The two main treatments were a continuous rotation of wheat and a rotation of wheat-winter fallow-sorghum-winter fallow-wheat.

In the third and fourth years of continuous wheat rotation, cultivated fallow using tines increased wild oat density and reduced grain yield compared with a no-tillage fallow. At the end of the experiment the seed reservoir was also smaller under the no-tillage fallow regime. However, the most effective means of reducing oat seed reservoir was the rotation of wheat with sorghum. The rotational strategies for weed control were also believed to be effective in delaying or minimizing the development of herbicide resistance.

Annual use of either tri-allate or flamprop-methyl in four successive wheat crops did not prevent a massive build-up of wild oat seed. Wild oats were found to be well adapted to continuous cropping with wheat and maintained the population despite the use of selective herbicides. Therefore, this indicated that a continuous wheat rotation using herbicides to control wild oats was likely to be much less effective in reducing the wild oats seed reservoir.

Gonzalez-Andujar and Fernandez-Quintanilla (1993) described a bioeconomic model of wild oats growing in winter wheat production systems representative of central Spain. They used the model to investigate the agronomic and economic consequences of using a range of management strategies for the control of wild oats in cereal cropping systems. Results of the simulations indicated that growing winter wheat continuously with the annual application of herbicides may be the optimum strategy, resulting in acceptable wild oat populations and maximum economic benefits. However, the practice of wheat monoculture was only a valid option as long as herbicides were applied annually, spraying herbicides in alternate years failed to control wild oats adequately and resulted in major economic losses. The rotation of wheat with a fallow year, with no herbicides applied in either of the two years, may be a satisfactory low-cost alternative when wild oat infestations levels are low, but it is not valid when infestation levels are high. The strategy that combines the use of a fallow year with herbicide application in the wheat year resulted in optimum wild oat control and moderate profitability under all conditions. However, the net returns obtained were substantially lower than in the continuous wheat plus herbicide strategy. Although this model did not allow definite conclusions to be drawn about the optimal control strategies for wild oats, it offered some practical guidance regarding the possibilities and limitations of various strategic approaches for control of this weed.

Weed Control Measurement. In preceding studies, weed control effectiveness was measured in varying ways, depending on the end result being reached or the data available. The research in this study attempts to determine the consequences of weed control on yields and profit in the current and subsequent years. Auld, Menz, and Tisdell (1987) describe two possible approaches to estimating the effects due to weeds. The first approach, *absolute value*, simply measures the difference in the value of agricultural output in the presence and absence of weeds without considering the possibility of any control to the presence of the weed. The second approach, *opportunity profit*, measures the difference in profit between the existing level of weed control and the economic optimum level of control. For the purpose of the current research a modified version of *opportunity profit* was used. This version measures the difference in the harvesting alternatives and the conventional harvesting method, producing either net profit or net loss for the alternative in the current year. In the case of net loss, an additional calculation is needed to derive the effect in subsequent years. However, as Young et al. (1997) established, weed competition influence on crops are often subtle and difficult to determine. This is especially true for the cases with insufficient data, such as the current research. To account for the lack of data, certain adjustments were made to the analysis process. These adjustments are discussed in detail in the procedures section of the report.

Conservation Tillage Research. The previous studies were directed at the topic of weed control, but another benefit from the new harvesting methods is the possibility of using conservation tillage methods. Fortunately, research has also been performed in this area, particularly with the no-till system. Swenson and Johnson (1982) cited that no-till was a superior soil conservation practice and offers reductions in fuel, labor, and machinery requirements. It is also a means of conserving soil moisture. However, negative aspects, increased costs of pesticides and seeding equipment, plus the greater potential for certain disease and insect problems cause proper management skills to be critical.

Epplin et al. (1993) conducted a study to determine the economics of a no-till production system relative to a conventional till system for continuous Oklahoma winter wheat. They found that the no-till system required 63% less machinery labor, 60% less tractor fuel, and 34% less machinery investment capital. The costs of fuel, lubricants, and repairs were 46% less, and machinery fixed costs were also 35% less than the conventional system. The herbicide program, however, costs $43.50/acre for the no-till system and only $1.31/acre for the conventional till procedure. The conventional system resulted in greater average economic returns than the no-till system for both locations and varied planting dates. For the prices during that time and technology used, the no-till system evaluated was not economically competitive with the conventional till system.

Painter et al. (1995) examined the possibility of using crop rotations as a form of prevention for soil erosion in the Palouse region of Washington State. Two of the alternative systems used green manure crops and had low fertilizer and pesticide requirements. The remaining two systems included soil-building crops, bluegrass seed and rapeseed. Benefits from soil-building crops are increased organic matter content, higher water content, better soil structure, and deeper topsoil. These make soil more productive and less vulnerable to erosion.

Several alternative systems show potential for improved financial and environmental performance compared with the two dominant conventional systems. However, widespread adoption is hindered by unresolved agronomic and economic issues. The green manure crop rotation had problems with establishing good stands. Limited markets for bluegrass seed, increasing restrictions on burning of grass straw, and the potential for nitrate leaching all posed problems for the bluegrass rotation. Economically, all the alternative systems in this study are estimated to be equal to or better than the conventional systems, but the soil-conserving alternative systems have smaller proportions of alternative and therefore were found to have riskier crops.

Wheat Cleaning Research. Even though weed control and conservation tillage are benefits from the alternative harvesting techniques of this research, cleaning the wheat may also reduce dockage and price discounts. Although, few studies have been performed in the area of on-farm wheat cleaning involved in these techniques, research has been conducted on cleaning wheat at the elevator level and cleaning in general. This subject was brought about by increasing competition that U.S. grain exporters are facing for export sales. Buyers have complained about relatively poor quality of U.S. grain and this has led to arguments that changes in U.S. grain standards are necessary. Congress took action from the complaints of poor quality and mandated that the U.S.D.A. conduct an economic study on the costs and benefits of cleaning U.S. wheat and present implications and policy options to enhance U.S. wheat cleanliness and quality competitiveness in the world market.

Lin and Leath (1993) found that cleaning all U.S. wheat for export above the current level is not economically feasible because costs of additional cleaning at the lowest net-cost location--country elevators for spring wheat and subterminal elevators for winter wheat--would outweigh benefits by at least $8 million in the short run. Since it is not in the U.S. wheat industry's interest to clean all export wheat, an alternative would be to target clean wheat for special niche markets. The wheat industry could potentially gain $8 to $10 million in net benefits if it targets wheat cleaning to the cleanliness-conscious markets, that account for about 20 percent of all U.S. exports. It was also determined that any public policy designed to promote cleanliness of U.S. wheat exports and to improve U.S. competitiveness in the world market must address the issue of how much, where, and which classes of wheat to clean and target for cleanliness-conscious markets. Policy options worthy of consideration included establishing dockage as a grade-determining factor, segregating wheat by its intrinsic characteristics, and launching an information (outreach) program to meet buyer preferences and to familiarize foreign buyers with U.S. wheat quality.

Hyberg et al. (1993), of the U.S.D.A.'s Economic Research Service, in cooperation with researchers at land-grant universities conducted commodity-by-commodity studies in fulfilling part of the congressional mandate. The report determined the domestic costs and benefits of cleaning wheat to a standard comparable to that of major export competitors. The results showed the costs of cleaning wheat exceeded the domestic benefits of cleaning wheat. The absence of net domestic benefits from cleaning wheat suggested that the U.S. wheat market is responding efficiently to domestic market signals for less dockage and foreign material in wheat. An overall reduction in dockage and foreign material could benefit the U.S. wheat industry only if cleaner U.S. wheat induces sufficient trade benefits to overcome the net domestic cost. It was determined that, barring any benefits from increased sales and premiums on the international market, there was no basis for mandatory cleaning requirements in the United States based on the costs and benefits of cleaning wheat. The least-cost alternative of cleaning wheat was at the subterminal elevator, which had a $23 million net cost.

As part of the Hyberg et al. (1993) study, Adam, Kenkel, and Anderson (1992) analyzed the Oklahoma economic implications of changing grain standards. They conducted an economic-engineering study to determine the costs and benefits of cleaning hard and soft red winter wheat at country and terminal elevators. Results indicated that cleaning wheat is profitable under some conditions, but for many elevators the costs of cleaning were likely to be larger than the benefits. The net benefits from cleaning varied depending on premium received for cleaned wheat, price of wheat, price of cleanings, level of cleanliness achieved, and capacity utilization.

From continued research, Adam, Kenkel, and Anderson (1994) reported estimates for costs and benefits to the grain industry of cleaning export grain to achieve cleanliness standards. The calculations indicated that cost of cleaning wheat exceeded benefits by

0.5¢ per bushel to 3.9¢ per bushel, depending on the cleaning configuration used. From another perspective, individual firms would need to receive these amounts as premiums for clean wheat for cleaning wheat to be a breakeven proposition. Implications derived from these results were that economies of size are present in wheat cleaning. However, even if all size economies were achieved, the reduced transportation costs, insect control costs, and feed value of cleanings were insufficient to offset costs of cleaning for typical elevator conditions.

Summary. This review has examined previous studies conducted on the topic of weed control in Oklahoma, the United States, and the world. It also investigated studies on conservation tillage and wheat cleaning at the elevator level. From most of this research, herbicide treatments seem to be a popular topic and effective on general weed control. Unfortunately, most chemical treatments have been found to be ineffective in controlling cheat. Innovative cultural methods such as planting date, seeding rate, row spacing, cultivar selection, and crop rotation are becoming popular and contain positive effects but, they have yet to show consistency in restricting cheat and weed growth. Therefore, farmers may be relying on environmentally damaging cultural control methods. These methods may include burning and deep plowing the cheat so that it can not germinate. Either of these tactics have the likelihood of increasing soil erosion problems. These many problems associated with cheat infested wheat provided impetus for the current research to investigate the economics of novel harvesting techniques, which involve wheat cleaning. Even though cleaning at the elevator-level was determined to be infeasible, cleaning at the farm-level may prove economical as a weed control tactic. These methods could reduce or replace some herbicide use and still provide successful and consistent control of cheat, and other annual bromes, while reducing price discounts and dockage on the marketed wheat.

These improved procedures of control may be beneficial in the movement from conventional tillage systems to conservation compliance systems. The major problem in this shift is the need of herbicides to control the additional infestations of cheat and weeds caused by the reduced tillage. With the new harvesting techniques, conservation tillage may be more acceptable due to the possibility of maintaining the same returns as current conventional tillage practices.

Figure 1-1. Summary of Tested Oklahoma Cultural Cheat Control Practices

Technique /Year	Author(s)	Effective	Economical	Environmentally Sound
Row Spacing: *3-, 6-, 9-in. rows* {1990}	Koscelny, J.A. Peeper, T.F. Solie, J.B. Solomon Jr., S.G.	not always	unknown	possibly
Seeding Rate: *24-, 37-, 49-seeds/ft^2* {1990}	Koscelny, J.A. Peeper, T.F. Solie, J.B. Solomon Jr., S.G.	partially	unknown	yes
Cultivar Selection {1990}	Koscelny, J.A. Peeper, T.F. Solie, J.B. Solomon Jr., S.G.	uncertain	unknown	yes
Seeding Date: *late-Sept., mid-Oct., early-Nov.* {1991}	Koscelny, J.A. Peeper, T.F. Solie, J.B. Solomon Jr., S.G.	yes	unknown	yes
Seeding Rate: *1-, 1.5-, 2- bu/ac* {1991}	Koscelny, J.A. Peeper, T.F. Solie, J.B. Solomon Jr., S.G.	yes	unknown	yes
Row Spacing: *3-, 6-, 9- in. rows* {1991}	Koscelny, J.A. Peeper, T.F. Solie, J.B. Solomon Jr., S.G.	yes	unknown	maybe
Seeding Date: *early, trad., late* {1990}	Ferreira, K.L. Peeper, T.F. Epplin, F.M.	yes	no	yes
Row Spacing: *3-, 6-, 9- in. rows* {1993}	Justice, G.G. Peeper, T.F. Solie, J.B. Epplin, F.M.	uncertain	no	maybe
Seeding Rate: *1.25 and 2 bu/ac* {1993}	Justice, G.G. Peeper, T.F. Solie, J.B. Epplin, F.M.	yes	possibly	yes

Figure 1-2. Summary of Tested Oklahoma Chemical Cheat Control Practices

Technique /Year	Author(s)	Effective	Economical	Environmentally Sound
Chlorsulfuron plus Metsulfuron {1993}	Driver, J.E. Peeper, T.F. Koscelny, J.A.	yes	unknown	Pesticide Usage
Triasulfuron {1993}	Driver, J.E. Peeper, T.F. Koscelny, J.A.	yes	unknown	Pesticide Usage
Ethyl-metribuzin {1990}	Ferreira, K.L. Peeper, T.F. Epplin, F.M.	yes	sometimes	Pesticide Usage
Cyanazine {1990}	Ferreira, K.L. Peeper, T.F. Epplin, F.M.	no	no	Pesticide Usage
Metribuzin {1990}	Ferreira, K.L. Peeper, T.F. Epplin, F.M.	yes	sometimes	Pesticide Usage
Chlorsulfuron plus Metsulfuron {1993}	Justice, G.G. Peeper, T.F. Solie, J.B. Epplin, F.M.	maybe	sometimes	Pesticide Usage
Metribuzin {1993}	Justice, G.G. Peeper, T.F. Solie, J.B. Epplin, F.M.	maybe	sometimes	Pesticide Usage
Ethyl-metribuzin {1990}	Koscelny, J.A. Peeper, T.F.	yes	unknown	Pesticide Usage
Metribuzin {1990}	Koscelny, J.A. Peeper, T.F.	yes	unknown	Pesticide Usage

Figure 1-3. Summary of Tested Oklahoma Biological Cheat Control Practices

Technique /Year	Author(s)	Effective	Economical	Environmentally Sound
Grazing {1990}	Koscelny, J.A. Peeper, T.F.	no	unknown	maybe

CHAPTER II

THEORY AND METHODS

Conceptual Model

The basis for the conceptual framework of this study is the economic theory of profit maximization. The profit maximization model is a simplification of reality. It ignores personal motivations and assumes that profits are the only relevant goal. Other assumptions for the use of this model are that the farm has sufficient information about its costs to discover what are its profit-maximizing decisions. Most real-world situations do not have this information readily available. Fortunately, through field studies conducted by OSU research, information is obtainable to compare these alternative types of wheat harvesting systems to a conventional system.

The traditional profit model, which will be initially applied to the objective of determining the most efficient method of harvesting wheat in cheat- and ryegrass-infested fields, is

$$\pi = TR - TC \tag{1}$$

where, π is profit, TR equals total revenue, and TC represents total cost. This basic equation derives profit by subtracting total cost from total revenue. With this rudimentary form of profit determination a basic understanding will be gained.

Now that an initial grasp has been achieved, the profit model can be modified to better represent the research objective. The new form takes the appearance of equation 2,

$$NR(x) = [\, GR_W(x) + GR_C(x)\,] - [OC + CC(x)] \tag{2}$$

In this formula NR, net returns, now replaces π, profit. The total revenue portion becomes, $GR_W + GR_C$, the sum of gross revenues from wheat production and the possible sale of the cleanings (cheat) as a feedstuff. Also, the total cost section is modified into OC and CC. OC designates the operating costs (machinery, labor, depreciation, interest, insurance, taxes, fuel, lube, repairs) and CC symbolizes the costs of the cleaning procedures (machinery, repairs, labor) associated with the various experimental harvest systems. The variable x stands for the harvest method that was used, thereby indicating the elements that will change when the treatment is varied.

The revenue parts can then be broken down into more specific components, so they are achievable through the data obtained from field studies. The gross revenues for wheat and cheat sales (Eq. 3 and 4) are determined by multiplying the market price received by the yield attained from the crop,

$$GR_W(x) = P_W(x) * Y_W(x) \tag{3}$$

$$GR_C(x) = P_C * Y_C(x) \tag{4}$$

where, P_W and P_C represent the market price for wheat and cheat, also Y_W and Y_C denote the yield of wheat and cheat, respectively. From the equations it is possible to see that gross revenues, price received for wheat, and yield are all a function of the harvest system, x. It is understandable that the revenue and yield change with the different methods, but the price received for wheat also changes. The cause of this variation is the differing prices paid for wheat containing dockage, such as weed seed. These price discounts are discussed in detail later in the procedures section of this chapter. The exception to this variability issue is the price of cheat. Due to the estimation process to obtain a price for the cleanings it is constant for all the treatments being evaluated.

Once returns were obtained from the experimental systems, a modified version of *opportunity profit* was used to evaluate the weed control economic possibilities (Auld, Menz, and Tisdell, 1987). This was to determine what benefits (if any) the weed control treatments offered. The procedure measured the difference of the experimental harvesting systems and the conventional harvesting method in terms of net profit or loss.

Procedures

System Descriptions. Method (1) is the *"Conventional"* treatment. It represents the check or base system for comparison of the experimental techniques. This procedure consisted of a combine, with normal (book) settings, harvesting the wheat with no special cleaning machines. The "Conventional" denotes the common form of wheat harvest.

Method (2) is the *"Normal Bin-Unit"* system. This approach utilizes a combine mounted recleaner to separate the cheat and wheat seed at the harvester level, removing the weed seed from the field and collecting it for use as a possible feedstuff. OSU agricultural engineers designed and constructed a prototype aspirator cleaner for this treatment. It was modeled after the larger Kice machine and works on the same principals of airflow. To conduct the field studies, the bin-unit was mounted in the grain tank of the combine. The grain tank was partitioned to hold the cheat seed and other dockage material separate from the relatively clean wheat. Handling the cleanings in this way proved to have some drawbacks, but the underling principal was sound. During these studies the combine air was normally set to book recommendations.

The second experimental approach was to lower the air speed of the grain combine to collect the weed seed with the crop in the grain tank. The purpose for this tactic was to extract the cheat seed from the field in hope of lessening reinfestation. This strategy sparked three options. The first is considered method (3), *"Low Air"*. This included no additional cleaning, only lowering the air speed and taking the grain and cheat to market.

Method (4) *"Low Air with Kice"* is the next option. It embellished on the previous treatment by cleaning the wheat with a Kice six stage aspirator grain cleaner at the edge of the field to make the grain marketable. OSU agricultural engineers adapted a holding tank and auger system to the Kice cleaner making it a high capacity cleaning system. By removing the cheat and chaff from the wheat the dockage is lowered, thereby reducing the price discounts. The cheat, or cleanings, is also considered a possible feed source for animals.

Method (5) *"Low Air with Bin-Unit"* is the last option of the low air approach. It is nearly identical to method (3). The combine mounted recleaner was used, although the air system of the combine was set lower than normal to bring more of the cheat seed into the bin-unit cleaner. As previously stated, this approach was designed to remove the cheat seed from the field. During the field studies this method and the *Low Air* option were conducted simultaneously. For comparison purposes, they were considered different treatments. However, the only distinction between them was the addition of expected revenue from cheat sales and the supplementary cost of the bin-unit cleaner.

The next experimental strategy was to raise the combine air speed slightly over normal. This tactic attempted to clean the wheat as well as possible with the combine.

The majority of the cheat seed was returned back to the field, hence leaving the likelihood of reinfestation. Method (6), the *"High Air"* treatment, uses this approach. It excludes secondary cleaning and delivers the grain straight to market. However, method (7) *"High Air with Kice"* employs the Kice aspirator cleaner to improve the grain marketability, thus reducing price discounts. The cleanings from this treatment are also a possible feed source for animals.

Data Collection. The objective of the research was to determine the most profitable method of harvesting wheat in cheat-infested fields. This objective, therefore, was the foundation for the plan of research and the specific objective formulates the steps involved. The strategy then, was to determine the expected costs and returns of each system in some common basis for comparison.

To begin the study, the conventional and alternative methods were employed in field studies during wheat harvest in the summer of 1997. With the use of the OSU M-3 Gleaner combine, data were collected at four locations in north central Oklahoma. These locations consisted of fields near Red Rock, Marland, Billings, and Hunter. A randomized complete block design was used to designate the plots at all four locations. The dimensions of the plots varied between locations, but were recorded to calculate the acreage that the plot represented. This allows the conversion of the data to a per acre basis for comparison purposes.

The treatments (*Figure 2-1*) and replications performed varied across fields, because of the need for an area which contained a uniform cheat infestation. Three locations, Red Rock, Billings, and Marland, contained all seven methods. However, there were only three replications at Marland while Red Rock and Billings had four. The final site at Hunter allowed three schemes, the *"Conventional"* and two of the low air options *(Low Air* and *Low Air with Kice)*. In addition to treatment modifications across sites, the cheat level also varied according to the dockage results. Hence, each field is considered unique and separate.

Additional data collection included weights and samples from the plots. Wheat and cheat weights were taken when the combine's grain tank was emptied. They were used to calculate yields for both items. Samples were also taken for analysis purposes. Official grades (*tables 2-1, 2-2, and 2-3*) of the samples from the combine and Kice cleaner were attained from the Enid Grain Inspection of Enid, Oklahoma, so that revenue determination and cleaner efficiency could be evaluated as accurately as possible. Samples of the cheat and cleanings were delivered to Servi-Tech Laboratories Inc. of Dodge City, Kansas. Servi-Tech conducted nutritive analysis for feeding purposes (*table 2-4*).

<u>Gross Revenue for Wheat</u>. In determining gross revenue from wheat production there are two main factors, price and yield. The price received for the wheat at the elevator is reflected by equation (5),

$$P_W(x) = Base\ Price - Discounts\ (x) \tag{5}$$

where, the price of wheat for a certain harvest method is computed by subtracting the price discounts for that system from the base price. The base price used, was the June 1997 average price of $3.28 per bushel (Agricultural Prices, 1997). The discounts for each treatment were calculated using a discount schedule (*table 2-5*) from Farmland Grain Division and official grades obtained from grain samples evaluated by Enid Grain Inspection. With these two sources, the prices used in this study should be representative of real world situations.

The yield determination is more complicated. It consists of two parts; (i) calculating the physical yield from the plot, and (ii) determining how much of the grain is marketable. In other words, elevators do not pay for dockage (material other than wheat seed). Equation (6) is used to calculate the physical yield from the plot and convert it to a per acre basis.

$$AY_W(x) = [Wgt(x) / 60] \div [Size(x) / 43{,}560] \tag{6}$$

where, AY_W is the actual bushel per acre yield from the plot, *Wgt* represents the weight of the grain harvested from the plot, *Size* denotes the square footage of the plot, and *43,560* is the square feet per acre. This equation changes the weight per plot into bushels per acre. It works well when the weight of the plot (*Wgt*) is known. However, for some treatments *Wgt* was not measured.

For the Kice cleaning strategies, the direct weight of the grain after cleaning is not available because it was not measured. To achieve this needed information a system of equations (*figure 2-2*) was derived by Dr. John Solie and Byron Criner of the OSU Biosystems and Agricultural Engineering Department. These equations used four known variables (W_{in}, C_{in}, E_1, E_2) to calculate the four unknown variables (W_1, W_2, C_1, C_2). Three of the four known variables were acquired from data and grading of the 1997 wheat studies. The variable E_2 was estimated by taking samples of the Kice cleanings during 1998 field studies. These samples were evaluated by both Enid Grain Inspection and the Department of Plant and Soil Sciences of OSU to improve on the estimation process of the variable.

With the actual yield determined, equation 7 is used to derive the quantity of marketable grain.

$$Y_W(x) = [AY_W(x) * \{1 - \%Dock(x)\}] \tag{7}$$

This equation determines the bushels per acre of acceptable wheat. Thus, the results from equation 7, when combined with the results from equation 5, can be used to determine the gross revenue from wheat.

Gross Revenue for Cheat. The gross revenue determination for the cheat and cleanings was estimated from data collected. The feed analysis results from the cheat samples were compared to various feedstuffs in the NRC Nutrient Requirements of Beef Cattle. It was determined that on average the samples most closely represented the composition of oats (*Avena sativa*). Therefore, the Oklahoma 1997 average oat price of $2.40 per bushel was used to estimate the price for the cheat and cleanings (Oklahoma Crop Values - 1997). To account for the variation between the samples and test the sensitivity of the price of cheat, 80% and 50% of the oat price was be used as two approximate prices. Hence, prices for cheat and cleanings were $0.06 and $0.04 per pound. The per pound basis was used in cheat revenue determination because exact weight per bushel was not constant.

The yield of the cleanings was computed by equation (8). It is similar to the wheat yield calculations, although no adjustment for dockage is needed. Also, the standard weight measurement to convert pounds into bushels varied depending on the composition of the cleanings. Therefore yield calculation was left in pounds per acre.

$$Y_C(x) = Wgt(x) \div [Size(x) / 43,560] \tag{8}$$

This equation also poses similar problems, such as the lack of weight data. However, the same equation used to derive the weight for grain was used to derive the weight for the cheat. Thus, yield and gross revenue from the sale of cleanings was determined.

Costs. Costs were broken into two categories (Eq. 2). These operating costs (*OC*) and costs associated with the cleaning procedures of the trial systems (*CC*). Production costs were excluded from the budgets because they remain constant over differing acreage sizes, while *OC* and *CC* change depending on the representative farm size.

Machinery, labor, and harvest costs were included in the *OC* part, along with depreciation, interest, insurance, fuel, lubricants, and repairs. This portion of the costs segment was estimated by a modified version of *MACHSEL*, a farm machinery selection program (Kletke et al., 1991). The modification to the program was the addition of a combine to the machine complement section, making it possible to derive costs per acre for the harvester (National Farm Tractor and Implement Blue Book, 1992).

The *CC* division contains fixed and variable costs for the cleaning equipment used in the treatments, such as the cleaners, augers, hydraulic systems, cyclones, and an engine. The fixed costs included depreciation, interest, insurance, and taxes. The variable costs were repairs, fuel, and lubricants. Fuel and lubricants were only included for the Kice cleaner treatments because it has an engine.

Purchase price estimates were obtained from Dr. John Solie and Travis Tsunemori (E.I.) of the OSU Biosystems and Agricultural Engineering Department. The prototype bin-unit cleaner had three expected prices, $6,500, $13,000, and $19,500. The price variation allows manufacturing costs to be considered and adjustments made for larger farm sizes. Three different prices were also used for the Kice aspirator cleaner, $15,000, $30,000, and $45,000. This accounts for varying systems that may be used to handle the cleanings for small, medium, and large farms. Therefore, three different *CC* values were calculated for the Kice and bin-unit cleaners. These approximate prices were used with budgeting equations from the OSU Agricultural Economics Department to derive the various costs in this section. *Figure 2-3* contains a list of the equations used in the *CC* calculations (Kletke, 1979). Parameters *(figure 2-4)* for the equations were assumed to be similar to those of the combine, since the cleaners were operating for the same amount of time and acres and the same volume of wheat went through both machines. These costs allow for the determination of net returns above specific costs from the harvest systems being evaluated.

The *OC* and *CC* costs determined from the these procedures were constant for each location, but varied across farm size. At the 500 acre farm *(table 2-6)*, the operating costs were $62.78 per acre (/ac). It was estimated with the *MACHSEL* program and remained unchanged for each treatment at the four sites. Since three different initial price estimates were used, there were three separate *CC* values for the Kice and bin-unit strategies. The low cleaner cost was $4.55 /ac for the Kice and $1.87 /ac for the bin-unit. A cost of $8.86 /ac for the Kice and $3.74 /ac for the bin-unit was estimated for the medium *CC*. For the high cleaning equipment prices, the Kice had a value of $13.18 /ac and the bin-unit cleaner cost was $5.60 /ac. *OC* was $47.74 /ac, when it was estimated for the 1,000 acre farm size *(table 2-7)*. The cleaner cost values for the Kice strategies were $2.28, $4.43, and $6.59 /ac, for the low, medium, and high price estimates, respectively. The bin-unit cleaner costs were $0.93, $1.87, and $2.80 /ac for the bin-unit methods. The operating cost for the 1,500 acre size *(table 2-8)* was $45.51 /ac. *CC* values for the low, medium, and high cost options were $1.52, $2.95, and $4.39 /ac for the Kice cleaner and $0.62, $1.24, and $1.87 /ac for the bin-unit cleaner.

Timeliness costs are very difficult to estimate. When Short and Gitu (1991) compared the Boehlje and Eidman approach with that of the American Society of Agricultural Engineers (ASAE), significant differences were found. The ASAE estimates for timeliness costs were affected by the value of the crop, the price and/or the yield. The Boehlje and Eidman estimates for timeliness were affected only by yield. The Boehlje and Eidman procedure was somewhat *ad hoc* without clear guidelines on how timeliness coefficients were selected. The ASAE timeliness coefficients were the result of surveys and crop research reports. Since both guidelines and data are insufficient in the current study, timeliness costs were assumed to have little to no effect on the outcome of cost determination.

Returns. This is commonly known as *returns above specific costs*. Returns are the subtraction of costs from gross revenue (Eq. 2). For comparison purposes, it was computed on a per acre basis. To conduct sensitivity tests, three representative farm sizes of 500, 1,000, and 1,500 acres were used in the calculation of net returns. These sizes depict a small, medium, and large farming operation. When using *MACHSEL* with various acreage sizes the costs per acre differ, therefore the *OC* will also vary. To account for the three operations, different tractor combinations and combine setups were used in the *MACHSEL* program. By allowing the *CC* to be distributed over different land amounts, the costs per acre of the cleaning procedures were changed between farm sizes. The costs can then be subtracted from total gross revenue estimating the returns above operating and machinery costs, and possible showing the variation between farm sizes.

Net Benefit. When returns were obtained from the alternative systems they were compared to determine what benefits (if any) the experimental systems offered. A modified version of *opportunity profit* was used to conduct this analysis (Auld, Menz, and Tisdell, 1987). First the returns from the conventional scheme was subtracted from the returns of each alternative. This obtained a net benefit (or loss) per acre from using the alternative as opposed to the conventional method.

Then, if a net loss existed, an additional calculation was used to determined the amount of improvement needed in the yield of the subsequent year for the treatment to be effective. To begin, the base price of $3.28 per bushel was discounted by 5% to represent the possible price of $3.12 per bushel for the next year. Next each net loss was divided by this price. The result was the bushel per acre increase that was needed in year two for the treatment to be considered effective. This estimation offers some impression as to the plausibility of the alternative systems, by determining if the yield increase may be achievable (the lower the needed yield increase, the more attainable it is).

Figure 2-1. Treatments That Were Performed at the Four Locations

LOCATION	TREATMENTS CONDUCTED
RED ROCK	Normal Combine Settings. (*Conventional*) Normal Combine Settings, Bin Cleaner. (*Normal Bin-Unit*) Low Combine Air Settings. (*Low Air*) Low Combine Air Settings, Kice Cleaner. (*Low Air with Kice*) Low Combine Air Settings, Bin Cleaner. (*Low Air with Bin-Unit*) High Combine Air Settings. (*High Air*) High Combine Air Settings, Kice Cleaner. (*High Air with Kice*)
MARLAND	Normal Combine Settings. (*Conventional*) Normal Combine Settings, Bin Cleaner. (*Normal Bin-Unit*) Low Combine Air Settings. (*Low Air*) Low Combine Air Settings, Kice Cleaner. (*Low Air with Kice*) Low Combine Air Settings, Bin Cleaner. (*Low Air with Bin-Unit*) High Combine Air Settings. (*High Air*) High Combine Air Settings, Kice Cleaner. (*High Air with Kice*)
BILLINGS	Normal Combine Settings. (*Conventional*) Normal Combine Settings, Bin Cleaner. (*Normal Bin-Unit*) Low Combine Air Settings. (*Low Air*) Low Combine Air Settings, Kice Cleaner. (*Low Air with Kice*) Low Combine Air Settings, Bin Cleaner. (*Low Air with Bin-Unit*) High Combine Air Settings. (*High Air*) High Combine Air Settings, Kice Cleaner. (*High Air with Kice*)
HUNTER	Normal Combine Settings. (*Conventional*) Low Combine Air Settings. (*Low Air*) Low Combine Air Settings, Kice Cleaner. (*Low Air with Kice*)

Figure 2-2. **Equation System for Missing Data Solution**

(1) $$W_{in} = W_1 + W_2$$

(3) $$E_1 = C_1 / (C_1 + W_1)$$

(2) $$C_{in} = C_1 + C_2$$

(4) $$E_2 = W_2 / (C_2 + W_2)$$

Components:

W_{in} = total weight of the wheat contained in the inflow into the cleaner *(from 1997 data collection and grain grading results)*

W_1 = weight of the clean wheat in the trailer

W_2 = weight of the wheat material in the cleanings

C_{in} = total weight of the cheat contained in the inflow into the cleaner *(from 1997 data collection and grain grading results)*

C_1 = weight of the cheat in the trailer with the clean grain

C_2 = weight of the cheat in the cleanings

E_1 = efficiency rating for cheat in the clean grain *(from 1997 grading results)*

E_2 = efficiency rating for wheat in the cleanings *(estimation based on 1998 field test results)*

Figure 2-3. Budgeting Equations for *CC* Cost Determination

FIXED COSTS

$$\textit{Depreciation Cost per Hour} = \frac{(\text{Purchase Price} - \text{Salvage Value})}{(\text{Hours Used Annually} * \text{Years Owned})}$$

$$\textit{Interest Cost per Hour} = \frac{(\text{Purchase Price} + \text{Salvage Value}) * \text{Interest Rate}}{2 * \text{Hours Used Annually}}$$

$$\textit{Insurance Cost per Hour} = \frac{(\text{Purchase Price} + \text{Salvage Value}) * \text{Insurance Rate}}{2 * \text{Hours Used Annually}}$$

$$\textit{Tax Cost per Hour} = \frac{(\text{Purchase Price} * \text{Tax Rate})}{\text{Hours Used Annually}}$$

VARIABLE COSTS

$$\textit{Repair Cost per Hour} = \frac{(\text{Total Accumulated Repairs})}{(\text{Hours Used Annually} * \text{Year Owned})}$$

$$\text{Total Accumulated Repairs} = \text{Initial List Price} * \text{RC1} * \text{RC2} * (\text{Percent Life})^{\text{RC3}}$$

$$\text{Percent Life} = \frac{(\text{Years Owned} * \text{Hours Used Annually})}{\text{Hours of Life}}$$

(Only used for Kice, bin-unit does not have an engine)

$$\textit{Fuel Cost per Hour} = \text{Horsepower} * \text{Fuel Consumption Multiplier} * \text{Price per Gallon}$$

$$\textit{Lubricant per Hour} = .15 * \text{Fuel Cost per Hour}$$

COST PER ACRE CONVERSION

$$\textit{Cost per Acre} = \frac{(\text{Cost per Hour})}{(\text{Acre per Hour})}$$

Figure 2-4. **Cleaner Parameters Used with the Budgeting Equations to Derive *CC***

PURCHASE PRICES: **$15,000; $30,000; and $45,000 (for Kice)** **$6,500; $13,000; and $19,500 (for bin-unit)**	**INTEREST RATE: 0.09**
SALVAGE VALUE: $0	**INSURANCE RATE: 0.006**
HOURS USED ANNUALLY: 75.2	**TAX RATE: 0.01**
YEARS OWNED: 10	**RC1: 0.35**
HOURS OF LIFE: 2,000	**RC2: 0.000063**
FUEL CONSUMPTION MULTIPLIER: 0.048	**RC3: 2.1**
FUEL PRICE PER GALLON: 0.8	**ACRE PER HOUR: 7.31**
HORSEPOWER REQUIRED: 40	

Table 2-1. **Summary of Average Official Grade Results from Grain Samples for the Conventional and High Air Treatments**

Location	RED ROCK	MARLAND	BILLINGS	HUNTER
"CONVENTIONAL" TREATMENT				
Grade	4	2	1.8	1
Dockage (%)	14.8	5.0	1.4	0.5
Test Weight	54.6	59.5	59.4	61.8
Moisture	11.1	14.9	12.8	12.5
Damage	0.0	0.1	0.6	0.1
Foreign Material	1.0	0.1	0.1	0.1
Shrunken & Broken	1.3	0.4	0.7	0.9
Total Defects	2.3	0.6	1.3	1.1
"HIGH AIR" TREATMENT				
Grade	4.0	2.0	2.0	
Dockage (%)	12.3	2.9	0.6	
Test Weight	55.1	59.1	59.0	
Moisture	11.2	15.5	12.4	
Damage	0.2	0.1	0.1	
Foreign Material	0.6	0.1	0.2	
Shrunken & Broken	1.3	0.3	1.1	
Total Defects	2.0	0.5	1.3	

Table 2-2. Summary of Average Official Grade Results from Grain Samples of the Treatments involving the Bin-Unit Cleaner

Location	RED ROCK	MARLAND	BILLINGS
"NORMAL BIN-UNIT" TREATMENT			
Grade	3.8	2.0	2.0
Dockage (%)	11.5	3.5	1.2
Test Weight	55.2	59.4	59.4
Moisture	11.1	14.7	12.3
Damage	0.0	0.1	0.1
Foreign Material	0.6	0.3	0.1
Shrunken & Broken	1.1	0.8	0.7
Total Defects	1.7	1.2	0.9
"LOW AIR" AND "LOW AIR WITH BIN-UNIT" TREATMENT			
Grade	4.3	2.0	2.0
Dockage (%)	15.1	4.8	2.2
Test Weight	54.4	59.3	59.0
Moisture	11.5	14.8	12.2
Damage	.1	0.0	0.2
Foreign Material	2.1	0.2	0.2
Shrunken & Broken	1.0	0.3	0.8
Total Defects	1.8	0.6	1.2

Table 2-3. Summary of Average Official Grade Results from Grain Samples of the Treatments Involving the Kice Cleaner

Location	RED ROCK	MARLAND	BILLINGS	HUNTER
"LOW AIR WITH KICE" TREATMENT				
Grade	3.8	2.0	2.0	1.0
Dockage (%)	5.9	0.8	0.3	0.4
Test Weight	55.8	59.4	59.3	62.0
Moisture	11.7	15.2	12.5	11.1
Damage	0.0	0.0	0.2	0.0
Foreign Material	0.4	0.1	0.1	0.1
Shrunken & Broken	1.0	0.4	0.8	1.2
Total Defects	1.4	0.6	1.1	1.2
"HIGH AIR WITH KICE" TREATMENT				
Grade	2.8	2.0	2.0	
Dockage (%)	2.6	1.3	0.2	
Test Weight	56.6	59.5	59.6	
Moisture	11.4	15.9	12.7	
Damage	0.1	0.1	0.1	
Foreign Material	0.2	0.2	0.1	
Shrunken & Broken	0.9	0.4	0.8	
Total Defects	1.2	0.7	0.9	

Table 2-4. **Summary of Average Feed Analysis Results from Samples of Cleanings**

Location	Exp. #	A.S.	DM %	CP %	TDN %	Nem	NEg
BIN-UNIT CLEANINGS							
Red Rock	2	N	89.60	10.90	80.30	0.93	0.60
Marland	3	L	88.33	9.90	59.43	0.65	0.33
Billings	4	L	89.98	6.70	59.73	0.66	0.33
KICE CLEANINGS							
Red Rock	2	L	90.15	10.45	75.43	0.87	0.54
Red Rock	2	H	90.65	11.43	80.18	0.93	0.60
Marland	3	L	87.83	13.03	72.23	0.82	0.50
Marland	3	H	87.70	14.70	76.23	0.87	0.55
Billings	4	L	88.88	9.65	71.88	0.82	0.49
Billings	4	H	90.23	11.23	82.90	0.96	0.64
Hunter	5	L	91.18	7.38	50.73	0.54	0.21

Oats, grain*	89.00	13.30	77.00	0.84	0.55

Exp. # = *Experiment number*
A.S. = *combine air speed setting*
DM % = *percent dry matter*
CP% = *percent crude protein*
TDN% = *percent total digestible nutrient*
NEm = *net energy for maintenance in Mcal per lb.*
NEg = *net energy for gain in Mcal per lb.*

* *Nutrient Requirements for Beef Cattle. National Research Council. 1984*

Table 2-5. **Farmland Grain Division, Hard Red Winter Wheat Discount Schedule Enid, Oklahoma (Effective June 1, 1997)** (Discounts are cents per bushel)

Dockage		
Range		Discount
0.0	0.5	0.00
0.6	1.0	0.00
1.1	2.0	0.02
2.1	3.0	0.03
3.1	4.0	0.05
4.1	5.0	0.07
Plus for each 0.5% over 5.0		0.02

Moisture		
Range		Discount
13.6	13.7	0.02
13.8	14.0	0.04
14.1	14.2	0.06
14.3	14.5	0.08
14.6	14.7	0.10
14.8	15.0	0.12
Plus for each 0.25% over 15.0%		0.02

Total Damage		
Range		Discount
2.1	3.0	0.01
3.1	4.0	0.02
4.1	5.0	0.03
5.1	6.0	0.05
6.1	7.0	0.07
7.1	8.0	0.09
8.1	9.0	0.11
9.1	10.0	0.13
Plus for each 1.0% over 10.0		0.03

Foreign Material		
Range		Discount
0.5	0.7	0.005
0.8	1.0	0.03
1.1	1.3	0.05
1.4	2.0	0.06
2.1	2.5	0.07
2.6	3.0	0.08
3.1	4.0	0.10
4.1	5.0	0.12
Plus for each 1% over 5.0		0.02

Shrunken & Broken		
Range		Discount
3.1	4.0	0.005
4.1	5.0	0.01
5.1	6.0	0.03
6.1	7.0	0.04
7.1	8.0	0.05
8.1	9.0	0.06
9.1	10.0	0.07
Plus for each 1.0% over 10.0		0.01

Total Defects		
Range		Discount
3.1	4.0	0.005
4.1	5.0	0.01
5.1	6.0	0.03
6.1	7.0	0.05
7.1	8.0	0.07
8.1	9.0	0.09
9.1	10.0	0.11
(or greater of FM/DMG/S&B)		

Test Weight						
Range		Discount		Range		Discount
59.9	59.0	0.005		56.9	56.5	0.06
58.9	58.0	0.01		56.4	56.0	0.08
57.9	57.5	0.02		55.9	55.5	0.10
57.4	57.0	0.04		55.4	55.0	0.12
				Plus for each .5 lb below 55.0		0.03

Table 2-6. Cost Summary for the Treatments at the 500 Acre Farm

TREATMENT	OC	LOW CC	LOW COST OPTION	MED. CC	MED. COST OPTION	HIGH CC	HIGH COST OPTION
	$ per acre						
CONVENTIONAL	62.78	0.00	62.78	0.00	62.78	0.00	62.78
NORMAL BIN-UNIT	62.78	1.87	64.65	3.74	66.52	5.60	68.38
LOW AIR	62.78	0.00	62.78	0.00	62.78	0.00	62.78
LOW AIR WITH KICE	62.78	4.55	67.33	8.86	71.64	13.18	75.96
LOW AIR WITH BIN-UNIT	62.78	1.87	64.65	3.74	66.52	5.60	68.38
HIGH AIR	62.78	0.00	62.78	0.00	62.78	0.00	62.78
HIGH AIR WITH KICE	62.78	4.55	67.33	8.86	71.64	13.18	75.96

OC = operating costs derived from *MACHSEL*
Low CC = cleaner costs calculated with a $15,000 Kice purchase price or a $6,500 Bin-Unit purchase price
Med. CC = cleaner costs calculated with a $30,000 Kice purchase price or a $13,000 Bin-Unit purchase price
High CC = cleaner costs calculated with a $45,000 Kice purchase price or a $19,500 Bin-Unit purchase price

Table 2-7. Cost Summary for the Treatments at the 1,000 Acre Farm

Treatment	OC	Low CC	Low Cost Option	Med. CC	Med. Cost Option	High CC	High Cost Option
				$ per acre			
Conventional	47.74	0.00	47.74	0.00	47.74	0.00	47.74
Normal Bin-Unit	47.74	0.93	48.67	1.87	49.61	2.80	50.54
Low Air	47.74	0.00	47.74	0.00	47.74	0.00	47.74
Low Air with Kice	47.74	2.28	50.02	4.43	52.17	6.59	54.33
Low Air with Bin-Unit	47.74	0.93	48.67	1.87	49.61	2.80	50.54
High Air	47.74	0.00	47.74	0.00	47.74	0.00	47.74
High Air with Kice	47.74	2.28	50.02	4.43	52.17	6.59	54.33

OC = operating costs derived from *MACHSEL*
Low CC = cleaner costs calculated with a $15,000 Kice purchase price or a $6,500 Bin-Unit purchase price
Med. CC = cleaner costs calculated with a $30,000 Kice purchase price or a $13,000 Bin-Unit purchase price
High CC = cleaner costs calculated with a $45,000 Kice purchase price or a $19,500 Bin-Unit purchase price

Table 2-8. **Cost Summary for the Treatments at the 1,500 Acre Farm**

Treatment	OC	Low CC	Low Cost Option	Med. CC	Med. Cost Option	High CC	High Cost Option
	$ per acre						
Conventional	45.51	0.00	45.51	0.00	45.51	0.00	45.51
Normal Bin-Unit	45.51	0.62	46.13	1.24	46.75	1.87	47.38
Low Air	45.51	0.00	45.51	0.00	45.51	0.00	45.51
Low Air with Kice	45.51	1.52	47.03	2.95	48.46	4.39	49.90
Low Air with Bin-Unit	45.51	0.62	46.13	1.24	46.75	1.87	47.38
High Air	45.51	0.00	45.51	0.00	45.51	0.00	45.51
High Air with Kice	45.51	1.52	47.03	2.95	48.46	4.39	49.90

OC = operating costs derived from *MACHSEL*
Low CC = cleaner costs calculated with a $15,000 Kice purchase price or a $6,500 Bin-Unit purchase price
Med. CC = cleaner costs calculated with a $30,000 Kice purchase price or a $13,000 Bin-Unit purchase price
High CC = cleaner costs calculated with a $45,000 Kice purchase price or a $19,500 Bin-Unit purchase price

CHAPTER III

RED ROCK RESULTS

Preface

The Red Rock location had the highest cheat infestation of any site, this was based on the average dockage levels. There were seven treatments conducted at Red Rock. The *Conventional* was performed as the check system. The *Normal Bin-Unit* method and three low air options *(Low Air, Low Air with Kice,* and *Low Air with Bin-Unit)* were employed. Also, used were both high air strategies *(High Air* and *High Air with Kice)*.

Yields and Dockage

The dockage was calculated by Enid Grain Inspection from grain samples taken for each treatment *(table 3-1)*. This was combined with yield data to determine the dockage effects on yield. When an analysis of variance indicated significant difference across treatments, a Duncan multiple range test was performed to compare the treatment means.

The average wheat yield prior to dockage exhibited some statistical difference across methods. The *Conventional* and *Normal Bin-Unit* systems both had the highest mean yield before dock with 52 bushels per acre (bu/ac). The *High Air*, *Low Air*, and *Low Air with Bin-Unit* treatments had the next highest yield at 48 bu/ac. The *Low Air* and *Low Air with Bin-Unit* tactics were the same because they were performed at the same time on the same plots, the only difference in them was the sale of cheat for revenue and the cost of the cleaner in the determination of returns. Both of the remaining methods, *Low Air with Kice* and *High Air with Kice*, had the lowest average yield prior to dockage with 42 bu/ac.

The average dockage levels also varied significantly between certain treatments. The largest dockage levels were from the *Low Air* and *Low Air with Bin-Unit* systems, at 15.1%. The *Conventional* procedure was next with 14.8%, followed by the *High Air* method at 12.3%. The *Normal Bin-Unit* tactic had a mean dockage level of 11.5%. The treatments with the smallest dockage were the Kice cleaner strategies. The *Low Air with Kice* was 5.9% and the *High Air with Kice* was 2.6%.

Even though both wheat yield and dockage showed significant difference in treatments, the average yield after dockage reductions did not exhibit a statistical change between treatments. The *Normal Bin-Unit* method had the highest mean yield after dock with 46 bu/ac. The *Conventional* and *High Air* systems followed with yields of 44 and 43 bu/ac, respectively. There were three treatments with the average yield after dockage of 41 bu/ac. They were the *Low Air, Low Air with Bin-Unit, and High Air with Kice* procedures. The lowest yield was from the *Low Air with Kice* at 39 bu/ac.

Gross Revenues

Dockage effects on yield were combined with the price after discounts to achieve the gross revenue from wheat sales *(table 3-1)*. The *High Air with Kice* and *Normal Bin-Unit* treatments had average gross revenues for wheat of $130.84 and $130.71 per acre (/ac). The *Low Air with Kice* revealed mean gross revenue of $120.18 /ac, followed the *High Air* tactic at $119.13 /ac, and the *Conventional* system with $117.67 /ac. The *Low*

Air and *Low Air with Bin-Unit* were, of course, the same with a $106.91 /ac average gross revenue. Across the treatments, there was not a significant difference at the 5% level in average gross revenue for wheat.

Gross revenue from the expected sale of cheat and cleanings was calculated using two different prices, $0.06 and $0.04 per pound. This allowed the sensitivity of the cheat price to be tested. When these prices were applied to the weight of the cleanings per acre, a gross revenue for cheat sales per acre was determined. This was only needed for the four treatments that involved wheat cleaning. The *High Air with Kice* procedure had an average cheat gross revenue of $23.00 /ac with the high price and $15.33 /ac with the low price. Gross revenue for *Low Air with Kice* ranked next at $22.91 and $15.27 /ac for the two cheat prices, respectively. The *Low Air with Bin-Unit* treatment resulted in a mean gross revenue of $16.53 and $11.02 /ac. The *Normal Bin-Unit* method was last with $3.56 and $2.37 /ac. There was statistical difference between the gross revenues obtained for the treatments.

Red Rock 500 Acre Farm

Returns and Net Benefit (Loss). Returns were computed by subtracting the total of operating (*OC*) and cleaner related costs (*CC*) from the total gross revenue for wheat and cheat. The *OC* and *CC* estimates varied between farm sizes, but remained constant for the four locations. They were discussed in the *cost* section of *chapter 2*. Since there were two different cheat prices and three different cost estimates for the Kice and bin-unit strategies, each of these treatments at the 500 acre farm had six possible returns above the specific costs *(tables 3-2, 3-3, and 3-4)*. The *Conventional*, *Low Air*, and *High Air* systems remained constant because they had neither cleanings to sell nor included the variable *CC* section in their cost determination. Once returns above *OC* and *CC* were established for the alternatives, they were compared to the *Conventional* system to determine if any benefit or loss existed. If net loss was present, then the required yield increase for the subsequent year necessary to cover the loss was estimated to show the feasibility of adopting the alternative over the *Conventional*. To calculated this yield increase the base price of $3.28 per bushel was discounted 5% to represent the preceding year's price.

The *Conventional* system revealed an average return of $54.89 per acre (/ac) at the 500 acre farm size. The *Low Air* treatment had a return of $44.13 /ac, this resulted in a $10.76 /ac net loss and a required yield increase of 3.45 bushels per acre (bu/ac). Mean return from the *High Air* treatment was $56.35 /ac, a $1.46 /ac net benefit over the *Conventional* method.

The low cost option was considered first. At the $0.06 and $0.04 per pound cheat prices, the *Normal Bin-Unit* strategy showed average returns of $69.92 and $68.43 /ac, respectively. These resulted in net benefits of $14.73 and $13.54 /ac. The *Low Air with Bin-Unit* had returns of $58.79 and $53.28 /ac. One created a net benefit of $3.90 /ac and the other a net loss of $1.61 /ac, with a required yield increase of 0.52 bu/ac. When the medium cost alternative was analyzed the returns were lowered. The *Normal Bin-Unit* treatment had mean returns of $67.75 and $66.56 /ac for the high and low cheat prices, respectively. These resulted in net benefits of $12.86 and $11.67 /ac. The *Low Air with Bin-Unit* procedure displayed average returns of $56.92 and $51.41 /ac, creating a net benefit of $2.03 /ac and a net loss of $3.48 /ac, with a required yield increase of 1.12 bu/ac. For the high cost option, the *Normal Bin-Unit* tactic had returns of $65.89 and

$64.70 /ac, with benefits of $11.00 and $9.81 /ac over the *Conventional* system. Average returns for the *Low Air with Bin-Unit* went down to $55.06 and $49.55 /ac. They resulted in a net benefit of $0.17 and a net loss of $5.34 /ac, with a needed yield increase of 1.71 bu/ac.

Returns from the Kice strategies varied depending upon cheat price and estimated cost. Given the low cost option, the *Low Air with Kice* treatment had a return of $75.76 /ac with high cheat price, and $68.12 /ac with the low cheat price. This resulted in a $20.86 and $13.23 /ac net benefit, respectively. The *High Air with Kice* procedure showed returns of $86.51 and $78.84 /ac and benefits of $31.61 and $23.95 /ac. With the medium cost option, the *Low Air with Kice* method had returns of $71.54 and $63.81 /ac. The resulting net benefits were $16.55 and $8.92 /ac. The returns from the *High Air with Kice* treatment were $82.20 and $74.53 /ac, with benefits of $27.30 and $19.64 /ac over the *Conventional* system. For the high cost option, returns for *Low Air with Kice* dropped to $67.13 and $59.49 /ac, and the benefits went to $12.23 and $4.60 /ac. The *High Air with Kice* returns were now $77.88 and $70.21 /ac, with $22.98 and $15.32 /ac net benefits.

<u>Summary</u>. Even though it seems there was a difference in returns between the alternatives and *Conventional*, there was not a statistical difference at the 5% level. Although, a slight difference did exist between alternatives. It was determined that when cheat price decreases and/or cleaner costs increase the improvements on revenue were reduced, even to the point were there was not a significant difference between any of the treatments *(table 3-5)*.

Red Rock 1,000 Acre Farm

Returns and Net Benefit (Loss). At the 1,000 acre farm, there were still two different cheat prices and three different cost estimates for the Kice and bin-unit strategies *(tables 3-5, 3-6, and 3-7)*. Therefore, each of these treatments had six possible returns above *OC* and *CC*. The *Conventional*, *Low Air*, and *High Air* systems remained constant. With the increase in acreage size the returns also increased for each treatment. Once returns were established for the alternatives, they were compared to the *Conventional* system to determine if any benefit or loss existed. If net loss was present, then yield increase for the subsequent year was estimated to show the feasibility of adopting the alternative over the *Conventional*.

The *Conventional* system revealed an average return of \$69.93 per acre (/ac) at the 1,000 acre farm size. The *Low Air* treatment had a return of \$59.17 /ac, resulting in a \$10.76 /ac net loss and a required yield increase of 3.45 bushels per acre (bu/ac). Return from the *High Air* treatment was \$71.39 /ac, a \$1.46 /ac net benefit over the *Conventional* method.

Given the low cost option, at the high and low cheat prices the *Normal Bin-Unit* strategy showed mean returns of \$85.60 and \$84.41 /ac, respectively. The net benefits that resulted were \$15.67 and \$14.48 /ac. The *Low Air with Bin-Unit* had returns of \$74.77 and \$69.26 /ac. One created a net benefit of \$4.84 /ac and the other a net loss of \$0.67 /ac, with a required yield increase of 0.22 bu/ac. For the medium cost alternative, the *Normal Bin-Unit* treatment exhibited average returns of \$84.66 and \$83.47, with net benefits of \$14.73 and \$13.54 /ac. Returns for the *Low Air with Bin-Unit* tactic were \$73.83 and \$68.32 /ac. This created a net benefit of \$3.90 /ac and a net loss of \$1.61 /ac, with a required yield increase of 0.52 bu/ac for the subsequent year. With the high cost option, returns were reduced even more. The *Normal Bin-Unit* procedure had mean returns of $83.73 and $82.54 /ac, and net benefits of $13.80 and $12.61 /ac. The *Low Air with Bin-Unit* returns were $72.90 and $67.39 /ac, with a net benefit of $2.97 and a net loss of $2.54 /ac. To offset the loss a yield increase of 0.82 bu/ac was required.

The *Low Air with Kice* treatment had a average return of $93.07 /ac with high cheat price, and $85.43 /ac with the low cheat price. This created net benefits of $23.13 and $15.50 /ac, respectively. The *High Air with Kice* tactic had returns of $103.82 and $96.15 /ac and benefits of $33.88 and $26.22 /ac. With the medium cost option, the *Low Air with Kice* method had returns of $90.92 and $83.28 /ac. The resulting net benefits were $20.98 and $13.35 /ac. The mean returns from the *High Air with Kice* treatment were $101.67 and $94.00 /ac, with benefits of $31.73 and $24.07 /ac over the *Conventional* system. For the high cost option, average returns for *Low Air with Kice* dropped to $88.76 and $81.12 /ac, and the benefits went to $18.82 and $11.19 /ac. The *High Air with Kice* returns were now $99.51 and $91.84 /ac, with $29.57 and $21.91 /ac net benefits.

<u>Summary</u>. Even with the increase in acreage, there were no significant differences in returns between the alternatives and *Conventional* system. The difference between the *High Air with Kice* and the *Low Air* alternatives still existed. Again, when cheat price decreases and/or cleaner costs increase the improvements on revenue were reduced. However, with the larger farm size the statistical difference between alternative treatments was maintained. The effect of varying cleaner cost was lessened with a higher acreage level.

Red Rock 1,500 Acre Farm

Returns and Net Benefit (Loss). At the 1,500 acre farm, each Kice and bin-unit strategy *(tables 3-8, 3-9, and 3-10)* still had six possible returns above *OC* and *CC*, while the *Conventional*, *Low Air*, and *High Air* systems remained constant. Again, when the acreage size increased the returns also increased for each treatment. Returns were established for the alternatives and compared to the *Conventional* system to determine if any benefit or loss existed. If net loss was estimated, the required yield increase for the subsequent year necessary to cover the additional was estimated to compare the consequences of adopting the alternative over the *Conventional*.

The *Conventional* system exhibited an average return of $72.16 per acre (/ac) at the 1,500 acre farm size. The *Low Air* treatment had a return of $61.40 /ac, resulting in a $10.76 /ac net loss and a required yield increase of 3.45 bushels per acre (bu/ac). Return from the *High Air* treatment was $73.62 /ac, a $1.46 /ac net benefit over the *Conventional* method.

With the low cost option, the *Normal Bin-Unit* strategy had average returns of $88.14 and $86.95 /ac, for the high and low cheat prices, respectively. The net benefits that resulted were $15.98 and $14.79 /ac. The *Low Air with Bin-Unit* showed returns of $77.31 and $71.80 /ac. One created a net benefit of $5.15 /ac and the other a net loss of $0.36 /ac, with a required yield increase of 0.12 bu/ac. For the medium cost estimates, the *Normal Bin-Unit* treatment had average returns of $87.52 and $86.33 /ac, with net benefits of $15.36 and $14.17 /ac. Returns for the *Low Air with Bin-Unit* system were $76.69 and $71.18 /ac. This created a net benefit of $4.53 /ac and a net loss of $0.98 /ac, with a required yield increase of 0.32 bu/ac for the subsequent year. With the high cost alternative, returns were reduced even more. The *Normal Bin-Unit* procedure had mean returns of $86.89 and $85.70 /ac, and net benefits of $14.73 and $13.54 /ac. The *Low Air with Bin-Unit* returns were $76.06 and $70.55 /ac, with a net benefit of $3.90 and a net loss of $1.61 /ac. To offset the loss a yield increase of 0.52 bu/ac was required.

Using the low cost option, the *Low Air with Kice* treatment had a mean return of $96.06 /ac with high cheat price, and $88.42 /ac with the low cheat price. This created net benefits of $23.89 and $16.26 /ac, respectively. The *High Air with Kice* tactic displayed returns of $106.81 and $99.14 /ac, with benefits of $34.64 and $26.98 /ac. With the medium cost option, the *Low Air with Kice* average returns decreased to $94.63 and $86.99 /ac. The resulting net benefits were $22.46 and $14.83 /ac. The mean returns from the *High Air with Kice* treatment were $105.38 and $97.71 /ac, and benefits were $33.21 and $25.55 /ac over the *Conventional* system. For the high cost option, returns for *Low Air with Kice* dropped to $93.19 and $85.55 /ac, and the benefits went to $21.02 and $13.39 /ac. The *High Air with Kice* average returns were now $103.94 and $96.27 /ac, with $31.77 and $24.11 /ac as net benefits.

Summary. When the acreage was increased, the statistical difference between treatments changed. At the low cost option for the high cheat price, the *High Air with Kice* alternative was significantly different from the *Conventional* system. Although, when the cheat price was lowered or the cost estimate was increased this difference was eliminated. Differences also existed within the alternatives, but no other treatment was statistically different from the *Conventional*. It was again determined that when cheat price decreases and/or cleaner costs increase the improvements on revenue were reduced. However, with the 1,500 farm size the statistical difference that existed between the alternative treatments was sustained through more cost options than the smaller acreages.

Red Rock Conclusions

Since the *High Air with Kice* alternative provided the largest benefit over the *Conventional* system at Red Rock, it could be chosen as the most profitable. However, there was only a significant difference between the two treatments for the 1,500 acre farm with the high cheat price and low cost option. With a statistical advantage in merely one of the eighteen combinations of cheat prices, cost options, and farm sizes, it could be concluded that the *High Air with Kice* strategy does not consistently improve returns to the point of significance. Therefore, a wheat producer with a high cheat infestation would probably be unwilling to select an alternative harvesting method over the *Conventional* system.

Table 3-1. Summary of the Averages for Treatments at the Red Rock Location

Treatment	Wheat Yield	Dockage	Yield After Dockage	Price after Discounts	Gross Rev. for Wheat	Gross Rev. for Cheat $0.06 / lb	Gross Rev. for Cheat $0.04 / lb
	bu / ac	%	bu / ac	$ / bu	$ / ac		
Conventional	52*a	14.8*a	44*	2.64*c	117.67*	0.00*c	0.00*c
Normal Bin-Unit	52a	11.5ab	46	2.82bc	130.71	3.56c	2.37c
Low Air	48abc	15.1a	41	2.60c	106.91	0.00c	0.00c
Low Air with Kice	42c	5.9bc	39	3.05ab	120.18	22.91a	15.27a
Low Air with Bin-Unit	48abc	15.1a	41	2.60c	106.91	16.53b	11.02b
High Air	48ab	12.3a	43	2.78bc	119.13	0.00c	0.00c
High Air with Kice	42bc	2.6c	41	3.19a	130.84	23.00a	15.33a

* Means in a column followed by the same letter or no letter are not significantly different at P= 0.05, Duncan's multiple range test; some rounding error exists within the averages.
Gross Rev.= gross revenue
$0.06 / lb = a high cheat price per pound
$0.04 / lb = a low cheat price per pound
bu /ac = bushels per acre
$ / bu = dollars per bushel
$ / ac = dollars per acre

Table 3-2. Average Net Returns at the Red Rock 500 Acre Farm With the Low Cost Option

TREATMENT	NET RET. HIGH CHT. $	NET BENEFIT (OR LOSS)	REQUIRED YIELD INCR.	NET RET. LOW CHT. $	NET BENEFIT (OR LOSS)	REQUIRED YIELD INCR.
	dollars per acre		*bushels / acre*	*dollars per acre*		*bushels / acre*
CONVENTIONAL	54.89*ab	—	—	54.89*	—	—
NORMAL BIN-UNIT	69.92ab	14.73	—	68.43	13.54	—
LOW AIR	44.13b	-10.76	3.45	44.13	-10.76	3.45
LOW AIR WITH KICE	75.76ab	20.86	—	68.12	13.23	—
LOW AIR WITH BIN-UNIT	58.79ab	3.90	—	53.28	-1.61	0.52
HIGH AIR	56.35ab	1.46	—	56.35	1.46	—
HIGH AIR WITH KICE	86.51a	31.61	—	78.84	23.95	—

* Means in a column followed by the same letter or no letter are not significantly different at P= 0.05, Duncan's multiple range test; some rounding error exists within the averages.

Net Ret. High Cht. $ = returns above *OC* and *CC* determined with the $0.06/lb cheat price

Net Ret. Low Cht. $ = returns above *OC* and *CC* determined with the $0.04/lb cheat price

Required Yield Incr. = the required yield increase

Table 3-3. **Average Net Returns at the Red Rock 500 Acre Farm With the Medium Cost Option**

Treatment	Net Ret. High Cht. $	Net Benefit (or Loss)	Required Yield Incr.	Net Ret. Low Cht. $	Net Benefit (or Loss)	Required Yield Incr.
	——dollars per acre——		*bushels / acre*	*——dollars per acre——*		*bushels / acre*
Conventional	54.89*ab	—	—	54.89*	—	—
Normal Bin-Unit	67.75ab	12.86	—	66.56	11.67	—
Low Air	44.13b	-10.76	3.45	44.13	-10.76	3.45
Low Air with Kice	71.54ab	16.55	—	63.81	8.92	—
Low Air with Bin-Unit	56.92ab	2.03	—	51.41	-3.48	1.12
High Air	56.35ab	1.46	—	56.35	1.46	—
High Air with Kice	82.20a	27.30	—	74.53	19.64	—

* Means in a column followed by the same letter or no letter are not significantly different at P= 0.05, Duncan's multiple range test; some rounding error exists within the averages.
Net Ret. High Cht. $ = returns above *OC* and *CC* determined with the $0.06/lb cheat price
Net Ret. Low Cht. $ = returns above *OC* and *CC* determined with the $0.04/lb cheat price
Required Yield Incr. = the required yield increase

Table 3-4. **Average Net Returns at the Red Rock 500 Acre Farm With the High Cost Option**

Treatment	Net Ret. High Cht. $	Net Benefit (or Loss)	Required Yield Incr.	Net Ret. Low Cht. $	Net Benefit (or Loss)	Required Yield Incr.
	dollars per acre		*bushels / acre*	*dollars per acre*		*bushels / acre*
Conventional	54.89*	—	—	54.89*	—	—
Normal Bin-Unit	65.89	11.00	—	64.70	9.81	—
Low Air	44.13	-10.76	3.45	44.13	-10.76	3.45
Low Air with Kice	67.13	12.23	—	59.49	4.60	—
Low Air with Bin-Unit	55.06	0.17	—	49.55	-5.34	1.71
High Air	56.35	1.46	—	56.35	1.46	—
High Air with Kice	77.88	22.98	—	70.21	15.32	—

* Means in a column followed by the same letter or no letter are not significantly different at P= 0.05, Duncan's multiple range test; some rounding error exists within the averages.

Net Ret. High Cht. $ = returns above *OC* and *CC* determined with the $0.06/lb cheat price

Net Ret. Low Cht. $ = returns above *OC* and *CC* determined with the $0.04/lb cheat price

Required Yield Incr. = the required yield increase

Table 3-5. **Average Net Returns at the Red Rock 1,000 Acre Farm With the Low Cost Option**

Treatment	Net Ret. High Cht. $	Net Benefit (or Loss)	Required Yield Incr.	Net Ret. Low Cht. $	Net Benefit (or Loss)	Required Yield Incr.
	dollars per acre		*bushels / acre*	*dollars per acre*		*bushels / acre*
Conventional	69.93*ab	—	—	69.93*ab	—	—
Normal Bin-Unit	85.60ab	15.67	—	84.41ab	14.48	—
Low Air	59.17b	-10.76	3.45	59.17b	-10.76	3.45
Low Air with Kice	93.07ab	23.13	—	85.43ab	15.50	—
Low Air with Bin-Unit	74.77ab	4.84	—	69.26ab	-0.67	0.22
High Air	71.39ab	1.46	—	71.39ab	1.46	—
High Air with Kice	103.82a	33.88	—	96.15a	26.22	—

* Means in a column followed by the same letter or no letter are not significantly different at P= 0.05, Duncan's multiple range test; some rounding error exists within the averages.
Net Ret. High Cht. $ = returns above *OC* and *CC* determined with the $0.06/lb cheat price
Net Ret. Low Cht. $ = returns above *OC* and *CC* determined with the $0.04/lb cheat price
Required Yield Incr. = the required yield increase

Table 3-6. Average Net Returns at the Red Rock 1,000 Acre Farm With the Medium Cost Option

TREATMENT	NET RET. HIGH CHT. $	NET BENEFIT (OR LOSS)	REQUIRED YIELD INCR.	NET RET. LOW CHT. $	NET BENEFIT (OR LOSS)	REQUIRED YIELD INCR.
	dollars per acre		*bushels / acre*	*dollars per acre*		*bushels / acre*
CONVENTIONAL	69.93*ab	—	—	69.93*	—	—
NORMAL BIN-UNIT	84.66ab	14.73	—	83.47	13.54	—
LOW AIR	59.17b	-10.76	3.45	59.17	-10.76	3.45
LOW AIR WITH KICE	90.92ab	20.98	—	83.28	13.35	—
LOW AIR WITH BIN-UNIT	73.83ab	3.90	—	68.32	-1.61	0.52
HIGH AIR	71.39ab	1.46	—	71.39	1.46	—
HIGH AIR WITH KICE	101.67a	31.73	—	94.00	24.07	—

* Means in a column followed by the same letter or no letter are not significantly different at P= 0.05, Duncan's multiple range test; some rounding error exists within the averages.

Net Ret. High Cht. $ = returns above *OC* and *CC* determined with the $0.06/lb cheat price

Net Ret. Low Cht. $ = returns above *OC* and *CC* determined with the $0.04/lb cheat price

Required Yield Incr. = the required yield increase

Table 3-7. **Average Net Returns at the Red Rock 1,000 Acre Farm With the High Cost Option**

TREATMENT	NET RET. HIGH CHT. $	NET BENEFIT (OR LOSS)	REQUIRED YIELD INCR.	NET RET. LOW CHT. $	NET BENEFIT (OR LOSS)	REQUIRED YIELD INCR.
	dollars per acre		*bushels / acre*	*dollars per acre*		*bushels / acre*
CONVENTIONAL	69.93*ab	—	—	69.93*	—	—
NORMAL BIN-UNIT	83.73ab	13.80	—	82.54	12.61	—
LOW AIR	59.17b	-10.76	3.45	59.17	-10.76	3.45
LOW AIR WITH KICE	88.76ab	18.82	—	81.12	11.19	—
LOW AIR WITH BIN-UNIT	72.90ab	2.97	—	67.39	-2.54	0.82
HIGH AIR	71.39ab	1.46	—	71.39	1.46	—
HIGH AIR WITH KICE	99.51a	29.57	—	91.84	21.91	—

* Means in a column followed by the same letter or no letter are not significantly different at P= 0.05, Duncan's multiple range test; some rounding error exists within the averages.

Net Ret. High Cht. $ = returns above *OC* and *CC* determined with the $0.06/lb cheat price

Net Ret. Low Cht. $ = returns above *OC* and *CC* determined with the $0.04/lb cheat price

Required Yield Incr. = the required yield increase

Table 3-8. **Average Net Returns at the Red Rock 1,500 Acre Farm With the Low Cost Option**

TREATMENT	NET RET. HIGH CHT. $	NET BENEFIT (OR LOSS)	REQUIRED YIELD INCR.	NET RET. LOW CHT. $	NET BENEFIT (OR LOSS)	REQUIRED YIELD INCR.
	dollars per acre		*bushels / acre*	*dollars per acre*		*bushels / acre*
CONVENTIONAL	72.16*bc	—	—	72.16*ab	—	—
NORMAL BIN-UNIT	88.14abc	15.98	—	86.95ab	14.79	—
LOW AIR	61.40c	-10.76	3.45	61.40b	-10.76	3.45
LOW AIR WITH KICE	96.06ab	23.89	—	88.42ab	16.26	—
LOW AIR WITH BIN-UNIT	77.31abc	5.15	—	71.80ab	-0.36	0.12
HIGH AIR	73.62abc	1.46	—	73.62ab	1.46	—
HIGH AIR WITH KICE	106.81a	34.64	—	99.14a	26.98	—

* Means in a column followed by the same letter or no letter are not significantly different at P= 0.05, Duncan's multiple range test; some rounding error exists within the averages.

Net Ret. High Cht. $ = returns above *OC* and *CC* determined with the $0.06/lb cheat price

Net Ret. Low Cht. $ = returns above *OC* and *CC* determined with the $0.04/lb cheat price

Required Yield Incr. = the required yield increase

Table 3-9. Average Net Returns at the Red Rock 1,500 Acre Farm With the Medium Cost Option

Treatment	Net Ret. High Cht. $	Net Benefit (or Loss)	Required Yield Incr.	Net Ret. Low Cht. $	Net Benefit (or Loss)	Required Yield Incr.
	dollars per acre		*bushels / acre*	*dollars per acre*		*bushels / acre*
Conventional	72.16*ab	—	—	72.16*ab	—	—
Normal Bin-Unit	87.52ab	15.36	—	86.33ab	14.17	—
Low Air	61.40b	-10.76	3.45	61.40b	-10.76	3.45
Low Air with Kice	94.63ab	22.46	—	86.99ab	14.83	—
Low Air with Bin-Unit	76.69ab	4.53	—	71.18ab	-0.98	0.32
High Air	73.62ab	1.46	—	73.62ab	1.46	—
High Air with Kice	105.38a	33.21	—	97.71a	25.55	—

* Means in a column followed by the same letter or no letter are not significantly different at P= 0.05, Duncan's multiple range test; some rounding error exists within the averages.

Net Ret. High Cht. $ = returns above *OC* and *CC* determined with the $0.06/lb cheat price

Net Ret. Low Cht. $ = returns above *OC* and *CC* determined with the $0.04/lb cheat price

Required Yield Incr. = the required yield increase

Table 3-10. Average Net Returns at the Red Rock 1,500 Acre Farm With the High Cost Option

TREATMENT	NET RET. HIGH CHT. $	NET BENEFIT (OR LOSS)	REQUIRED YIELD INCR.	NET RET. LOW CHT. $	NET BENEFIT (OR LOSS)	REQUIRED YIELD INCR.
	dollars per acre		*bushels / acre*	*dollars per acre*		*bushels / acre*
CONVENTIONAL	72.16*ab	—	—	72.16*	—	—
NORMAL BIN-UNIT	86.89ab	14.73	—	85.70	13.54	—
LOW AIR	61.40b	-10.76	3.45	61.40	-10.76	3.45
LOW AIR WITH KICE	93.19ab	21.02	—	85.55	13.39	—
LOW AIR WITH BIN-UNIT	76.06ab	3.90	—	70.55	-1.61	0.52
HIGH AIR	73.62ab	1.46	—	73.62	1.46	—
HIGH AIR WITH KICE	103.94a	31.77	—	96.27	24.11	—

* Means in a column followed by the same letter or no letter are not significantly different at P= 0.05, Duncan's multiple range test; some rounding error exists within the averages.

Net Ret. High Cht. $ = returns above *OC* and *CC* determined with the $0.06/lb cheat price

Net Ret. Low Cht. $ = returns above *OC* and *CC* determined with the $0.04/lb cheat price

Required Yield Incr. = the required yield increase

CHAPTER IV

MARLAND RESULTS

Preface

The Marland site had a much smaller cheat population than Red Rock. However, it did rank as the second worst cheat infestation of the four locations. This was based on the average dockage level from the grain samples. The same seven treatments that were conducted at Red Rock were also performed at Marland. The *Conventional* was the check system. The *Normal Bin-Unit* method, the three low air options *(Low Air, Low Air with Kice*, and *Low Air with Bin-Unit)*, and both high air strategies *(High Air* and *High Air with Kice)* were the alternatives.

Yields and Dockage

Dockage for each treatment was calculated by Enid Grain Inspection from grain samples taken in the field *(table 4-1)*. This information was combined with yield data to determine the effect of dockage on yield. Analysis of variance was performed to determine if any significant difference existed across treatments. In the event of significant differences across treatments the Duncan multiple means comparison test was used.

The average wheat yield before dockage was statistically different. The *High Air with Kice* treatment was significantly lower than the *Conventional* system. The *Conventional* had the highest mean yield before dock with 58 bushels per acre (bu/ac).

The *Low Air* and *Low Air with Bin-Unit* tactics both had yields of 57 bu/ac. These two treatments were the same because they were performed at the same time on the same plots, the only difference in them was the sale of cheat for revenue and the cost of the cleaner in the determination of returns. The *Normal Bin-Unit* treatment was next with 55 bu/ac and the *Low Air with Kice* had a yield of 54 bu/ac. The two high air options had the lowest yields. The *High Air* and *High Air with Kice* average yields prior to dockage were 52 and 51 bu/ac, respectively.

The average dockage levels had significant variability across treatments. The largest dockage level was 5.0% from the *Conventional* procedure, followed by the *Low Air* and *Low Air with Bin-Unit* systems at 4.8%. The *Normal Bin-Unit* tactic had a mean dockage level of 3.5%. The *High Air* treatment was next at 2.9%. The treatments with the smallest dockage were the Kice cleaner strategies. The *High Air with Kice* was 1.3% and the *Low Air with Kice* was 0.8%.

There were no significant differences in average yield after dockage reductions across treatments. The *Conventional* method had the highest mean yield after dock with 55 bu/ac. The *Low Air* and *Low Air with Bin-Unit* systems followed with a yield of 54 bu/ac. Then, there was the *Normal Bin-Unit* and *Low Air with Kice* treatments at 53 bu/ac. The lowest average yield was from the *High Air* and *High Air with Kice* procedures with 39 bu/ac.

Gross Revenues

Dockage effects on yield were combined with the price after discounts to achieve the gross revenue from wheat sales *(table 4-1)*. The *Conventional* and *Low Air with Kice* treatments had average gross revenues for wheat of $169.78 and $167.33 per acre (/ac), respectively. The *Low Air* and *Low Air with Bin-Unit* were, of course, the same with a $166.63 /ac average gross revenue. Mean gross revenue for the *Normal Bin-Unit* was $165.53 /ac, followed the *High Air* tactic at $156.37 /ac, and the *High Air with Kice* system with $155.60 /ac. There was not a significant difference across the treatments at the 5% level in average gross revenue for wheat.

Gross revenue from the expected sale of cheat and cleanings was calculated using two different prices, $0.06 and $0.04 per pound. This allowed the sensitivity of the cheat price to be tested. When these prices were applied to the weight of the cleanings per acre, a gross revenue for cheat sales per acre was determined. This was only needed for the four treatments that involved wheat cleaning. The *Low Air with Bin-Unit* procedure had an average cheat gross revenue of $14.26 /ac with the high price and $9.50 /ac with the low price. Gross revenue for *Low Air with Kice* was next at $10.73 and $7.15 /ac. The *High Air with Kice* treatment resulted in a mean gross revenue of $3.99 and $2.66 /ac for the two cheat prices. The *Normal Bin-Unit* method was last with $1.98 and $1.32 /ac, respectively. There was statistical difference across treatments for gross revenues from the sale of cheat.

Marland 500 Acre Farm

Returns and Net Benefit (Loss). Returns were calculated by subtracting the total of *OC* and *CC* from the total gross revenue for wheat and cheat. The *OC* and *CC* estimates varied between farm sizes, but remained constant for the four locations. They were discussed in the *cost* section of *chapter 2*. With two different cheat prices and three different cost estimates, the Kice and bin-unit strategies had six possible returns above the specific costs at the 500 acre level *(tables 4-2, 4-3, and 4-4)*. The *Conventional*, *Low Air*, and *High Air* systems remained constant because they had neither cleanings to sell nor included the variable *CC* section in their cost determination. As previously stated at the Red Rock site, returns above *OC* and *CC* for the alternatives were compared to the *Conventional* system to determine if any benefit or loss existed. Then, if a net loss was present, the required yield increase for the subsequent year necessary to cover the loss was estimated to show the feasibility of adopting the alternative over the *Conventional*. To calculate this yield increase the price of $3.12 per bushel (base price discounted 5%) represented the succeeding year's price.

The *Conventional* system had an average return of $107.00 per acre (/ac) at the 500 acre farm size. The *Low Air* treatment had a return of $103.85 /ac, this resulted in a $3.15 /ac net loss relative to the *Conventional* system and a required yield increase of 1.01 bushels per acre (bu/ac). Mean return from the *High Air* treatment was $93.59 /ac, a $13.41 /ac net loss, with a required yield increase of 4.30 bu/ac.

The low cost option was considered first. At the $0.06 and $0.04 per pound cheat prices, the *Normal Bin-Unit* strategy showed average returns of $102.86 and $102.20 /ac, respectively. These resulted in net losses of $4.14 and $4.80 /ac, with required yield increases of 1.33 and 1.54 bu/ac. The *Low Air with Bin-Unit* had returns of $116.24 and $111.49 /ac, creating net benefits of $9.24 /ac and $4.49 /ac. When the medium cost alternative was analyzed the returns were lowered. The *Normal Bin-Unit* treatment had mean returns of $100.99 and $100.33 /ac for the high and low cheat prices, respectively. Net losses for these returns were $6.01 and $6.67 /ac, with 1.93 and 2.14 required yield increases. The *Low Air with Bin-Unit* procedure displayed average returns of $114.37 and $109.62 /ac, producing net benefits of $7.37 and $2.62 /ac. For the high cost option, the *Normal Bin-Unit* tactic had returns of $99.13 and $98.47 /ac, with losses of $7.87 and $8.53 /ac. The yield increases necessary to offset these losses were 2.52 and 2.73 bu/ac. Average returns for the *Low Air with Bin-Unit* were $112.51 and $107.76 /ac. They resulted in net benefits of $5.51 and $0.76 /ac, over the *Conventional* system.

Returns from the Kice strategies varied depending upon cheat price and estimated cost. Given the low cost option, the *Low Air with Kice* treatment revealed an average return of $110.73 /ac with the high cheat price, and $107.15 /ac with the low cheat price. This resulted in a $3.73 and $0.15 /ac net benefit, respectively. The *High Air with Kice* method had returns of $92.26 and $90.93 /ac and losses of $14.74 and $16.07 /ac, with required yield increases of 4.72 and 5.15 bu/ac. With the medium cost option, the *Low Air with Kice* tactic showed mean returns of $106.42 and $102.84 /ac. The resulting net losses were $0.58 and $4.16 /ac, producing a needed yield increase of 0.19 and 1.33 bu/ac. The average returns from the *High Air with Kice* treatment were $87.95 and $86.62 /ac, with losses of $19.05 and $20.38 /ac and needed yield increases of 6.11 and 6.53 bu/ac. For the high cost option, returns for *Low Air with Kice* dropped to $102.10 and $98.52 /ac, and the losses went to $4.90 and $8.48 /ac. They required yield increases of 1.57 and 2.72 bu/ac for the subsequent year. The *High Air with Kice* returns were $83.63 and $82.30 /ac, resulting in net losses of $23.37 and $24.70 /ac, with needed yield increases of 7.49 and 7.92 bu/ac.

Summary. Even though there appears to be a vast difference in returns between the alternatives and *Conventional*, there was not a statistical improvement over the check system at the 5% level. However, for the high cost option and high cheat price, the *Conventional* system had returns that were significantly larger than the high air strategies.

A slight difference also existed between the *Low Air with Bin-Unit* and high air strategies at various cost options and cheat prices. It was determined that when cheat price decreases and/or cleaner costs increase the harvesting alternatives were less likely to be economical. Also, decreases in revenue were enhanced, making them statistically lower than other alternatives *(table 4-4)*.

Marland 1,000 Acre Farm

Returns and Net Benefit (Loss). At the 1,000 acre farm, the Kice and bin-unit strategies still had six possible returns above *OC* and *CC (tables 4-5, 4-6, and 4-7)*. The *Conventional*, *Low Air*, and *High Air* systems remained constant. With the increase in acreage size the returns also increased for each treatment. After returns were established for the alternatives, they were compared to the *Conventional* system to determine if any benefit or loss existed. If net loss was present, then yield increase for the subsequent year was estimated to show the feasibility of adopting the alternative over the *Conventional*.

The *Conventional* system revealed an average return of $122.04 per acre (/ac) at the 1,000 acre farm size. The *Low Air* treatment had a return of $118.89 /ac, resulting in a $3.15 /ac net loss and a required yield increase of 1.01 bushels per acre (bu/ac). Mean return from the *High Air* treatment was $108.63 /ac, a $13.41 /ac net loss, and a needed yield increase of 4.30 bu/ac.

Given the low cost option, at the high and low cheat prices the *Normal Bin-Unit* strategy showed mean returns of $118.84 and $118.18 /ac, respectively. The net losses that resulted were $3.20 and $3.86 /ac, requiring yield increases of 1.03 and 1.24 bu/ac. The *Low Air with Bin-Unit* had returns of $132.22 and $127.47 /ac. They created net benefits of $10.18 and $5.43 /ac. For the medium cost alternative, the *Normal Bin-Unit* treatment exhibited average returns of $117.90 and $117.24, with net losses of $4.14 and $4.80 /ac, and needed yield increases of 1.33 and 1.54 bu/ac for the subsequent year. Returns for the *Low Air with Bin-Unit* tactic were $131.28 and $126.53 /ac. This produced net benefits of $9.24 and $4.49 /ac. With the high cost option, returns were reduced even more. The *Normal Bin-Unit* procedure had mean returns of $116.97 and $116.31 /ac, creating net losses of $5.07 and $5.73 /ac. To offset the losses, yield increases of 1.63 and 1.84 bu/ac would be required. The *Low Air with Bin-Unit* returns were $130.35 and $125.60 /ac, with net benefits of $8.31 and $3.56 /ac.

The *Low Air with Kice* treatment had, with low cost option, a average return of $128.04 /ac with high cheat price, and $124.46 /ac with the low cheat price. This created net benefits of $6.00 and $2.42 /ac, respectively. The *High Air with Kice* tactic had returns of $109.57 and $108.24 /ac, with net losses of $12.47 and $13.80 /ac, and required 4.00 and 4.42 bu/ac increase in yields. With the medium cost option, the *Low Air with Kice* method had returns of $125.89 and $122.31 /ac. They resulted in $3.85 and $0.27 /ac net benefits. The mean returns from the *High Air with Kice* treatment were $107.42 and $106.09 /ac. They produced net losses of $14.62 and $15.95 /ac and needed yield increases of 4.69 and 5.11 bu/ac. For the high cost option, average returns for *Low Air with Kice* dropped to $123.73 and $120.15 /ac. One resulted in a $1.69 /ac net benefit and the other a net loss of $1.89 /ac, with a 0.61 required yield increase. The *High Air with Kice* returns were now $105.26 and $103.93 /ac, with $16.78 and $18.11 /ac in net losses. The necessary yield increases in the subsequent year were 5.38 and 5.80 bu/ac, respectively.

Summary. Even with the increase in acreage, there were no significant differences in returns between the alternatives and *Conventional* system. The difference between the *Low Air* treatments and high air alternatives still existed. Again, when cheat price decreases and/or cleaner costs increase the negative effects on revenue were enhanced.

Marland 1,500 Acre Farm

Returns and Net Benefit (Loss). At the 1,500 acre farm, each Kice and bin-unit strategy *(tables 4-8, 4-9, and 4-10)* had six possible returns above *OC* and *CC*, while the *Conventional*, *Low Air*, and *High Air* systems remained constant. Again, when the acreage size increased, costs per acre declined and the returns increased for each treatment. Returns were established for the alternatives and compared to the *Conventional* system to determine if any benefit or loss existed. If net loss was estimated, the required yield increase for the subsequent year necessary to cover the additional cost was estimated to compare the consequences of adopting the alternative over the *Conventional*.

The *Conventional* system exhibited an average return of \$124.27 per acre (/ac) at the 1,500 acre farm size. The *Low Air* treatment had a return of \$121.12 /ac, resulting in a \$3.15 /ac net loss and a required yield increase of 1.01 bushels per acre (bu/ac). Return from the *High Air* treatment was \$110.86 /ac. This created a net loss of \$13.41 /ac and a required yield increase of 4.30 bu/ac.

With the low cost option, the *Normal Bin-Unit* strategy had average returns of \$121.38 and \$120.72 /ac, for the high and low cheat prices, respectively. The net losses produced were \$2.89 and \$3.55 /ac, with required yield increases of 0.93 and 1.14 bu/ac. The *Low Air with Bin-Unit* showed mean returns of \$134.76 and \$130.01 /ac, creating net benefits at $10.49 and $5.74 /ac. For the medium cost estimates, the *Normal Bin-Unit* treatment had average returns of $120.76 and $120.10 /ac, with net losses of $3.51 and $4.17 /ac. The needed yield increases for the subsequent year were 1.13 and 1.34 bu/ac. Returns for the *Low Air with Bin-Unit* system were $134.14 and $129.39 /ac. This resulted in net benefits of $9.87 and $5.12 /ac. With the high cost alternative, returns were reduced even more. The *Normal Bin-Unit* treatment had mean returns of $120.13 and $119.47 /ac, net losses at $4.14 and $4.80 /ac, and 1.33 and 1.54 bu/ac as the required yield increases. The *Low Air with Bin-Unit* returns were $133.51 and $128.76 /ac, with net benefits of $9.24 and $4.49 /ac.

Using the low cost option, the *Low Air with Kice* treatment showed an average return of $131.03 /ac with the high cheat price, and $127.45 /ac with the low cheat price. This created net benefits of $6.76 and $3.18 /ac, respectively. The *High Air with Kice* method had returns of $112.56 and $111.23 /ac, with losses of $11.71 and $13.04 /ac, requiring yield increases of 3.75 and 4.18 bu/ac. With the medium cost option, the *Low Air with Kice* average returns decreased to $129.60 and $126.02 /ac. The resulting net benefits were $5.33 and $1.75 /ac. The mean returns from the *High Air with Kice* treatment were $111.13 and $109.80 /ac. These returns produced net losses at $13.14 and $14.47 /ac, with 4.21 and 4.64 bu/ac needed yield increases. For the high cost option, returns for *Low Air with Kice* method decreased to $128.16 and $124.58 /ac, and the benefits went to $3.89 and $0.31 /ac. The *High Air with Kice* average returns were now $109.69 and $108.36 /ac, with $14.58 and $15.91 /ac as net losses. The required increase in yields to offset these losses was 4.67 and 5.10 bu/ac.

Summary. When the acreage was increased, the statistical difference between treatments was lessened. No alternatives were significantly different from the *Conventional* system, and the difference across alternatives was reduced with the farm size increase. It was again determined that when cheat price decreases and/or cleaner costs increase the improvements in revenue were reduced and losses in revenue due to the alternatives were magnified.

Marland Conclusions

The most profitable treatment was the *Low Air with Bin-Unit* alternative. It provided the largest benefit over the *Conventional* system at every cost option and cheat price. However, there were no significant differences between the two treatments at the 5% level for Marland. Without a statistical advantage, it could be concluded that this strategy does not significantly improve returns. Hence, a wheat producer with a similar cheat infestation may not consider altering the harvesting method from the *Conventional* system to one of the alternatives that were studied. Even though an increase in revenue exists, it was not determined to be statistically significant.

Table 4-2. **Average Net Returns at the Marland 500 Acre Farm With the Low Cost Option**

Treatment	Net Ret. High Cht. $	Net Benefit (or Loss)	Required Yield Incr.	Net Ret. Low Cht. $	Net Benefit (or Loss)	Required Yield Incr.
	dollars per acre		*bushels / acre*	*dollars per acre*		*bushels / acre*
Conventional	107.00*ab	—	—	107.00*	—	—
Normal Bin-Unit	102.86ab	-4.14	1.33	102.20	-4.80	1.54
Low Air	103.85ab	-3.15	1.01	103.85	-3.15	1.01
Low Air with Kice	110.73ab	3.73	—	107.15	0.15	—
Low Air with Bin-Unit	116.24a	9.24	—	111.49	4.49	—
High Air	93.59b	-13.41	4.30	93.59	-13.41	4.30
High Air with Kice	92.26b	-14.74	4.72	90.93	-16.07	5.15

* Means in a column followed by the same letter or no letter are not significantly different at P= 0.05, Duncan's multiple range test; some rounding error exists within the averages.

Net Ret. High Cht. $ = returns above *OC* and *CC* determined with the $0.06/lb cheat price

Net Ret. Low Cht. $ = returns above *OC* and *CC* determined with the $0.04/lb cheat price

Required Yield Incr. = the required yield increase

Table 4-3. **Average Net Returns at the Marland 500 Acre Farm With the Medium Cost Option**

TREATMENT	NET RET. HIGH CHT. $	NET BENEFIT (OR LOSS)	REQUIRED YIELD INCR.	NET RET. LOW CHT. $	NET BENEFIT (OR LOSS)	REQUIRED YIELD INCR.
	dollars per acre		*bushels / acre*	*dollars per acre*		*bushels / acre*
CONVENTIONAL	107.00*ab	—	—	107.00*ab	—	—
NORMAL BIN-UNIT	100.99ab	-6.01	1.93	100.33ab	-6.67	2.14
LOW AIR	103.85ab	-3.15	1.01	103.85ab	-3.15	1.01
LOW AIR WITH KICE	106.42ab	-0.58	0.19	102.84ab	-4.16	1.33
LOW AIR WITH BIN-UNIT	114.37a	7.37	—	109.62a	2.62	—
HIGH AIR	93.59b	-13.41	4.30	93.59ab	-13.41	4.30
HIGH AIR WITH KICE	87.95b	-19.05	6.11	86.62b	-20.38	6.53

* Means in a column followed by the same letter or no letter are not significantly different at P= 0.05, Duncan's multiple range test; some rounding error exists within the averages.

Net Ret. High Cht. $ = returns above *OC* and *CC* determined with the $0.06/lb cheat price

Net Ret. Low Cht. $ = returns above *OC* and *CC* determined with the $0.04/lb cheat price

Required Yield Incr. = the required yield increase

Table 4-4. **Average Net Returns at the Marland 500 Acre Farm With the High Cost Option**

TREATMENT	NET RET. HIGH CHT. $	NET BENEFIT (OR LOSS)	REQUIRED YIELD INCR.	NET RET. LOW CHT. $	NET BENEFIT (OR LOSS)	REQUIRED YIELD INCR.
	dollars per acre		*bushels / acre*	*dollars per acre*		*bushels / acre*
CONVENTIONAL	107.00*a	—	—	107.00*a	—	—
NORMAL BIN-UNIT	99.13ab	-7.87	2.52	98.47ab	-8.53	2.73
LOW AIR	103.85ab	-3.15	1.01	103.85a	-3.15	1.01
LOW AIR WITH KICE	102.10ab	-4.90	1.57	98.52ab	-8.48	2.72
LOW AIR WITH BIN-UNIT	112.51a	5.51	—	107.76a	0.76	—
HIGH AIR	93.59ab	-13.41	4.30	93.59ab	-13.41	4.30
HIGH AIR WITH KICE	83.63b	-23.37	7.49	82.30b	-24.70	7.92

* Means in a column followed by the same letter or no letter are not significantly different at P= 0.05, Duncan's multiple range test; some rounding error exists within the averages.

Net Ret. High Cht. $ = returns above *OC* and *CC* determined with the $0.06/lb cheat price

Net Ret. Low Cht. $ = returns above *OC* and *CC* determined with the $0.04/lb cheat price

Required Yield Incr. = the required yield increase

Table 4-5. Average Net Returns at the Marland 1,000 Acre Farm With the Low Cost Option

Treatment	Net Ret. High Cht. $	Net Benefit (or Loss)	Required Yield Incr.	Net Ret. Low Cht. $	Net Benefit (or Loss)	Required Yield Incr.
	dollars per acre		*bushels / acre*	*dollars per acre*		*bushels / acre*
Conventional	122.04*ab	—	—	122.04*	—	—
Normal Bin-Unit	118.84ab	-3.20	1.03	118.18	-3.86	1.24
Low Air	118.89ab	-3.15	1.01	118.89	-3.15	1.01
Low Air with Kice	128.04ab	6.00	—	124.46	2.42	—
Low Air with Bin-Unit	132.22a	10.18	—	127.47	5.43	—
High Air	108.63b	-13.41	4.30	108.63	-13.41	4.30
High Air with Kice	109.57b	-12.47	4.00	108.24	-13.80	4.42

* Means in a column followed by the same letter or no letter are not significantly different at P= 0.05, Duncan's multiple range test; some rounding error exists within the averages.

Net Ret. High Cht. $ = returns above *OC* and *CC* determined with the $0.06/lb cheat price

Net Ret. Low Cht. $ = returns above *OC* and *CC* determined with the $0.04/lb cheat price

Required Yield Incr. = the required yield increase

Table 4-6. Average Net Returns at the Marland 1,000 Acre Farm With the Medium Cost Option

Treatment	Net Ret. High Cht. $	Net Benefit (or Loss)	Required Yield Incr.	Net Ret. Low Cht. $	Net Benefit (or Loss)	Required Yield Incr.
	dollars per acre		*bushels / acre*	*dollars per acre*		*bushels / acre*
Conventional	122.04*ab	—	—	122.04*	—	—
Normal Bin-Unit	117.90ab	-4.14	1.33	117.24	-4.80	1.54
Low Air	118.89ab	-3.15	1.01	118.89	-3.15	1.01
Low Air with Kice	125.89ab	3.85	—	122.31	0.27	—
Low Air with Bin-Unit	131.28a	9.24	—	126.53	4.49	—
High Air	108.63b	-13.41	4.30	108.63	-13.41	4.30
High Air with Kice	107.42b	-14.62	4.69	106.09	-15.95	5.11

* Means in a column followed by the same letter or no letter are not significantly different at P= 0.05, Duncan's multiple range test; some rounding error exists within the averages.
Net Ret. High Cht. $ = returns above *OC* and *CC* determined with the $0.06/lb cheat price
Net Ret. Low Cht. $ = returns above *OC* and *CC* determined with the $0.04/lb cheat price
Required Yield Incr. = the required yield increase

Table 4-7. **Average Net Returns at the Marland 1,000 Acre Farm With the High Cost Option**

Treatment	Net Ret. High Cht. $	Net Benefit (or Loss)	Required Yield Incr.	Net Ret. Low Cht. $	Net Benefit (or Loss)	Required Yield Incr.
	dollars per acre		*bushels / acre*	*dollars per acre*		*bushels / acre*
Conventional	122.04*ab	—	—	122.04*ab	—	—
Normal Bin-Unit	116.97ab	-5.07	1.63	116.31ab	-5.73	1.84
Low Air	118.89ab	-3.15	1.01	118.89ab	-3.15	1.01
Low Air with Kice	123.73ab	1.69	—	120.15ab	-1.89	0.61
Low Air with Bin-Unit	130.35a	8.31	—	125.60a	3.56	—
High Air	108.63b	-13.41	4.30	108.63ab	-13.41	4.30
High Air with Kice	105.26b	-16.78	5.38	103.93b	-18.11	5.80

* Means in a column followed by the same letter or no letter are not significantly different at P= 0.05, Duncan's multiple range test; some rounding error exists within the averages.

Net Ret. High Cht. $ = returns above *OC* and *CC* determined with the $0.06/lb cheat price

Net Ret. Low Cht. $ = returns above *OC* and *CC* determined with the $0.04/lb cheat price

Required Yield Incr. = the required yield increase

Table 4-8. Average Net Returns at the Marland 1,500 Acre Farm With the Low Cost Option

Treatment	Net Ret. High Cht. $	Net Benefit (or Loss)	Required Yield Incr.	Net Ret. Low Cht. $	Net Benefit (or Loss)	Required Yield Incr.
	dollars per acre		*bushels / acre*	*dollars per acre*		*bushels / acre*
Conventional	124.27*ab	—	—	124.27*	—	—
Normal Bin-Unit	121.38ab	-2.89	0.93	120.72	-3.55	1.14
Low Air	121.12ab	-3.15	1.01	121.12	-3.15	1.01
Low Air with Kice	131.03ab	6.76	—	127.45	3.18	—
Low Air with Bin-Unit	134.76a	10.49	—	130.01	5.74	—
High Air	110.86b	-13.41	4.30	110.86	-13.41	4.30
High Air with Kice	112.56b	-11.71	3.75	111.23	-13.04	4.18

* Means in a column followed by the same letter or no letter are not significantly different at P= 0.05, Duncan's multiple range test; some rounding error exists within the averages.

Net Ret. High Cht. $ = returns above *OC* and *CC* determined with the $0.06/lb cheat price

Net Ret. Low Cht. $ = returns above *OC* and *CC* determined with the $0.04/lb cheat price

Required Yield Incr. = the required yield increase

Table 4-9. Average Net Returns at the Marland 1,500 Acre Farm With the Medium Cost Option

Treatment	Net Ret. High Cht. $	Net Benefit (or Loss)	Required Yield Incr.	Net Ret. Low Cht. $	Net Benefit (or Loss)	Required Yield Incr.
	dollars per acre		*bushels / acre*	*dollars per acre*		*bushels / acre*
Conventional	124.27*ab	—	---	124.27*	—	—
Normal Bin-Unit	120.76ab	-3.51	1.13	120.10	-4.17	1.34
Low Air	121.12ab	-3.15	1.01	121.12	-3.15	1.01
Low Air with Kice	129.60ab	5.33	—	126.02	1.75	—
Low Air with Bin-Unit	134.14a	9.87	—	129.39	5.12	—
High Air	110.86b	-13.41	4.30	110.86	-13.41	4.30
High Air with Kice	111.13b	-13.14	4.21	109.80	-14.47	4.64

* Means in a column followed by the same letter or no letter are not significantly different at P= 0.05, Duncan's multiple range test; some rounding error exists within the averages.

Net Ret. High Cht. $ = returns above *OC* and *CC* determined with the $0.06/lb cheat price

Net Ret. Low Cht. $ = returns above *OC* and *CC* determined with the $0.04/lb cheat price

Required Yield Incr. = the required yield increase

Table 4-10. **Average Net Returns at the Marland 1,500 Acre Farm With the High Cost Option**

Treatment	Net Ret. High Cht. $	Net Benefit (or Loss)	Required Yield Incr.	Net Ret. Low Cht. $	Net Benefit (or Loss)	Required Yield Incr.
	dollars per acre		*bushels / acre*	*dollars per acre*		*bushels / acre*
Conventional	124.27*ab	—	—	124.27*	—	—
Normal Bin-Unit	120.13ab	-4.14	1.33	119.47	-4.80	1.54
Low Air	121.12ab	-3.15	1.01	121.12	-3.15	1.01
Low Air with Kice	128.16ab	3.89	—	124.58	0.31	—
Low Air with Bin-Unit	133.51a	9.24	—	128.76	4.49	—
High Air	110.86b	-13.41	4.30	110.86	-13.41	4.30
High Air with Kice	109.69b	-14.58	4.67	108.36	-15.91	5.10

* Means in a column followed by the same letter or no letter are not significantly different at P= 0.05, Duncan's multiple range test; some rounding error exists within the averages.

Net Ret. High Cht. $ = returns above *OC* and *CC* determined with the $0.06/lb cheat price

Net Ret. Low Cht. $ = returns above *OC* and *CC* determined with the $0.04/lb cheat price

Required Yield Incr. = the required yield increase

CHAPTER V

BILLINGS RESULTS

Preface

The Billings location had a slightly lower cheat population than Marland, resulting in the second smallest cheat infestation of the four sites. This was based on the average dockage level from the grain samples. The same seven treatments that were conducted at Red Rock and Marland were also performed at Billings. The *Conventional* was the check system. The *Normal Bin-Unit* method, the three low air options *(Low Air, Low Air with Kice*, and *Low Air with Bin-Unit)*, and both high air strategies *(High Air* and *High Air with Kice)* were the alternatives.

Yields and Dockage

The dockage results were combined with yield data to calculate the effect of dockage on yield *(table 5-1)*. An analysis of variance was conducted to determine if there was differences across treatments. If a difference existed, a Duncan multiple range test was performed to compare the treatment means.

The average wheat yield before dockage did not exhibit a statistical difference across the treatments. The *High Air* and *High Air with Kice* methods had the highest mean yields before dock with 42 bushels per acre (bu/ac). The *Conventional, Low Air*, and *Low Air with Bin-Unit* treatments were next with yields of 41 bu/ac. The two low air options were the same because they were performed at the same time on the same plots, the only difference in them was the sale of cheat for revenue and the cost of the cleaner in the determination of returns. The *Low Air with Kice* treatment had an average yield of 40 bu/ac and the *Normal Bin-Unit* was 39 bu/ac.

With less cheat infestation at Billings, the average dockage levels only had a slight significant variability across treatments. The largest dockage level was 2.2% from the *Low Air* and *Low Air with Bin-Unit* systems, followed by the *Conventional* procedure at 1.4% and the *Normal Bin-Unit* tactic at 1.2%. The *High Air* treatment had the next mean dockage level at 0.6%. The treatments with the smallest dockage were the Kice cleaner strategies. The *Low Air with Kice* was 0.3% and the *High Air with Kice* was 0.2%.

The average yield after dockage reductions showed no statistical difference across treatments. The *High Air* and *High Air with Kice* methods had the highest mean yield after dock with 42 bu/ac. The *Conventional*, *Low Air*, *Low Air with Kice*, and *Low Air with Bin-Unit* systems followed with yields at 40 bu/ac. The lowest average yield was from the *Normal Bin-Unit* treatment with 39 bu/ac.

<u>Gross Revenues</u>

The yield after dockage was combined with the price after discounts to achieve the gross revenue from wheat sales *(table 5-1)*. The *High Air with Kice* and *High Air* treatments had average gross revenues for wheat of $137.65 and $137.52 per acre (/ac), respectively. The mean gross revenues for the *Conventional* and *Low Air with Kice* strategies were $130.26 and $130.00 /ac. The *Low Air* and *Low Air with Bin-Unit* were, of course, the same with a $129.74 /ac average gross revenue. Gross revenue for the *Normal Bin-Unit* was $124.84 /ac. There was not a significant difference across the treatments at the 5% level in average gross revenue for wheat.

The sensitivity of cheat price was tested by using two different prices, $0.06 and $0.04 per pound, to calculate gross revenue for the expected sale of cheat and cleanings. When these prices were applied to the weight of the cleanings per acre, a gross revenue for cheat sales per acre was determined. This was only needed for the four treatments that involved wheat cleaning. The *Low Air with Bin-Unit* procedure had an average cheat gross revenue of $10.62 /ac with the high price and $7.08 /ac with the low price. Gross revenue for *Low Air with Kice* was next at $3.67 and $2.44 /ac. The *Normal Bin-Unit* treatment resulted in a mean gross revenue of $0.76 and $0.51 /ac for the two cheat prices. The *High Air with Kice* method was last with $0.71 and $0.47 /ac, respectively. There was statistical difference across treatments for gross revenues.

Billings 500 Acre Farm

Returns and Net Benefit (Loss). Returns were calculated by subtracting the total of *OC* (operating cost) and *CC* (cleaner costs) from the total gross revenue for wheat and cheat. The *OC* and *CC* estimates varied between farm sizes, but were the same for the four sites. They were discussed in the *cost* section of *chapter 2*. With two different cheat prices and three different cost estimates, the Kice and bin-unit strategies had six possible returns above the specific costs at the 500 acre level *(tables 5-2, 5-3, and 5-4)*. The *Conventional*, *Low Air*, and *High Air* systems remained constant. Returns from the experimental methods were compared to the *Conventional* system to determine if any benefit or loss existed. Then, if a net loss was present, the required yield increase for the subsequent year necessary to cover the loss was estimated. To calculate the required yield increase the base price of $3.28 per bushel was discounted 5% to represent the succeeding year's price.

The *Conventional* system had an average return of $67.48 per acre (/ac) at the 500 acre farm size. The *Low Air* treatment had a return of $66.96 /ac, this resulted in a $0.52 /ac net loss and a required yield increase of 0.17 bushels per acre (bu/ac). Mean return from the *High Air* treatment was $74.74 /ac, a $7.26 /ac net benefit over the *Conventional* method.

When the low cost option was considered, the *Normal Bin-Unit* strategy showed average returns of $60.95 and $60.69 /ac, respectively, for the $0.06 and $0.04 per pound cheat prices. These resulted in net losses of $6.53 and $6.79 /ac, with needed yield increases of 2.09 and 2.18 bu/ac. The *Low Air with Bin-Unit* had returns of $75.71 and $72.17 /ac, creating net benefits relative to the *Conventional* system of $8.23 /ac and $4.69 /ac. The medium cost alternative lowered average returns. The *Normal Bin-Unit* treatment had mean returns of $59.08 and $58.82 /ac for the high and low cheat prices, respectively. Net losses for these returns relative the *Conventional* system were $8.40 and $8.66 /ac, with 2.69 and 2.77 required yield increases. The *Low Air with Bin-Unit* procedure showed average returns of $73.84 and $70.30 /ac, producing net benefits of $6.36 and $2.82 /ac. For the high cost option, the *Normal Bin-Unit* tactic had returns of $57.22 and $56.96 /ac, with losses of $10.26 and $10.52 /ac. The yield increase necessary to offset these losses were 3.29 and 3.37 bu/ac. Average returns for the *Low Air with Bin-Unit* went down to $71.98 and $68.44 /ac. They resulted in net benefits of $4.50 and $0.96 /ac, over the *Conventional* system.

The Kice strategies had varying returns depending upon cheat price and cost estimate. Given the low cost option, the *Low Air with Kice* treatment revealed an average return of $66.33 /ac with high cheat price, and $65.11 /ac with the low cheat price. This resulted in $1.15 and $2.37 /ac net losses, producing a needed yield increase of 0.37 and 0.67 bu/ac. The *High Air with Kice* method had returns of $71.03 and $70.80 /ac and benefits of $3.55 and $3.32 /ac. With the medium cost option, the *Low Air with Kice* tactic showed mean returns of $62.02 and $60.80 /ac. The resulting net losses were $5.46 and $6.68 /ac, with required yield increases of 1.75 and 2.14 bu/ac. The average returns from the *High Air with Kice* treatment were $66.72 and $66.49 /ac, with losses of $0.76 and $0.99 /ac and needed yield increases of 0.24 and 0.32 bu/ac. For the high cost option, returns for *Low Air with Kice* decreased to $57.70 and $56.48 /ac, and the losses went to $9.78 and $11.00 /ac. They required yield increases of 3.13 and 3.53 bu/ac for the subsequent year. The *High Air with Kice* returns were now $62.40 and $62.17 /ac, creating net losses of $5.08 and $5.31 /ac, with needed yield increases of 1.63 and 1.70 bu/ac.

Summary. No statistical difference existed across the treatments for any of the cost options or cheat prices at the 500 acre farm. However as these variables changed improvements on revenue were reduced and decreases in revenue were heightened. This indicated that for the cheat infestation level at the Billings location none of the alternative harvest systems were superior to the *Conventional* system in terms of generating net revenue.

Billings 1,000 Acre Farm

Returns and Net Benefit (Loss). At the 1,000 acre farm, the Kice and bin-unit strategies still had six possible returns above *OC* and *CC (tables 5-5, 5-6, and 5-7)*. The *Conventional*, *Low Air*, and *High Air* systems remained constant. With the increase in acreage size the returns also increased for each treatment. Net benefits or losses of the alternatives over the *Conventional* system were determined. If net loss was present, then yield increase for the subsequent year was estimated to show the feasibility of adopting the alternative over the *Conventional*.

The *Conventional* system revealed an average return of $82.52 per acre (/ac) at the 1,000 acre farm size. The *Low Air* treatment had a return of $82.00 /ac, resulting in a $0.52 /ac net loss relative to the *Conventional* and a required yield increase of 0.17 bushels per acre (bu/ac). Mean return from the *High Air* treatment was $89.78 /ac, with a net benefit of $7.26 /ac over the *Conventional* method.

Given the low cost option, at the high and low cheat prices the *Normal Bin-Unit* strategy showed mean returns of $76.93 and $76.67 /ac, respectively. The net losses that resulted were $5.59 and $5.85 /ac, requiring yield increases of 1.79 and 1.87 bu/ac. The *Low Air with Bin-Unit* had returns of $91.96 and $88.15 /ac. They created net benefits of $9.17 and $5.63 /ac. For the medium cost alternative, the *Normal Bin-Unit* treatment exhibited average returns of $75.99 and $75.73, with net losses of $6.53 and $6.79 /ac, and needed yield increases of 2.09 and 2.18 bu/ac for the subsequent year. Returns for the *Low Air with Bin-Unit* tactic were $90.75 and $87.21 /ac. This produced net benefits of $8.23 and $4.69 /ac. With the high cost option, returns were reduced even more. The *Normal Bin-Unit* procedure had mean returns of $75.06 and $74.80 /ac, creating net losses of $7.46 and $7.72 /ac. To offset the losses yield increases of 2.39 and 2.47 bu/ac were required. The *Low Air with Bin-Unit* returns were $89.82 and $86.28 /ac, with net benefits of $7.30 and $3.76 /ac.

The average return for the *Low Air with Kice* treatment was $83.64 /ac with high cheat price, and $82.42 /ac with the low cheat price. One created a net benefit of $1.12 /ac and the other a net loss of $0.10 /ac, requiring a 0.03 bu/ac yield increase. The *High Air with Kice* tactic had returns of $88.34 and $88.11 /ac, with net benefits at $5.82 and $5.59 /ac. With the medium cost option, the *Low Air with Kice* method had returns of $81.49 and $80.27 /ac. They resulted in $1.03 and $2.25 /ac net losses and needed yield increases of 0.33 and 0.72 bu/ac. The mean returns from the *High Air with Kice* treatment were $86.19 and $85.96 /ac. They produced net benefits of $3.67 and $3.44 /ac over the *Conventional* system. For the high cost option, average returns for *Low Air with Kice* dropped to $79.33 and $78.11 /ac, resulting in net losses of $3.19 and $4.41 /ac, and required yield increases of 1.02 and 1.41 bu/ac. The *High Air with Kice* returns were now $84.03 and $83.80 /ac, with $1.51 and $1.28 /ac in net benefits.

Summary. Again, there were no significant differences in returns between the alternatives and *Conventional* system. A change in cheat price and/or cleaner costs resulted in negative effects on revenue, however, with the increase in farm size certain alternatives now had benefits over the *Conventional* under certain circumstances. At the 1,000 acre size, the *High Air with Kice* treatment showed positive effects at each cost option and for both cheat prices, and the *Low Air with Kice* method now displayed a benefit at the high cheat price and low cost estimate.

Billings 1,500 Acre Farm

Returns and Net Benefit (Loss). At the 1,500 acre farm, each Kice and bin-unit strategy *(tables 5-8, 5-9, and 5-10)* had six possible returns above *OC* and *CC*, while the *Conventional*, *Low Air*, and *High Air* systems remained constant. Again, when the acreage size increased the returns also increased for each treatment. Net benefits or losses were established for the alternatives over the *Conventional* system, and the required yield increases for the subsequent year necessary to cover the losses was estimated.

The *Conventional* system exhibited an average return of $84.75 per acre (/ac) at the 1,500 acre farm size. The *Low Air* treatment had a return of $84.23 /ac, resulting in a $0.52 /ac net loss and a required yield increase of 0.17 bushels per acre (bu/ac). Return from the *High Air* treatment was $92.01 /ac. This created a net benefit of $7.26 /ac.

With the low cost option, the *Normal Bin-Unit* strategy had average returns of $79.47 and $79.21 /ac, for the high and low cheat prices, respectively. The net losses produced were $5.28 and $5.54 /ac, with required yield increases of 1.69 and 1.77 bu/ac. The *Low Air with Bin-Unit* showed mean returns of $94.23 and $90.69 /ac, creating net benefits at $9.48 and $5.94 /ac. For the medium cost estimates, the *Normal Bin-Unit* treatment had average returns of $78.85 and $78.59 /ac, with net losses of $5.90 and $6.16 /ac. The needed yield increases for the subsequent year were 1.89 and 1.97 bu/ac. Returns for the *Low Air with Bin-Unit* system were $93.61 and $90.07 /ac. This resulted in net benefits of $8.86 and $5.32 /ac. With the high cost alternative, returns were reduced even more. The *Normal Bin-Unit* treatment had mean returns of $78.22 and $77.96 /ac, net losses at $6.53 and $6.79 /ac, and 2.09 and 2.18 bu/ac as the required yield increases. The *Low Air with Bin-Unit* returns were $92.98 and $89.44 /ac, with net benefits of $8.23 and $4.69 /ac.

Using the low cost option, the *Low Air with Kice* treatment showed an average return of $86.63 /ac with high cheat price, and $85.41 /ac with the low cheat price. This created net benefits of $1.88 and $0.66 /ac, respectively. The *High Air with Kice* method had returns of $91.33 and $91.10 /ac, with net benefits at $6.58 and $6.35 /ac. With the medium cost option, the *Low Air with Kice* average returns decreased to $85.20 and $83.98/ac. The results were a $0.45 /ac net benefit and a $0.77 /ac net loss, with a required yield increase of 0.25 bu/ac. The mean returns from the *High Air with Kice* treatment were $89.90 and $89.67 /ac. These returns produced net benefits at $5.15 and $4.92 /ac. For the high cost option, returns for *Low Air with Kice* method decreased to $83.76 and $82.54 /ac. This created net losses of $0.99 and $2.21 /ac and needed yield increases of 0.32 and 0.71 bu/ac. The *High Air with Kice* average returns were now $88.46 and $88.23 /ac, with $3.71 and $3.48 /ac as net benefits.

Summary. When the acreage was increased, statistical difference across the treatments was still not evident. Net returns across treatments were not significantly different. The 1,500 acre farm increased overall revenue from the treatments, and some of the methods displayed benefits that were not present at the previous acreages. This indicated that the relationship between revenue and cost was effected by the size of the farm.

Billings Conclusions

The most profitable treatment varied depending on the cheat price. With the $0.06 per pound cheat price, the *Low Air with Bin-Unit* had the highest returns. However, when cheat price was lowered the *High Air* alternative proved to be the most effective method. This outcome stood true at each farm size and for the varied cost options. Unfortunately, there was never a significant difference between either of these the two treatments and the *Conventional* at the 5% level for Billings. In fact, given three farm sizes, three cost estimates, and two cheat prices, none of the treatments were determined to be statistically different from any of the other treatments. Without a statistical advantage, a wheat producer with a similar cheat infestation may not consider altering the *Conventional* harvesting system. To the extend the differences in net returns may exist, the statistical test did not have sufficient power to detect them.

Table 5-1. **Summary of the Averages for Treatments at the Billings Location**

TREATMENT	WHEAT YIELD	DOCKAGE	YIELD AFTER DOCKAGE	PRICE AFTER DISCOUNTS	GROSS REV. FOR WHEAT	GROSS REV. FOR CHEAT $0.06 / LB	GROSS REV. FOR CHEAT $0.04 / LB
	bu / ac	*%*	*bu / ac*	*$ / bu*	*$ / ac*		
CONVENTIONAL	41*	1.4*ab	40*	3.26*bc	130.26*	0.00*c	0.00*c
NORMAL BIN-UNIT	39	1.2ab	38	3.26abc	124.84	0.76c	0.51c
LOW AIR	41	2.2a	40	3.25c	129.74	0.00c	0.00c
LOW AIR WITH KICE	40	0.3b	40	3.27a	130.00	3.67b	2.44b
LOW AIR WITH BIN-UNIT	41	2.2a	40	3.25c	129.74	10.62a	7.08a
HIGH AIR	42	0.6b	42	3.27ab	137.52	0.00c	0.00c
HIGH AIR WITH KICE	42	0.2b	42	3.28a	137.65	0.71c	0.47c

* Means in a column followed by the same letter or no letter are not significantly different at P= 0.05, Duncan's multiple range test; some rounding error exists within the averages.

Gross Rev.= gross revenue

$0.06 / lb = a high cheat price per pound

$0.04 / lb = a low cheat price per pound

bu /ac = bushels per acre

$ / bu = dollars per bushel

$ / ac = dollars per acre

Table 5-2. **Average Net Returns at the Billings 500 Acre Farm With the Low Cost Option**

TREATMENT	NET RET. HIGH CHT. $	NET BENEFIT (OR LOSS)	REQUIRED YIELD INCR.	NET RET. LOW CHT. $	NET BENEFIT (OR LOSS)	REQUIRED YIELD INCR.
	dollars per acre		*bushels / acre*	*dollars per acre*		*bushels / acre*
CONVENTIONAL	67.48*	—	—	67.48*	—	—
NORMAL BIN-UNIT	60.95	-6.53	2.09	60.69	-6.79	2.18
LOW AIR	66.96	-0.52	0.17	66.96	-0.52	0.17
LOW AIR WITH KICE	66.33	-1.15	0.37	65.11	-2.37	0.67
LOW AIR WITH BIN-UNIT	75.71	8.23	—	72.17	4.69	—
HIGH AIR	74.74	7.26	—	74.74	7.26	—
HIGH AIR WITH KICE	71.03	3.55	—	70.80	3.32	—

* Means in a column followed by the same letter or no letter are not significantly different at P= 0.05, Duncan's multiple range test; some rounding error exists within the averages.

Net Ret. High Cht. $ = returns above *OC* and *CC* determined with the $0.06/lb cheat price

Net Ret. Low Cht. $ = returns above *OC* and *CC* determined with the $0.04/lb cheat price

Required Yield Incr. = the required yield increase

Table 5-3. **Average Net Returns at the Billings 500 Acre Farm With the Medium Cost Option**

Treatment	Net Ret. High Cht. $	Net Benefit (or Loss)	Required Yield Incr.	Net Ret. Low Cht. $	Net Benefit (or Loss)	Required Yield Incr.
	dollars per acre		*bushels / acre*	*dollars per acre*		*bushels / acre*
Conventional	67.48*	—	—	67.48*	—	—
Normal Bin-Unit	59.08	-8.40	2.69	58.82	-8.66	2.77
Low Air	66.96	-0.52	0.17	66.96	-0.52	0.17
Low Air with Kice	62.02	-5.46	1.75	60.80	-6.68	2.14
Low Air with Bin-Unit	73.84	6.36	—	70.30	2.82	—
High Air	74.74	7.26	—	74.74	7.26	—
High Air with Kice	66.72	-0.76	0.24	66.49	-0.99	0.32

* Means in a column followed by the same letter or no letter are not significantly different at P= 0.05, Duncan's multiple range test; some rounding error exists within the averages.

Net Ret. High Cht. $ = returns above *OC* and *CC* determined with the $0.06/lb cheat price

Net Ret. Low Cht. $ = returns above *OC* and *CC* determined with the $0.04/lb cheat price

Required Yield Incr. = the required yield increase

Table 5-4. **Average Net Returns at the Billings 500 Acre Farm With the High Cost Option**

TREATMENT	NET RET. HIGH CHT. $	NET BENEFIT (OR LOSS)	REQUIRED YIELD INCR.	NET RET. LOW CHT. $	NET BENEFIT (OR LOSS)	REQUIRED YIELD INCR.
	dollars per acre		*bushels / acre*	*dollars per acre*		*bushels / acre*
CONVENTIONAL	67.48*	—	—	67.48*	—	—
NORMAL BIN-UNIT	57.22	-10.26	3.29	56.96	-10.52	3.37
LOW AIR	66.96	-0.52	0.17	66.96	-0.52	0.17
LOW AIR WITH KICE	57.70	-9.78	3.13	56.48	-11.00	3.53
LOW AIR WITH BIN-UNIT	71.98	4.50	—	68.44	0.96	—
HIGH AIR	74.74	7.26	—	74.74	7.26	—
HIGH AIR WITH KICE	62.40	-5.08	1.63	62.17	-5.31	1.70

* Means in a column followed by the same letter or no letter are not significantly different at P= 0.05, Duncan's multiple range test; some rounding error exists within the averages.
Net Ret. High Cht. $ = returns above *OC* and *CC* determined with the $0.06/lb cheat price
Net Ret. Low Cht. $ = returns above *OC* and *CC* determined with the $0.04/lb cheat price
Required Yield Incr. = the required yield increase

Table 5-5. Average Net Returns at the Billings 1,000 Acre Farm With the Low Cost Option

TREATMENT	NET RET. HIGH CHT. $	NET BENEFIT (OR LOSS)	REQUIRED YIELD INCR.	NET RET. LOW CHT. $	NET BENEFIT (OR LOSS)	REQUIRED YIELD INCR.
	dollars per acre		*bushels / acre*	*dollars per acre*		*bushels / acre*
CONVENTIONAL	82.52*	—	—	82.52*	—	—
NORMAL BIN-UNIT	76.93	-5.59	1.79	76.67	-5.85	1.87
LOW AIR	82.00	-0.52	0.17	82.00	-0.52	0.17
LOW AIR WITH KICE	83.64	1.12	—	82.42	-0.10	0.03
LOW AIR WITH BIN-UNIT	91.96	9.17	—	88.15	5.63	—
HIGH AIR	89.78	7.26	—	89.78	7.26	—
HIGH AIR WITH KICE	88.34	5.82	—	88.11	5.59	—

* Means in a column followed by the same letter or no letter are not significantly different at P= 0.05, Duncan's multiple range test; some rounding error exists within the averages.

Net Ret. High Cht. $ = returns above *OC* and *CC* determined with the $0.06/lb cheat price

Net Ret. Low Cht. $ = returns above *OC* and *CC* determined with the $0.04/lb cheat price

Required Yield Incr. = the required yield increase

Table 5-6. Average Net Returns at the Billings 1,000 Acre Farm With the Medium Cost Option

Treatment	Net Ret. High Cht. $	Net Benefit (or Loss)	Required Yield Incr.	Net Ret. Low Cht. $	Net Benefit (or Loss)	Required Yield Incr.
	dollars per acre		*bushels / acre*	*dollars per acre*		*bushels / acre*
Conventional	82.52*	—	—	82.52*	—	—
Normal Bin-Unit	75.99	-6.53	2.09	75.73	-6.79	2.18
Low Air	82.00	-0.52	0.17	82.00	-0.52	0.17
Low Air with Kice	81.49	-1.03	0.33	80.27	-2.25	0.72
Low Air with Bin-Unit	90.75	8.23	—	87.21	4.69	—
High Air	89.78	7.26	—	89.78	7.26	—
High Air with Kice	86.19	3.67	—	85.96	3.44	—

* Means in a column followed by the same letter or no letter are not significantly different at P= 0.05, Duncan's multiple range test; some rounding error exists within the averages.

Net Ret. High Cht. $ = returns above *OC* and *CC* determined with the $0.06/lb cheat price

Net Ret. Low Cht. $ = returns above *OC* and *CC* determined with the $0.04/lb cheat price

Required Yield Incr. = the required yield increase

Table 5-7. **Average Net Returns at the Billings 1,000 Acre Farm With the High Cost Option**

Treatment	Net Ret. High Cht. $	Net Benefit (or Loss)	Required Yield Incr.	Net Ret. Low Cht. $	Net Benefit (or Loss)	Required Yield Incr.
	dollars per acre		*bushels / acre*	*dollars per acre*		*bushels / acre*
Conventional	82.52*	—	—	82.52*	—	—
Normal Bin-Unit	75.06	-7.46	2.39	74.80	-7.72	2.47
Low Air	82.00	-0.52	0.17	82.00	-0.52	0.17
Low Air with Kice	79.33	-3.19	1.02	78.11	-4.41	1.41
Low Air with Bin-Unit	89.82	7.30	—	86.28	3.76	—
High Air	89.78	7.26	—	89.78	7.26	—
High Air with Kice	84.03	1.51	—	83.80	1.28	—

* Means in a column followed by the same letter or no letter are not significantly different at P= 0.05, Duncan's multiple range test; some rounding error exists within the averages.

Net Ret. High Cht. $ = returns above *OC* and *CC* determined with the $0.06/lb cheat price

Net Ret. Low Cht. $ = returns above *OC* and *CC* determined with the $0.04/lb cheat price

Required Yield Incr. = the required yield increase

Table 5-8. **Average Net Returns at the Billings 1,500 Acre Farm With the Low Cost Option**

TREATMENT	NET RET. HIGH CHT. $	NET BENEFIT (OR LOSS)	REQUIRED YIELD INCR.	NET RET. LOW CHT. $	NET BENEFIT (OR LOSS)	REQUIRED YIELD INCR.
	dollars per acre		*bushels / acre*	*dollars per acre*		*bushels / acre*
CONVENTIONAL	84.75*	—	—	84.75*	—	—
NORMAL BIN-UNIT	79.47	-5.28	1.69	79.21	-5.54	1.77
LOW AIR	84.23	-0.52	0.17	84.23	-0.52	0.17
LOW AIR WITH KICE	86.63	1.88	—	85.41	0.66	—
LOW AIR WITH BIN-UNIT	94.23	9.48	—	90.69	5.94	—
HIGH AIR	92.01	7.26	—	92.01	7.26	—
HIGH AIR WITH KICE	91.33	6.58	—	91.10	6.35	—

* Means in a column followed by the same letter or no letter are not significantly different at P= 0.05, Duncan's multiple range test; some rounding error exists within the averages.

Net Ret. High Cht. $ = returns above *OC* and *CC* determined with the $0.06/lb cheat price

Net Ret. Low Cht. $ = returns above *OC* and *CC* determined with the $0.04/lb cheat price

Required Yield Incr. = the required yield increase

Table 5-9. **Average Net Returns at the Billings 1,500 Acre Farm With the Medium Cost Option**

Treatment	Net Ret. High Cht. $	Net Benefit (or Loss)	Required Yield Incr.	Net Ret. Low Cht. $	Net Benefit (or Loss)	Required Yield Incr.
	dollars per acre		*bushels / acre*	*dollars per acre*		*bushels / acre*
Conventional	84.75*	—	—	84.75*	—	—
Normal Bin-Unit	78.85	-5.90	1.89	78.59	-6.16	1.97
Low Air	84.23	-0.52	0.17	84.23	-0.52	0.17
Low Air with Kice	85.20	0.45	—	83.98	-0.77	0.25
Low Air with Bin-Unit	93.61	8.86	—	90.07	5.32	—
High Air	92.01	7.26	—	92.01	7.26	—
High Air with Kice	89.90	5.15	—	89.67	4.92	—

* Means in a column followed by the same letter or no letter are not significantly different at P= 0.05, Duncan's multiple range test; some rounding error exists within the averages.

Net Ret. High Cht. $ = returns above *OC* and *CC* determined with the $0.06/lb cheat price

Net Ret. Low Cht. $ = returns above *OC* and *CC* determined with the $0.04/lb cheat price

Required Yield Incr. = the required yield increase

Table 5-10. **Average Net Returns at the Billings 1,500 Acre Farm With the High Cost Option**

Treatment	Net Ret. High Cht. $	Net Benefit (or Loss)	Required Yield Incr.	Net Ret. Low Cht. $	Net Benefit (or Loss)	Required Yield Incr.
	dollars per acre		*bushels / acre*	*dollars per acre*		*bushels / acre*
Conventional	84.75*	—	—	84.75*	—	—
Normal Bin-Unit	78.22	-6.53	2.09	77.96	-6.79	2.18
Low Air	84.23	-0.52	0.17	84.23	-0.52	0.17
Low Air with Kice	83.76	-0.99	0.32	82.54	-2.21	0.71
Low Air with Bin-Unit	92.98	8.23	—	89.44	4.69	—
High Air	92.01	7.26	—	92.01	7.26	—
High Air with Kice	88.46	3.71	—	88.23	3.48	—

* Means in a column followed by the same letter or no letter are not significantly different at P= 0.05, Duncan's multiple range test; some rounding error exists within the averages.

Net Ret. High Cht. $ = returns above *OC* and *CC* determined with the $0.06/lb cheat price

Net Ret. Low Cht. $ = returns above *OC* and *CC* determined with the $0.04/lb cheat price

Required Yield Incr. = the required yield increase

CHAPTER VI

HUNTER RESULTS

Preface

The field study conducted at Hunter had the smallest cheat population of any site, based on the grading results. The *Conventional* and two alternative treatments *(Low Air* and *Low Air with Kice)* were used from this site for comparison purposes. The bin-unit alternatives were conducted, but due to the lack of feed analysis data on the cleanings, they were disregarded for this study. Therefore, the Conventional system was only compared to these two low air strategies.

Yields and Dockage

The dockage was calculated by Enid Grain Inspection from grain samples at the field studies *(table 6-1)*. This was combined with yield data to determine the effect of dockage on yield. If an analysis of variance indicated a significant difference across treatments, then a Duncan multiple range test was performed to compare the treatment means.

The average wheat yield before dockage had no statistical difference across methods. The *Conventional* had the highest mean yield before dockage with 58 bushels per acre (bu/ac). There was a yield of 57 bu/ac for both the *Low Air* and *Low Air with Kice* tactics.

The slight difference in average dockage levels across treatments was significant at the 5% level. The largest dockage level was 1.1% from the *Low Air* procedure. Next was the *Conventional* system with an average dockage level of 0.5%. Then, the *Low Air with Kice* treatment at 0.4%.

The average yield after dockage reductions did not exhibit a statistical change across treatments. The *Conventional* method had the highest mean yield after dockage with 58 bu/ac. The *Low Air* and *Low Air with Kice* systems followed with a yield after dock of 56 bu/ac.

Gross Revenues

Dockage effects on yield were combined with the price after discounts to achieve the gross revenue from wheat sales *(table 6-1)*. The *Conventional* treatment had an average gross revenue of $190.26 per acre (/ac). The *Low Air with Kice* method showed a $184.67gross revenue from wheat . Mean gross revenue for the *Low Air* system was $184.25 /ac.

Gross revenue from the expected sale of cheat and cleanings was calculated using two different prices, $0.06 and $0.04 per pound. This allowed the sensitivity of the cheat price to be tested. For Hunter, this was only needed for the *Low Air with Kice* treatment, because it involved wheat cleaning. With the high price, the gross cheat revenue for this method was $1.92 /ac, and with the low price it was $1.28 /ac.

Hunter 500 Acre Farm

Returns and Net Benefit (Loss). Returns were calculated by subtracting the total of *OC* and *CC* from the total gross revenue for wheat and cheat. The *OC* and *CC* estimates varied between acreage sizes, but remained constant for the four locations. They were discussed in the *cost* section of *chapter 2*. With two different cheat prices and three different cost estimates, the Kice strategy had six possible returns above the specific costs at the 500 acre level *(tables 6-2, 6-3, and 6-4)*. The *Conventional* and *Low Air* systems remained constant because they had neither cleanings to sell nor included the variable *CC* section in their cost determination. As previously stated, returns above *OC* and *CC* for the alternatives were compared to the *Conventional* system to determine if any benefit or loss existed. Then, if a net loss was present, the required yield increase for the subsequent year necessary to cover the loss was estimated to show the feasibility of adopting the alternative over the *Conventional*. To calculate this yield increase the base price of $3.28 per bushel was discounted 5% to represent the following year's price.

The *Conventional* system had an average return of $127.48 per acre (/ac) at the 500 acre farm size. The *Low Air* treatment had a return of $121.47 /ac, this resulted in a $6.00 /ac net loss. The required yield increase to offset the loss was 1.92 bushels per acre (bu/ac).

For the low cost option and the high cheat price, the *Low Air with Kice* strategy showed an average return of $119.26, with a net loss of $8.22 /ac, and required a yield increase of 2.63 bu/ac. With the low cheat price the return was reduced to $118.62 /ac. The resulting net loss was $8.85 /ac with a needed yield increase of 2.84 bu/ac. Given the medium cost option, the *Low Air with Kice* tactic showed mean returns of $114.95 and $114.31 /ac, for the high and low cheat price, respectively. The net losses were $12.53 and $13.16 /ac, producing a needed yield increase of 4.01 and 4.22 bu/ac. The high cost option dropped returns for *Low Air with Kice* to $110.63 and $109.99 /ac, and the losses went to $16.85 and $17.48 /ac. They required yield increases of 5.40 and 5.60 bu/ac for the subsequent year.

Summary. Neither of the alternatives at the Hunter 500 acre farm had returns above *OC* and *CC* that were greater than the *Conventional* system. In fact, at the medium cost option the *Low Air with Kice* treatment generated significantly lower net returns than the *Conventional*, and under the high cost scenario this alternative generated statistically lower net returns than either of the other treatments. It was also determined that when cheat price decreased and/or the cost estimate increased the negative impacts of cleaning on revenue were increased.

Hunter 1,000 Acre Farm

Returns and Net Benefit (Loss). At the 1,000 acre farm, the Kice strategy still had six possible returns above *OC* and *CC (tables 6-5, 6-6, and 6-7)*. The *Conventional* and *Low Air* systems remained constant. With the increase in acreage size the returns also increased for each treatment. After returns were established for the alternatives, they were compared to the *Conventional* system to determine if any benefit or loss existed. If net loss was present, then yield increase for the subsequent year was estimated to show the feasibility of adopting the alternative over the *Conventional*.

The *Conventional* system revealed an average return of $142.52 per acre (/ac) at the 1,000 acre farm size. The *Low Air* treatment had a mean return of $136.51 /ac. A net loss of $6.00 /ac existed, and the required yield increase was 1.92 bushels per acre (bu/ac).

Given the low cost option, the *Low Air with Kice* treatment had a average return of $136.57 /ac with high cheat price, and $135.93 /ac with the low cheat price. This created net losses of $5.95 and $6.58 /ac, respectively. The required yield increases were 1.91 and 2.11 bu/ac. With the medium cost estimate, the *Low Air with Kice* method had returns of $134.42 and $133.78 /ac. They resulted in net losses of $8.10 and $8.73 /ac, and needed yield increases of 2.59 and 2.80 bu/ac. At the high cost alternative, returns were reduced. Returns from the *Low Air with Kice* procedure were now $132.26 and $132.62 /ac, with $10.26 and $10.89 /ac in net losses. The necessary yield increases in the subsequent year were 3.29 and 3.49 bu/ac, respectively.

Summary. Even with the increase in acreage, the alternatives resulted in lower net returns than the *Conventional* system. At the high cost alternative the *Low Air with Kice* treatment resulted in statistically lower net returns than the *Conventional*. With an increase in acreage, the variability of cheat price and cost estimates had less effect on net returns.

Hunter 1,500 Acre Farm

Returns and Net Benefit (Loss). For the 1,500 acre farm, each Kice strategy *(tables 6-8, 6-9, and 6-10)* had six possible returns above *OC* and *CC*, while the *Conventional* and *Low Air* systems remained constant. Again, when the acreage size increased the returns also increased for each treatment. Returns were established for the alternatives and compared to the *Conventional* system to determine if any benefit or loss existed. If net loss was estimated, the required yield increase for the subsequent year necessary to cover the additional cost was estimated to compare the consequences of adopting the alternative over the *Conventional*.

The *Conventional* system exhibited an average return of $144.75 per acre (/ac) at the 1,500 acre farm size. The *Low Air* treatment had a return of $138.74 /ac, resulting in a $6.00 /ac net loss. The needed yield increase for the subsequent year was 1.92 bu/ac.

Using the low cost option, the *Low Air with Kice* treatment showed an average return of $139.56 /ac with high cheat price, and $138.92 /ac with the low cheat price. This created net losses of $5.19 and $5.82 /ac, respectively, and required yield increases at 1.66 and 1.87 bu/ac. With the medium cost option, the *Low Air with Kice* average returns decreased to $138.13 and $137.49 /ac. These returns produced net losses of $6.62 and $7.25 /ac, with 2.12 and 2.33 bu/ac needed yield increases. For the high cost option, returns for *Low Air with Kice* method decreased to $136.69 and $136.05 /ac, with $8.06 and $8.69 /ac as net losses. The required increase in yields to offset these losses was 2.58 and 2.79 bu/ac.

Summary. The alternatives still had smaller returns than the *Conventional* system, but with the low cost option the cleaning strategy was more profitable, although not significant, than low air without cleaning. When the acreage was increased, the statistical difference between treatments never appeared. With the 1,500 acre size, returns from the *Low Air with Kice* method were not significantly lower than the *Conventional* for any of the cost options. Therefore, increases in acreage could offset the negative effects of varying cheat price and cost estimate.

Hunter Conclusions

The most profitable treatment was the *Conventional* system at very cost option and cheat price, under none of the machine cost and cheat price scenarios were the alternatives more profitable. For a majority of the options the *Low Air with Kice* treatment resulted in significantly lower net returns than the *Conventional*. A wheat producer with a slight cheat infestation may not consider altering the harvesting method from the *Conventional* system, because revenues would not be expected to increase. This was the anticipated outcome at a site with such a small cheat population.

Table 6-1. **Summary of the Averages for Treatments at the Hunter Location**

Treatment	Wheat Yield	Dockage	Yield After Dockage	Price after Discounts	Gross Rev. for Wheat	Gross Rev. for Cheat $0.06 / lb	Gross Rev. for Cheat $0.04 / lb
	bu / ac	*%*	*bu / ac*	*$ / bu*	*$ / ac*		
Conventional	58[*]	0.5[*]b	58[*]	3.28[*]a	190.26[*]	0.00[*]b	0.00[*]b
Low Air	57	1.1a	56	3.27b	184.25	0.00b	0.00b
Low Air with Kice	57	0.4b	56	3.28a	184.67	1.92a	1.28a

[*] Means in a column followed by the same letter or no letter are not significantly different at P= 0.05, Duncan's multiple range test; some rounding error exists within the averages.

Gross Rev.= gross revenue

$0.06 / lb = a high cheat price per pound

$0.04 / lb = a low cheat price per pound

bu /ac = bushels per acre

$ / bu = dollars per bushel

$ / ac = dollars per acre

Table 6-2. Average Net Returns at the Hunter 500 Acre Farm With the Low Cost Option

Treatment	Net Ret. High Cht. $	Net Benefit (or Loss)	Required Yield Incr.	Net Ret. Low Cht. $	Net Benefit (or Loss)	Required Yield Incr.
	dollars per acre		*bushels / acre*	*dollars per acre*		*bushels / acre*
Conventional	127.48*	—	—	127.48*	—	—
Low Air	121.47	-6.00	1.92	121.47	-6.00	1.92
Low Air with Kice	119.26	-8.22	2.63	118.62	-8.85	2.84

* Means in a column followed by the same letter or no letter are not significantly different at P= 0.05, Duncan's multiple range test; some rounding error exists within the averages.

Net Ret. High Cht. $ = returns above *OC* and *CC* determined with the $0.06/lb cheat price

Net Ret. Low Cht. $ = returns above *OC* and *CC* determined with the $0.04/lb cheat price

Required Yield Incr. = the required yield increase

Table 6-3. **Average Net Returns at the Hunter 500 Acre Farm With the Medium Cost Option**

TREATMENT	NET RET. HIGH CHT. $	NET BENEFIT (OR LOSS)	REQUIRED YIELD INCR.	NET RET. LOW CHT. $	NET BENEFIT (OR LOSS)	REQUIRED YIELD INCR.
	dollars per acre		*bushels / acre*	*dollars per acre*		*bushels / acre*
CONVENTIONAL	127.48*a	—	—	127.48*a	—	—
LOW AIR	121.47ab	-6.00	1.92	121.47ab	-6.00	1.92
LOW AIR WITH KICE	114.95b	-12.53	4.01	114.31b	-13.16	4.22

* Means in a column followed by the same letter or no letter are not significantly different at P= 0.05, Duncan's multiple range test; some rounding error exists within the averages.

Net Ret. High Cht. $ = returns above *OC* and *CC* determined with the $0.06/lb cheat price

Net Ret. Low Cht. $ = returns above *OC* and *CC* determined with the $0.04/lb cheat price

Required Yield Incr. = the required yield increase

Table 6-4. Average Net Returns at the Hunter 500 Acre Farm With the High Cost Option

TREATMENT	NET RET. HIGH CHT. $	NET BENEFIT (OR LOSS)	REQUIRED YIELD INCR.	NET RET. LOW CHT. $	NET BENEFIT (OR LOSS)	REQUIRED YIELD INCR.
	dollars per acre		bushels / acre	dollars per acre		bushels / acre
CONVENTIONAL	127.48* a	—	—	127.48* a	—	—
LOW AIR	121.47a	-6.00	1.92	121.47a	-6.00	1.92
LOW AIR WITH KICE	110.63b	-16.85	5.40	109.99b	-17.48	5.60

* Means in a column followed by the same letter or no letter are not significantly different at P= 0.05, Duncan's multiple range test; some rounding error exists within the averages.

Net Ret. High Cht. $ = returns above *OC* and *CC* determined with the $0.06/lb cheat price

Net Ret. Low Cht. $ = returns above *OC* and *CC* determined with the $0.04/lb cheat price

Required Yield Incr. = the required yield increase

Table 6-5. Average Net Returns at the Hunter 1,000 Acre Farm With the Low Cost Option

Treatment	Net Ret. High Cht. $	Net Benefit (or Loss)	Required Yield Incr.	Net Ret. Low Cht. $	Net Benefit (or Loss)	Required Yield Incr.
	dollars per acre		bushels / acre	dollars per acre		bushels / acre
Conventional	142.52*	—	—	142.52*	—	—
Low Air	136.51	-6.00	1.92	136.51	-6.00	1.92
Low Air with Kice	136.57	-5.95	1.91	135.93	-6.58	2.11

* Means in a column followed by the same letter or no letter are not significantly different at P= 0.05, Duncan's multiple range test; some rounding error exists within the averages.
Net Ret. High Cht. $ = returns above *OC* and *CC* determined with the $0.06/lb cheat price
Net Ret. Low Cht. $ = returns above *OC* and *CC* determined with the $0.04/lb cheat price
Required Yield Incr. = the required yield increase

Table 6-6. **Average Net Returns at the Hunter 1,000 Acre Farm With the Medium Cost Option**

TREATMENT	NET RET. HIGH CHT. $	NET BENEFIT (OR LOSS)	REQUIRED YIELD INCR.	NET RET. LOW CHT. $	NET BENEFIT (OR LOSS)	REQUIRED YIELD INCR.
	dollars per acre		*bushels / acre*	*dollars per acre*		*bushels / acre*
CONVENTIONAL	142.52*	—	—	142.52*	—	—
LOW AIR	136.51	-6.00	1.92	136.51	-6.00	1.92
LOW AIR WITH KICE	134.42	-8.10	2.59	133.78	-8.73	2.80

* Means in a column followed by the same letter or no letter are not significantly different at P= 0.05, Duncan's multiple range test; some rounding error exists within the averages.

Net Ret. High Cht. $ = returns above *OC* and *CC* determined with the $0.06/lb cheat price

Net Ret. Low Cht. $ = returns above *OC* and *CC* determined with the $0.04/lb cheat price

Required Yield Incr. = the required yield increase

Table 6-7. Average Net Returns at the Hunter 1,000 Acre Farm With the High Cost Option

Treatment	Net Ret. High Cht. $	Net Benefit (or Loss)	Required Yield Incr.	Net Ret. Low Cht. $	Net Benefit (or Loss)	Required Yield Incr.
	dollars per acre		*bushels / acre*	*dollars per acre*		*bushels / acre*
Conventional	142.52* a	—	—	142.52* a	—	—
Low Air	136.51ab	-6.00	1.92	136.51ab	-6.00	1.92
Low Air with Kice	132.26b	-10.26	3.29	132.62b	-10.89	3.49

* Means in a column followed by the same letter or no letter are not significantly different at P= 0.05, Duncan's multiple range test; some rounding error exists within the averages.

Net Ret. High Cht. $ = returns above *OC* and *CC* determined with the $0.06/lb cheat price

Net Ret. Low Cht. $ = returns above *OC* and *CC* determined with the $0.04/lb cheat price

Required Yield Incr. = the required yield increase

Table 6-8. Average Net Returns at the Hunter 1,500 Acre Farm With the Low Cost Option

Treatment	Net Ret. High Cht. $	Net Benefit (or Loss)	Required Yield Incr.	Net Ret. Low Cht. $	Net Benefit (or Loss)	Required Yield Incr.
	dollars per acre		*bushels / acre*	*dollars per acre*		*bushels / acre*
Conventional	144.75*	—	—	144.75*	—	—
Low Air	138.74	-6.00	1.92	138.74	-6.00	1.92
Low Air with Kice	139.56	-5.19	1.66	138.92	-5.82	1.87

* Means in a column followed by the same letter or no letter are not significantly different at P= 0.05, Duncan's multiple range test; some rounding error exists within the averages.

Net Ret. High Cht. $ = returns above *OC* and *CC* determined with the $0.06/lb cheat price

Net Ret. Low Cht. $ = returns above *OC* and *CC* determined with the $0.04/lb cheat price

Required Yield Incr. = the required yield increase

Table 6-9. Average Net Returns at the Hunter 1,500 Acre Farm With the Medium Cost Option

Treatment	Net Ret. High Cht. $	Net Benefit (or Loss)	Required Yield Incr.	Net Ret. Low Cht. $	Net Benefit (or Loss)	Required Yield Incr.
	dollars per acre		*bushels / acre*	*dollars per acre*		*bushels / acre*
Conventional	144.75*	—	—	144.75*	—	—
Low Air	138.74	-6.00	1.92	138.74	-6.00	1.92
Low Air with Kice	138.13	-6.62	2.12	137.49	-7.25	2.33

* Means in a column followed by the same letter or no letter are not significantly different at P= 0.05, Duncan's multiple range test; some rounding error exists within the averages.

Net Ret. High Cht. $ = returns above *OC* and *CC* determined with the $0.06/lb cheat price

Net Ret. Low Cht. $ = returns above *OC* and *CC* determined with the $0.04/lb cheat price

Required Yield Incr. = the required yield increase

Table 6-10. **Average Net Returns at the Hunter 1,500 Acre Farm With the High Cost Option**

Treatment	Net Ret. High Cht. $	Net Benefit (or Loss)	Required Yield Incr.	Net Ret. Low Cht. $	Net Benefit (or Loss)	Required Yield Incr.
	dollars per acre		*bushels / acre*	*dollars per acre*		*bushels / acre*
Conventional	144.75*	—	—	144.75*	—	—
Low Air	138.74	-6.00	1.92	138.74	-6.00	1.92
Low Air with Kice	136.69	-8.06	2.58	136.05	-8.69	2.79

* Means in a column followed by the same letter or no letter are not significantly different at P= 0.05, Duncan's multiple range test; some rounding error exists within the averages.

Net Ret. High Cht. $ = returns above *OC* and *CC* determined with the $0.06/lb cheat price

Net Ret. Low Cht. $ = returns above *OC* and *CC* determined with the $0.04/lb cheat price

Required Yield Incr. = the required yield increase

CHAPTER VII

WHEAT CLEANING SUMMARY

Preface

Four wheat cleaning strategies were employed for this study. Two treatments involved a Kice aspirator cleaner and the other two used a prototype combine bin mounted cleaner. The Kice alternatives had low and high combine air options, while the air settings for the bin-unit cleaner were normal and low. The following briefly discusses the cleaner efficiency that resulted in the field studies.

Kice Cleaner Efficiency

The low air treatment with the Kice was performed at all four locations *(table 7-1)*. The inflow was the *Low Air* method and the outflow, of course, was the *Low Air with Kice*. The most important aspect of cleaning was the outcome on dockage level. Dockage changes varied depending on the beginning dockage level. The higher the initial level the more dock that was removed. Red Rock had a mean original level of 15.1 %, the largest. It was reduced by 9.2 %, to an average outflow dockage of 5.9 %. Cleaning decreased the dockage level at Marland and Billings on average by 4.0 % and 1.9 %, respectively. Hunter had the least amount of change with 0.7 %, but it was also the lowest initial level.

An additional factor of cleaner effectiveness is its consequences on yields. Yields impact revenue, therefore, one the major factors in determining if the Kice cleaner is helpful. Even with discounts on grades lessened, yield may be too damaged to show the benefits. The optimal result is for dockage to be decreased enough to offset the harmful effect on before dockage yields. This is evident by comparing the inflow yields (yield prior to cleaning) to that of the outflow yields.

Red Rock showed the greatest drop in average yield before dockage reduction with 6.36 bushel per acre (bu/ac), 47.94 bu/ac down to 41.58 bu/ac. However, its yield after being docked was only lessened by 1.56 bu/ac. This is the equalizing outcome of lowering dockage level with the cleaner. Red Rock also contained the highest cheat infestation. Marland exhibited the next highest decline in yield. The average inflow yield, prior to dockage, was 56.85 bu/ac. It diminished to 53.87 bu/ac, a change of 2.98 bu/ac. Nevertheless, when the yields were docked accordingly the average change was only 0.73 bu/ac. Billings and Hunter revealed similar yield changes only in smaller proportions. The average yield decrease before and after dockage was 1.02 and 0.25 bu/ac at Billings and 0.54 and 0.13 bu/ac at Hunter.

The effects of cleaning the wheat were also reflected in the differences in discounted prices. Red Rock showed the largest change in discounted price, from $2.60 /bu up to $3.05 /bu. Marland displayed the next best increase in discounted price due to cleaning with $0.04 /bu. Billings and Hunter exhibited the smallest change in discounted price, $0.03 and $0.01 /bu, respectively. However, these two locations also had the smallest discounts prior to cleaning.

By excluding the sale of cheat for the gross revenue determination, a true value could be placed on the efficiency of cleaning. Without assuming a cheat market, the wheat gross revenue will reflect the cleaner feasibility to cover its own costs. Cleaning the wheat increased gross revenue at each location, but only slightly at three sites. Red

Rock had an average of $13.27 per acre (/ac) addition to wheat gross revenue. This was the largest growth in revenue displayed at any location. Hunter was next with a mean change $0.70 /ac more after cleaning. Marland and Billings showed minimal changes in average gross revenue for wheat with $0.42 and $0.26 /ac, respectively. The only significant differences that existed at the low air option were in the dockage and discounted price categories. This was based on a Duncan's multiple range test at the 5% level.

The high air treatment with the Kice was conducted at three sites; Red Rock, Marland, and Billings *(table 7-2)*. The inflow was the *High Air* method and the outflow was the *High Air with Kice*. By measuring cleaner efficiency with the high air strategy cleaner effectiveness was determined at a range of initial dockage levels. The improvements in dockage and discounted prices were not as extensive as the low air option. Although, at Red Rock the improvements in wheat quality were similar. The official grades showed that average dockage level was reduced by 9.7 % at Red Rock, from 12.3 % down to 2.6 %. Marland and Billings had a lower beginning level and were only decreased by an average of 1.6 % and 0.4 %, respectively.

Since yield impacts revenue, the yield consequences of cleaning were essential to the Kice efficiency. Reductions in price discounts could not compensate the gross revenue if yield was lowered too much. Therefore, a comparison of yields before and after cleaning was instituted. Red Rock displayed the largest average decrease in yield, both before and after dockage reductions. The mean yield before dockage declined from 48.44 down to 42.05 bushels per acre (bu/ac), but after dockage was consider the average drop in yield was only 1.57 bu/ac. Marland and Billings exhibited minimal changes in yields after cleaning. The average effect on yield prior to dockage was a decrease of 1.11 and 0.19 bu/ac at Marland and Billings. After dock was removed the mean yield only fell by 0.27 and 0.05 bu/ac, respectively.

The Kice cleaner efficiency reflected in discounted price summarizes the overall effect of the change in official grades. At Red Rock the average discounted price improved from $2.78 to $3.19 /bu. Marland had no reductions in average discounts, and therefore no changes in price. There was a $0.01 /bu decrease in discounted price for Billings. The effect on mean discounted price was an increase from $3.26 to $3.27 /bu.

The sale of cheat was excluded from the gross revenue determination to achieve a value for cleaning efficiency. If a cheat market was not assumed, the gross revenue will reflect the cleaner's ability to cover specific costs. By cleaning the wheat, average gross revenue was increased at two of the three sites. However, Red Rock showed a more extensive change than the other two locations. The average gross revenue for wheat at Red Rock was raised by $11.71 /ac, from $119.13 to $130.84 /ac. Billings only increased by $0.13 /ac, and Marland's mean gross revenue from wheat actually decreased by $0.77 /ac because of cleaning. Statistical differences only lied within the Red Rock location for dockage and discounted price.

<u>Bin-Unit Cleaner Efficiency</u>

The bin-unit efficiency for the normal air option was derived through comparison of inflow and outflow for the cleaner. Due to the difficulty of collecting inflow samples from the cleaner, the outflow results from the *Normal Bin-Unit* treatment were compared to the *Conventional* system results to determine efficiency *(table 7-3)*. Both of these methods consisted of the same combine air speed, only different plots. Therefore, by making the assumption of uniform wheat yield these two strategies were compared to show the effectiveness of the cleaner. The bin-unit cleaner with the low air option did not have a treatment that it could be compared to, because all of the low air treatments were conducted simultaneously. The only difference in the *Low Air* and *Low Air with Bin-Unit* was the revenue effects from the sale of cheat and the cleaner cost.

Dockage level, one the most important factors, was barely changed at each of the three locations. Red Rock only showed an average decrease of 3.3 % in dockage. The initial dock was 14.8 % and it dropped to 11.5%. The mean dockage at Marland and Billings was reduced by 1.5 % and 0.2 %, respectively.

To determine the consequences of the cleaner in terms of bushels per acre, yield before and after cleaning was compared. The normal response of cleaning upon yield was for it decrease. However, Red Rock showed a small increase of 0.11 bushels per acre (bu/ac) in average yield before it was docked, and after dockage this increase grew to 1.81 bu/ac. The average yield before dockage at Marland decreased by 3.25 bu/ac, from 58.34 to 55.09 bu/ac. Although after dockage, yield only dropped 2.28 bu/ac. The decline in average yield at Billings was similar both before and after dockage, 1.80 and 1.70 bu/ac, respectively.

The bin-unit cleaner efficiency was also illustrated in the changes of discounted prices. They showed the effects of cleaning in a dollar per bushel basis. Red Rock had an average decrease in price discounts of $0.18 per acre (/ac). This was the largest drop of the three locations. It resulted in a shift of discounted price from $2.64 up to $2.82 /ac. Marland's average discounted price only declined by $0.05 /ac, and Billings remained constant with a mean discounted price of $3.26 /ac.

Marketing of cheat was excluded from the gross revenue calculation to determine a value for cleaning efficiency. If a cheat market was not considered, the wheat gross revenue will reflect the cleaner's capability of covering specific costs. In this comparison average gross revenue for wheat was increased at only one location, Red Rock. It grew from $117.67 to $130.71 per acre (/ac), an average change of $13.04 /ac. Marland and Billings decreased in mean gross revenue by $4.32 and $5.54 /ac. This indicated that the drop in yield, because of cleaning, was not offset by the reduction in dockage level. There was no significant differences within this comparison between the *Conventional* and the *Normal Bin-Unit*.

Table 7-1. Average Kice Cleaner Efficiency for Low Air Treatments at Locations

Location	RED ROCK	MARLAND	BILLINGS	HUNTER
YIELD		bushels per acre		
Inflow	*47.94**	*56.85**	*40.83**	*57.05**
Outflow	*41.58*	*53.87*	*39.81*	*56.51*
Difference	**-6.36**	**-2.98**	**-1.02**	**-0.54**
DOCKAGE (%)				
Inflow	*15.1*a*	*4.8*a*	*2.2*a*	*1.1*a*
Outflow	*5.9b*	*0.8b*	*0.3b*	*0.4b*
Difference	**-9.2**	**-4.0**	**-1.9**	**-0.7**
YIELD AFTER DOCKAGE		bushels per acre		
Inflow	*40.80**	*54.15**	*39.96**	*56.43**
Outflow	*39.24*	*53.42*	*39.71*	*56.30*
Difference	**-1.56**	**-0.73**	**-0.25**	**-0.13**
DISCOUNTED PRICE		dollars per bushel		
Inflow	*$ 2.60*a*	*$ 3.08**	*$ 3.25*a*	*$ 3.27*a*
Outflow	*3.05b*	*3.13*	*3.27b*	*3.28b*
Difference	**0.45**	**0.05**	**0.02**	**0.01**
WHEAT GROSS REVENUE		dollars per acre		
Inflow	*$ 106.91**	*$ 166.63**	*$ 129.74**	*$ 184.25**
Outflow	*120.18*	*167.33*	*130.00*	*184.67*
Difference	**13.27**	**0.70**	**0.26**	**0.42**

* Means in a column followed by the same letter or not letter are not significantly different at P=0.05, Duncan's multiple range test; some rounding error exists within the averages.

Table 7-2 . **Average Kice Cleaner Efficiency for High Air Treatments at Locations**

Location	RED ROCK	MARLAND	BILLINGS
YIELD		*bushels per acre*	
Inflow	*48.44**	*52.43**	*42.31**
Outflow	*42.05*	*51.32*	*42.12*
Difference	**-6.39**	**-1.11**	**-0.19**
DOCKAGE (%)			
Inflow	*12.3*a*	*2.9**	*0.6**
Outflow	*2.6b*	*1.3*	*0.2*
Difference	**-9.7**	**-1.6**	**-0.4**
YIELD AFTER DOCKAGE		*bushels per acre*	
Inflow	*42.59**	*50.91**	*42.08**
Outflow	*41.02*	*50.64*	*42.03*
Difference	**-1.57**	**-0.27**	**-0.05**
DISCOUNTED PRICE		*dollars per bushel*	
Inflow	*$ 2.78*a*	*$ 3.07**	*$ 3.26**
Outflow	*3.19b*	*3.07*	*3.27*
Difference	**0.41**	**0.00**	**0.01**
WHEAT GROSS REVENUE		*dollars per acre*	
Inflow	*$ 119.13**	*$ 156.37**	*$ 137.52**
Outflow	*130.84*	*155.60*	*137.65*
Difference	**12.45**	**-0.77**	**0.13**

* Means in a column followed by the same letter or not letter are not significantly different at P=0.05, Duncan's multiple range test; some rounding error exists within the averages.

Table 7-3. **Average Bin-Unit Cleaner Efficiency for Normal Air Treatments at Locations**

Location	RED ROCK	MARLAND	BILLINGS
YIELD		*bushels per acre*	
Inflow	*51.96**	*58.34**	*40.56**
Outflow	*52.07*	*55.09*	*38.76*
Difference	**0.11**	**-3.25**	**-1.80**
DOCKAGE (%)			
Inflow	*14.8**	*5.0**	*1.4**
Outflow	*11.5*	*3.5*	*1.2*
Difference	**-3.3**	**-1.5**	**-0.2**
YIELD AFTER DOCKAGE		*bushels per acre*	
Inflow	*44.34**	*55.43**	*39.99**
Outflow	*46.15*	*53.15*	*38.29*
Difference	**1.81**	**-2.28**	**-1.70**
DISCOUNTED PRICE		*dollars per bushel*	
Inflow	$ 2.64*	$ 3.06*	$ 3.26*
Outflow	*2.82*	*3.11*	*3.26*
Difference	**0.18**	**0.05**	**0.00**
WHEAT GROSS REVENUE		*dollars per acre*	
Inflow	$ 117.67*	$ 169.78*	$ 130.26*
Outflow	*130.71*	*165.53*	*124.84*
Difference	**13.04**	**-4.25**	**-5.42**

* Means in a column followed by the same letter or not letter are not significantly different at P=0.05, Duncan's multiple range test; some rounding error exists within the averages.

CHAPTER VIII

SUMMARY AND CONCLUSIONS

Summary

Cheat is considered to be one of the most difficult to control pests in winter wheat throughout Oklahoma and the United States. Selective herbicides to control cheat are only effective under certain circumstances and conventional control methods, like deep plowing or burning, could result in soil erosion. Since cheat has a similar biological cycle to wheat, the cheat seed is harvested with the grain and either joins the wheat in the grain tank and enters the marketing channel as dockage or returns to the field to contaminate subsequent crops. An alternative method of harvesting might either provide a weed control method by removing the cheat seed from the field at the combine level, and/or reduce dockage and price discounts at the elevator. This study was conducted to determine if alternative harvesting systems would provide larger net returns than the traditional procedure. The treatments considered in this research were a conventional system and six experimental strategies. The alternative methods used a Kice aspirator grain cleaner, a prototype combine mounted (bin-unit) aspirator cleaner, or neither.

Method	*Description*	*Name*
(1)	Normal Combine Settings with Bin-Unit Cleaner	*Normal Bin-Unit*
(2)	Low Combine Air Settings	*Low Air*
(3)	Low Combine Air Settings with Kice Cleaner	*Low Air with Kice*
(4)	Low Combine Air Settings with Bin-Unit Cleaner	*Low Air with Bin-Unit*
(5)	High Combine Air Settings	*High Air*
(6)	High Combine Air Settings with Kice Cleaner	*High Air with Kice*

These methods were evaluated in field trials during the 1997 wheat harvest. The studies were performed on privately owned fields near Red Rock, Marland, Billings, and Hunter, Oklahoma. Net returns above operating (*OC*) and cleaning costs (*CC*) for the treatments were determined by subtracting *OC* and *CC* from the total gross revenue from wheat and expected cheat sales. Returns were calculated for three representative farm sizes; a low, medium, and high cleaner cost scenario; and two estimated cheat prices. After returns were established for the alternatives, they were compared to the net returns from the *Conventional* system to determine if any benefits existed. If a net loss existed, then the required yield increase for the subsequent year was estimated. If an analysis of variance indicated a significant difference across treatments, then a Duncan multiple range test was performed to compare the treatment means.

<u>Location Conclusions</u>

The Red Rock location had the largest cheat infestation of this study. The most profitable treatment at Red Rock was the *High Air with Kice* method. The net benefit offered over the *Conventional* system was between $34 and $15 per acre (/ac) for the various farm sizes, cheat prices, and cost options. The benefit was the additional returns above operating costs and cleaner related costs. This was a very unexpected outcome. The *High Air with Kice* treatment was anticipated as having better grades and less yield than the *Conventional*. Its wheat price after discounts was significantly larger due to enhanced grades and lower dockage, but the yield after dockage was slightly higher and than the base system, however it was not significant. Despite the large benefits from the *High Air with Kice* method, there was only a statistical difference in returns between it and the *Conventional* system for the 1,500 acre farm with the $0.06 per pound cheat price, and low cost estimation. With the 17 other combinations of cheat prices, cost options, and farm sizes, the null hypothesis of no difference in net returns between the *High Air with Kice* and the *Conventional* could not be rejected. It could be concluded that, even though the *High Air with Kice* treatment consistently improved returns, it was not to the point of statistically significance at the 5% level. Therefore, an unambiguous recommendation of this alternative over the *Conventional* system could not be made.

The Marland site had the second worst cheat infestation of the four locations, although it was much smaller than Red Rock. The most profitable treatment was the *Low Air with Bin-Unit* alternative. The benefits it produced over the *Conventional* system ranged from about $10 to $1 /ac. However, the null hypothesis of no difference in returns between the *Low Air with Bin-Unit* and *Conventional* treatments could not be rejected at the 5% level. It was determined that none of the alternatives significantly improved returns.

The Billings field studies had the second smallest cheat population. With the $0.06 per pound cheat price, the *Low Air with Bin-Unit* method generated the greatest net returns. However, when cheat price was lowered the *High Air* alternative proved to be the most effective method. This outcome stood true at each farm size and for the varied cost options at Billings. The results from this location demonstrate the importance of the cheat market and price. The *Low Air with Bin-Unit* procedure relied on selling its cleanings to be effective, while the *High Air* tactic was profitable based on an improved price and a higher yield, which was unexpected. However, despite the benefits offered by the alternatives there was never a significant difference between either of these the two treatments and the *Conventional* at the 5% level for Billings. Across the three farm sizes, three cost estimates, and two cheat prices, none of the treatments were statistically different from any of the other treatments.

Cheat infestation at the Hunter location was slight at best. It had the lowest average dockage level of the four sites. For comparison purposes there were only two alternatives to the *Conventional* system. However, the most profitable treatment was the *Conventional* system at every cost option and cheat price. At a majority of the cost and cheat price combinations the *Low Air with Kice* treatment was even significantly lower than the *Conventional.* This was the anticipated outcome at a site with such a small cheat population.

Limitations

To gain validity of commercial situations these treatments were conducted at privately owned farms instead of university research stations. Performing research in this manner is very precarious, and unfortunately the weed control effects for the subsequent year could not be evaluated. The agronomic effects of the methods studied in this report could hold the key to discovering an alternative to the *Conventional* wheat harvesting method that consistently and significantly improves returns.

An additional limitation to this study was the small amount of source data. With only three or four replications for each treatment, there may not have been enough power in the statistical analysis. If more data were available, some of the alternatives that indicated improvements in net returns might be prove to be significantly different than the *Conventional.*

The estimated cheat market was also a sensitive area in the research. Attempting to predict a price for an unknown market was very difficult. Even by using two price estimates, the revenue from the expected sale of cheat and cleaning was still questionable. Especially when a portion of net benefits was due to this anticipated revenue increase.

Conclusions

A change in the traditional procedure could benefit not only farmers and producers but the wheat industry in general, by providing cleaner wheat for the marketing channel. A need for additional research can be seen in the areas of aspirator cleaner design, the possible marketing of cheat and cleanings as a feed stuff, and the feasibility of additional cleaning equipment on modern grain combines.

Since the four locations had varying cheat problems important information was gained from this study. If a severe problem exists, such as the one at Red Rock, there are several alternatives to the *Conventional* system of harvest that may increase returns. However, at lower levels of cheat infestation the economics of the alternatives are less promising. Based on the results presented in the study, there was not an alternative procedure of harvest that consistently and significantly improved net returns at any level of cheat infestation.

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APPENDIX

Table A-1. Combine Cost Estimates Used in *MACHSEL*

National Farm Tractor and Implement Blue Book 1992

John Deere Combines

Year	Model	Description	Engine	Cylinder	Average Retail Value
1988	6620	Grain	466 6D	22 x 44	$51,125
1987	6620	Grain	466 6D	22 x 44	$46,050
1986	6620	Grain	466 6D	22 x 44	$44,550
1985	6620	Grain	466 6D	22 x 44	$41,700
1984	6620	Grain	466 6D	22 x 44	$37,800
1983	6620	Grain	466 6D	22 x 44	$37,475
Average Retail Value					***$43,120***
1988	7720	Grain	466 6TCD	22 x 55	$60,025
1987	7720	Grain	466 6TCD	22 x 55	$54,175
1986	7720	Grain	466 6TCD	22 x 55	$52,375
1985	7720	Grain	466 6TCD	22 x 55	$48,875
1984	7720	Grain	466 6TCD	22 x 55	$44,225
1983	7720	Grain	466 6D	22 x 55	$44,350
Average Retail Value					***$50,670***
1988	8820	Grain	466 6TCDI	22 x 65.5	$73,675
1987	8820	Grain	466 6TCDI	22 x 65.5	$66,450
1986	8820	Grain	466 6TCDI	22 x 65.5	$64,275
1985	8820	Grain	466 6TCDI	22 x 65.5	$58.825
1984	8820	Grain	466 6TCDI	22 x 65.5	$52.625
1983	8820	Grain	466 6D	22 x 65.5	$52,775
Average Retail Value					***$61,440***

* *National Farm Tractor and Implement Blue Book.* National Market Reports. Chicago. 1992:*88*-30,*87*-28,*86*-28,*85*-30,*84*-28,*83*-20.

Table A-2. **Oat Price Estimates Used in Cheat Revenue Calculations**

OKLAHOMA FARM STATISTICS

National Agricultural Statistics Service
Oklahoma Agricultural Statistics Service
Oklahoma Department of Agriculture
U.S. Department of Agriculture

Volume 18, Number 3 February 13, 1998

Oklahoma Crop Values - 1997

Oklahoma -- Crops: Total Production, Price, and Farm Value, 1996 and 1997

Crop	Unit	Production		Market Year Average Price	
		1996	1997	1996	1997
		thousands		dollars	
Oats	bushel	648	2070	3.10	2.40

Internet Address:
http://www.nass.usda.gov/ok/fms18_03.htm

* "Oklahoma Crop Values - 1997." *Oklahoma Farm Statistics*. Oklahoma Agricultural Statistics Service. Oklahoma Department of Agriculture. 18(February 13, 1998).

Table A-3. Winter Wheat Acreage in Oklahoma and the United States

1997 SMALL GRAIN ANNUAL SUMMARY

Oklahoma Agricultural Statistics Service **September 30, 1997**

Small Grain Acreage, Yield, and Production, Final 1996-1997

Crop	Planted Acreage		Harvested Acreage		Yield per Acre	
	1996	1997	1996	1997	1996	1997
	thousands				bushels	
Oklahoma Winter Wheat	7000	6800	4900	5400	19.0	33.0
United States Winter Wheat	51958	70989	62927	63577	36.3	39.7

Barry L. Bloyd -- State Statistician
Burt Bartlett and John Cole -- Agricultural Statisticians

Internet Address:
http://www.nass.usdu.gov/ok/smgrrel.htm

* Bloyd, B. L., B. Bartlett, J. Cole. *1997 Small Grain Annual Summary*. Oklahoma Agricultural Statistics Service. September 30, 1997.

Table A-4. Wheat Price Estimates Used in Wheat Revenue Calculations

Agricultural Prices

National Agricultural Statistics Service **USDA, Washington, D.C.**

Released July 31, 1997, by the National Agricultural Statistics Service (NASS), Agricultural Statistics Board, U.S. Department of Agriculture. For information on "Agricultural Prices" or other assistance, see page B-33.

Wheat: Prices Received, by States, June and July 1997

State	All Wheat		Winter Wheat		Durum Wheat		Oth Spring Wheat	
	Jun 1/	Jul 2/	Jun 1/	Jul 2/	Jun 1/	Jul 2/	Jun 1/	Jul 2/
	dollars per bushel							
KS	3.24	3.05	3.24	3.05				
OK	3.28	3.05	3.28	3.05				
TX	3.41	3.12	3.41	3.12				
U.S.	3.52	3.18	3.42	3.10	4.21	4.52	3.74	3.56

1/ Entire month.
2/ Mid-month.

Internet Address:
http://mann77.mannlib.cornell.edu/reports/nassr/price/pap.bb/1997/agricultural_prices_07.31.97

* *Agricultural Prices*. National Agricultural Statistics Service. United States Department of Agriculture. Washington, D.C. July 1997.

Table A-5. Selected Cost Output From *MACHSEL*

Per Acre Machinery Enterprise Cost Totals for Wheat

Farm Size (acres)	500	1,000	1,500
Annual Depreciation	$ 23.90	$ 15.94	$ 15.85
Interest Cost	18.17	12.62	12.51
Insurance Cost	1.21	0.84	0.83
Tax Cost	2.44	1.74	1.82
Fixed Cost / Acre	45.72	31.14	31.01
Repair Cost	4.60	5.44	5.27
Fuel Cost	5.67	5.04	4.85
Lube Cost	0.85	0.76	0.73
Variable Cost / Acre	11.12	11.24	10.84
Hired Labor Cost	0.41	2.06	1.46
Total Cost/Acre with Only Labor Hired	57.52	44.44	43.31
Total Cost/Acre with All Labor Paid	62.78	47.74	45.51

* Kletke, D. D. and R. Sestak. *The Operation and Use of MACHSEL: A Farm Machinery Selection Template*. Department of Agricultural Economics, Oklahoma State University. 1991.

Table A-6. 1996 Agricultural Chemical Use Estimates for Field Crops

Agricultural Chemical Usage 1996 Field Crop Summary

National Agricultural Statistics Service, Washington, D.C. **September 1997**

Winter Wheat: Agricultural Chemical Applications, Oklahoma, 1996 1/

Agricultural Chemical	Area Applied	Appli-cations	Rate per Application	Rate per Crop Year	Total Applied
	Percent	Number	Pounds per Acre		1,000 lbs.
Herbicides					
2, 4-D	23	1	0.57	0.57	648
Chlorsulfuron	8	1	0.01	0.01	5
Metsulfuron-methyl	7	1	0.003	0.003	1
Insecticides					
Dimethoate	15	1	0.19	0.19	136
Methyl parathion	12	1	0.42	0.42	254

1/ Harvested acres in 1996 for Oklahoma were 4.90 million acres.

Internet Address:
http://mann77.mannlib.cornell.edu/data-sets/inputs/9X171/97171/agch0997.txt

* *Agricultural Chemical Usage 1996 Field Crops Summary*. National Agricultural Statistics Service. Economic Research Service. Washington, D.C. September 1997.

Table A-7. Selected Cost Output From Budgeting Equations for Cleaner Costs

Per Acre Cost Totals for the Kice Aspirator Cleaner

Farm Size (acres)	500	1,000	1,500
Depreciation Cost	$ 3.27	$ 1.64	$ 1.09
Interest Cost	1.47	0.74	0.49
Insurance Cost	0.10	0.05	0.03
Tax Cost	0.33	0.16	0.11
Fixed Cost / Acre	5.17	2.59	1.72
Repair Cost	0 .00001	0 .000005	0 .000003
Fuel Cost	0.09	0.04	0.03
Lube Cost	0.01	0.01	0.01
Variable Cost / Acre	0.11	0.05	0.04
Total Cost/Acre	5.28	2.64	1.76

Per Acre Cost Totals for the Prototype Bin-Unit Cleaner

Farm Size (acres)	500	1,000	1,500
Depreciation Cost	$ 1.18	$ 0.59	$ 0.39
Interest Cost	0.53	0.27	0.18
Insurance Cost	0.04	0.02	0.01
Tax Cost	0.12	0.06	0.04
Fixed Cost / Acre	1.87	0.93	0.62
Repair Cost	0 .00003	0 .000001	0 .000001
Fuel Cost	-	-	-
Lube Cost	-	-	-
Variable Cost / Acre	0.00	0.00	0.00
Total Cost/Acre	1.87	0.93	0.62

* Kletke, D. D. "Operation of the Enterprise Budget Generator." *Oklahoma State University Agricultural Experiment Station Report*. P-790. August 1979.

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