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RYE STRIP-CROP BARRIERS: AN ECONOMIC ANALYSIS

by

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B. S., Kansas State University, 1970

9589

A MASTER'S THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

Department of Agricultural Economics

KANSAS STATE UNIVERSITY
Manhattan, Kansas

1972

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Major Professor

THIS BOOK CONTAINS NUMEROUS PAGES WITH THE ORIGINAL PRINTING BEING SKEWED DIFFERENTLY FROM THE TOP OF THE PAGE TO THE BOTTOM.

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ACKNOWLEDGEMENTS

I want to express my appreciation to my major professor, Dr. Orlan Buller, and the members of my committee, Dr. Leon Lyles and Dr. Frank Orazem, for their help and suggestions in writing this thesis.

A special note of thanks goes to my wife Trudy for her patience, help, and understanding during the course of writing this thesis as well as throughout my course of study.

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CHAPTER 1

INTRODUCTION

Vegetable crops are easily damaged by wind velocities high enough to cause blowing soil which is referred to as wind erosion. Several factors enter into determining the extent of wind erosion. One factor is the nature of the soil surface. The smoother the soil surface the more susceptible the soil is to wind erosion. Thus, one practice of controlling wind erosion is to roughen the soil surface. The freer the surface is of weeds, stubble, and other debris, the more likely wind erosion will occur. Thus, stubble mulching practices are recommended for wind erosion control because the stubble protects the soil from the wind and obstructs the wind flow. The protection of the soil from the wind is one reason that stubble and weeds are left standing on fields which are exposed to wind.

The composition of the soil is another factor which determines the amount of wind erosion. Soils with a high sand content tend to be more erodible than soils with a low sand content. Since vegetables are produced on soils high in sand content that are very susceptible to wind erosion, a highly erodible soil was assumed to be present in this study.

Other factors which affect the amount of wind erosion are the velocity of the wind and the topography of the land. The higher the wind velocity the higher the probability that wind erosion will occur. Tree rows, particularily perpendicular to the direction of the flow, reduces the air flow pattern and decreases the velocity of the wind. An area of flat open land with no obstacles to alter the flow makes the soil very susceptible to wind erosion.

Four commonly recommended conservation practices for controlling wind erosion are: (1) shelterbelts, (2) strip-farming, (3) stubble mulching, and (4) deep-plowing. Not all of these practices can be used in all circumstances, particularly where crops are being grown. A method currently under study is the use of strip-crop barriers. In vegetable producing areas this seems to be an acceptable practice but an economical analysis needs to be made of the practice. In this study, rye was used as the strip-crop barrier because it is planted in the fall when labor is not needed for other field work and also because it grows rapidly in the early spring. It also provides good height which is important to a barrier. Wheat or barley could have been used but they do not provide the height that rye provides.

One advantage of using barriers is to offer protection which may result in an earlier yield when prices are usually higher. If damage occurs early in plant life, the crop can be replanted, but then production is later and thus the crop is sold when prices are lower.

OBJECTIVE

The primary objective of the study was to determine the cost of using rye strip-crop barriers in the production of tomatoes, snap beans, dry edible beans, and melons. These crops were chosen because there was some data available concerning the influence of the barriers on their yields and/or they are produced in Kansas. A second objective was to estimate what increase in yields would be required for barriers to be profitable.

PROBLEM

Vebetable crops are normally planted in highly erodible soils for the following reasons: (1) the soils tend to warm up sooner in the spring allowing for earlier planting, (2) the soils drain easily preventing drowning of the plants, and (3) the availability of the water. Since vegetables are planted in sandy soils, crop damage from wind erosion frequently occurs. The damage varies from complete loss of crop due to blow-out, as was the case in Michigan in 1965 on some 8200 acres of sugar beets[1], to small damage to plant cells and/or a small decrease in either yield or quality of the fruit[2, 3, 4]. Research has been conducted on the extent of damage to various vegetable crops when subjected to various amounts of blowing sand for various time periods in the life cycle of the plants[5, 6, 7]. Research has also been conducted in field studies on the effect of rye strip-crop barriers on crop yields. There has been little work done on the economics of using strip-crop barriers as a means of controlling wind erosion and protecting vegetable crops from wind and sand-blast injury. The problem under consideration in this study was to evaluate the increase in yield from protection by the barriers needed to cover the cost to establishing the barriers and the reduction of income resulting from the loss of land from production which is occupied by the barriers.

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1. Drullinger, Richard H. and Schmidt, Berlie L. Wind Erosion Problems and Controls in the Great Lakes Region, Journal of Soil and Water Conservation, March-April, 1968.

2. Armbrust, D. V., Dickerson, J. D., and Greig, J. K. Effect of Soil Moisture on the Recovery of Sandblasted Tomato Seedlings, Journal of the American Society for Horticultural Science, Volume 94, Number 3, May, 1969.

3. Hayes, William A. Wind Erosion Equation Useful in Designing Northeastern Crop Protection, Journal of Soil and Water Conservation, July-August, 1965, p. 153-155.

4. Skidmore, E. L., Wind and Sandblast Injury to Seedling Green Beans, Agronomy Journal, Vol. 58, 1966, p. 153-155.

5. Armbrust, loc. cit.

6. Hayes, loc. cit.

7. Skidmore, loc. cit.

The practice of using strip-crop barriers has been established on some farms but their productivity or profit has not been considered. There is a possibility that the use of strip-crop barriers may actually reduce the return from a crop and thus decrease the profit. So this study was undertaken.

METHOD

In this study, it was assumed that the soil was tilled and vitually free of weeds, stubble, and debris because vegetable producers cultivate their crops so as to control weeds from competing with the crop for moisture and nutrients. Because the soil is free of debris, and also of a high sand content, it follows then that the soil is highly susceptible to wind erosion. Vegetable crops can be easily damaged by wind erosion in their seedling and flowering stages as well as during their entire growing season. This damage ranges from complete loss of crop to only minor decreases in yield and quality of the fruit.

The first step in determining the feasibility of using strip-crop barriers was to develop a cost budget based on a given model. The budget was determined by using an engineering approach in establishment of one acre of rye. The engineering approach was used because it furnished data for all the various operations providing consistency in estimating costs.

Variable costs were the only costs that the study was concerned with. Variable costs are the costs that change as the production changes. Fixed costs are the costs that are incurred with no respect to the method used or amount produced. Fixed costs are depreciation, taxes, buildings, etc. Total variable cost is the sum of fuel cost, repair and maintenance cost, and seed cost. The reason for only considering the variable costs is that the decision to use strip-crop barriers will be based on the change in cost compared with the change in value of production. The study considered the comparison of the marginal costs to marginal returns. Marginal cost is the additional cost that results from the change in method and the marginal return is the additional return or receipts which result from the change in method. Thus, the costs involved in the establishment of the barriers were only the variable costs because the fixed costs would be encountered even if barriers were not used.

After determining the cost of establishing the barriers, an estimate was made as to the increase in yield necessary to cover the cost of the barriers. This estimate was then compared with the actual yield data available on tomatoes, snap beans, and melons. Yield data available were limited to those three crops and not available for dry edible beans.

Dry edible beans are produced in Kansas, but only estimates of yield needed to cover the cost of establishing the barriers were made.

CHAPTER 2

THE COST OF ESTABLISHING RYE STRIP-CROP BARRIERS

Four assumptions were necessary to estimate the cost of establishing rye strip-crop barriers: that the rye was planted in the fall and that it was planted over the entire area where the barriers were to have an effect; the entire area was considered to be planted as the rye would help control any wind erosion that might occur if the field was left bare; rye was considered to be a cover crop and; that the producer would plow the area between the rye strips the following spring leaving the desired distance between the barriers and also the desired width of the barriers.

The first step in determining the feasibility of using rye strip-crop barriers was to develop a cost budget based on using a 40 horsepowered tractor, a 12 foot spring-tooth harrow, a nine (9) foot tandem disk, and a 16-8 grain drill. All of the implements can be operated with a 40 horsepower tractor. These are the only implements considered because no other implements are needed to establish the rye strip-crop barriers. The size of the tractor and implements are relatively small because vegetable farms have small areas between the rows which require cultivation.

All of the formulas and data used in the cost analysis were taken from the Agricultural Engineers Yearbook[9], unless otherwise stated. The normal average life of farm equipment is usually considered to be ten years. The average age of machines and equipment was assumed to be five years which is half life. This was used because some farmers have newer equipment or older equipment than other farmers, so the average age was assumed. Therefore, the original costs used in this study were based on 1968 prices of implements.

EFFECTIVE FIELD CAPACITY

Effective field capacity is needed to estimate time per acre which is used to estimate fuel, oil and repair and maintenance costs. The effective field capacity was computed by using the formula[10]:

$$C = \frac{SWE}{825} \qquad (1)$$

where

C = Effective field capacity of the machine in acres per hour
S = Speed traveled in miles per hour
W = Width of the machine in feet
and E = Field efficiency of the machine in percent

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9. Agricultural Engineers Yearbook, Sixteenth Edition, The American Society of Agricultural Engineers, St. Joseph: Michigan, 1969.

10. Ibid., p. 278.

The speed used for estimating the capacity of each implement was based on the average of the range in speed given for each operation. The speed of disking could not be found in the yearbook but from personal experience, it was considered to be a little slower than the speed of spring-tooth harrowing. The relationship between the speed of disking and the speed of spring-tooth harrowing was confirmed in the bulletin, Farm Machinery Cost in the Western States[11].

Field efficiency was the average efficiency of the machine and includes the effects of overlapping, turning around at the ned of the field, clogging of the equipment, machine adjustments, minor repairs done in the field, daily lubrication, and lubrication required in addition to the daily servicing.

Estimates of effective field capacity of the various implements can be found in Table 1. Capacity was converted from acres per hour to time per acre. The total time per acre was determined by multiplying the number of operations by the time per acre.

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11. Martin, William E. Farm Machinery Costs in the Western States. Tucsön; Arizona, Agricultural Experiment Station, College of Argiculture, The University of Arizona Technical Bulletin 154, 1964.

Table 1.
Field Capacity of Equipments

	Operation		
	Tamdem Disk	Spring-tooth Harrow	Planting
Speed (mph)	4.00	4.50	3.75
Width (feet)	9.00	12.00	10.67
Field Effeciency (percent)	82.50	82.50	70.00
Capacity (acres per hour)	3.600	5.400	3.395
Time Per Acre (hours)	0.278	0.185	0.295
Number of Operations	1.00	2.00	1.00
Total Time Per Acre (hours)	0.278	0.370	0.294

FUEL CONSUMPTION

To determine fuel consumption for the various operations, the following formula[12] was used:

$$\text{Gal/Hour} = \frac{\text{Equivalent PTO horsepower required}}{\text{hp-hr/gal. at the equivalent hp output}} \quad (2)$$

To use this formula several items had to be calculated. Table 2 gives a summary of all the items that were used and calculated.

The first step in determining the fuel consumption was to calculate the drawbar horsepower. This was calculated because it was needed to determine the PTO equivalent used in formula (2). The formula is[13]:

$$\text{dhp} = \frac{\text{(Draft, in pounds) (Speed, in mph)}}{375} \quad (3)$$

was used for determining the drawbar horsepower (dhp). Draft is the horizontal component of drawbar pull parallel to the direction of travel. Draft estimates used were determined by taking the average of the range. Speed used in calculating drawbar horsepower was the same as the speed used in Table 1 in determining the effective field capacity of machines.

Drawbar horsepower had to be determined to estimate the power take-off (PTO) horsepower. PTO horsepower was

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12. Agricultural Engineers Yearbook, op. cit., p. 281.

13. Agricultural Engineers Yearbook, op. cit., p. 278.

Table 2.
Fuel Consumption of Tractor by Operation

	Operation			
	Tandem Disk	Spring-tooth Harrow (first)	Spring-tooth Harrow (second)	Planting
Draft (lb/ft)	225.00	112.50	112.50	55.00
Width (feet)	9.00	12.00	12.00	10.67
Total Draft (lb)	2025.00	1350.00	1350.00	568.85
Speed (mph)	4.00	4.50	4.50	3.75
Drawbar Horsepower	21.60	16.20	16.20	5.87
T&T Coef.*	0.80	0.45	0.65	0.40
PTO hp	27.00	36.00	24.92	14.67
PTO hp/40 (percent)	67.50	90.00	62.30	36.70
hp-hr/gal	9.75	11.25	9.50	7.25
Gal/hr	2.77	3.20	2.62	2.02
Time/Acre	0.278	0.185	0.185	0.294
Gal/Acre	0.770	0.592	0.485	0.585
Cost/Gal (cents)	28.20	28.20	28.20	28.20
Cost/Acre (cents)	21.714	16.694	13.677	16.751

* Traction ans Transmission Coefficient

calculated by dividing drawbar horsepower by the traction and transmission coefficient[14]. The formula used then for determining the PTO horsepower was:

$$\text{PTO hp} = \frac{\text{Drawbar horsepower}}{\text{Traction and Transmission Coefficient}} \qquad (4)$$

The traction and transmission coefficients used is reported in Table 3. Variations in the traction and transmission coefficients among operations was due to the condition of the soil and to the pull of the load, or drawbar horsepower requirements, of the operation. The disking operation was assumed to require a moderately heavy drawbar load and the operation done on untilled soil so the traction and transmission coefficient was relatively high, 0.8. The first harrowing operation was assumed to follow the disking operation on freshly plowed ground and a moderately heavy drawbar load. Thus, the coefficient 0.45 was used for the first harrowing operation. A higher coefficient, 0.65, was used for the second harrowing operation because the first harrowing operation firmed the soil but still a moderately heavy drawbar load was required for the second harrowing. The planting operation was assumed to require a light drawbar pull and done on tilled but reasonably firm soil. Thus, the coefficient used for this operation was 0.40.

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14. _Agricultural Engineers Yearbook_, op. cit., p. 280.

Table 3.
Traction and Transmission Coefficients
for Wheel Type Tractors

Surface Condition	Light Drawbar Load	Medium Drawbar Load	Moderately Heavy Drawbar Load
Concrete	0.75	0.85	0.90
Firm, untilled field	0.60	0.75	0.80
Tilled, reasonably firm soil	0.40	0.60	0.65
Freshly plowed soil	0.25	0.40	0.45

Source: Agricultural Engineers Yearbook, 1969

Using the power take-off horsepower for the various operations, a percentage value of PTO horsepower was calculated by dividing the PTO hp by the maximum drawbar horsepower capacity of the tractor used in the model (40 dhp)[15]. The formula was:

$$\text{Percent Maximum PTO hp} = \frac{\text{PTO hp}}{\text{Maximum dhp} = 40} \quad (5)$$

The percent maximum PTO hp was needed to determine the horsepower-hour per gallon (hp-hr/gal) from Figure 1. To find the hp-hr/gal. from Figure 1, find the percent maximum PTO hp on the horizontal axis and then draw a line perpendicular to the axis at the proper percentage value and where this line crosses the curve for gas tractors, read on the vertical axis the hp-hr/gal of fuel required.

With estimated horsepower-hour per gallon and power take-off equivalent, fuel consumption was calculated using formula (2). Consumption in gallons per hour was converted into gallons per hour. The cost of fuel per acre was determined by multiplying the gallons per acre by the cost of fuel per gallon which was based on the average price paid by farmers in 1969[16].

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15. Agricultural Engineers Yearbook, op. cit., p. 281.

16. Kansas Agriculture, 53rd Annual Report, Kansas State Board of Agriculture. 1969

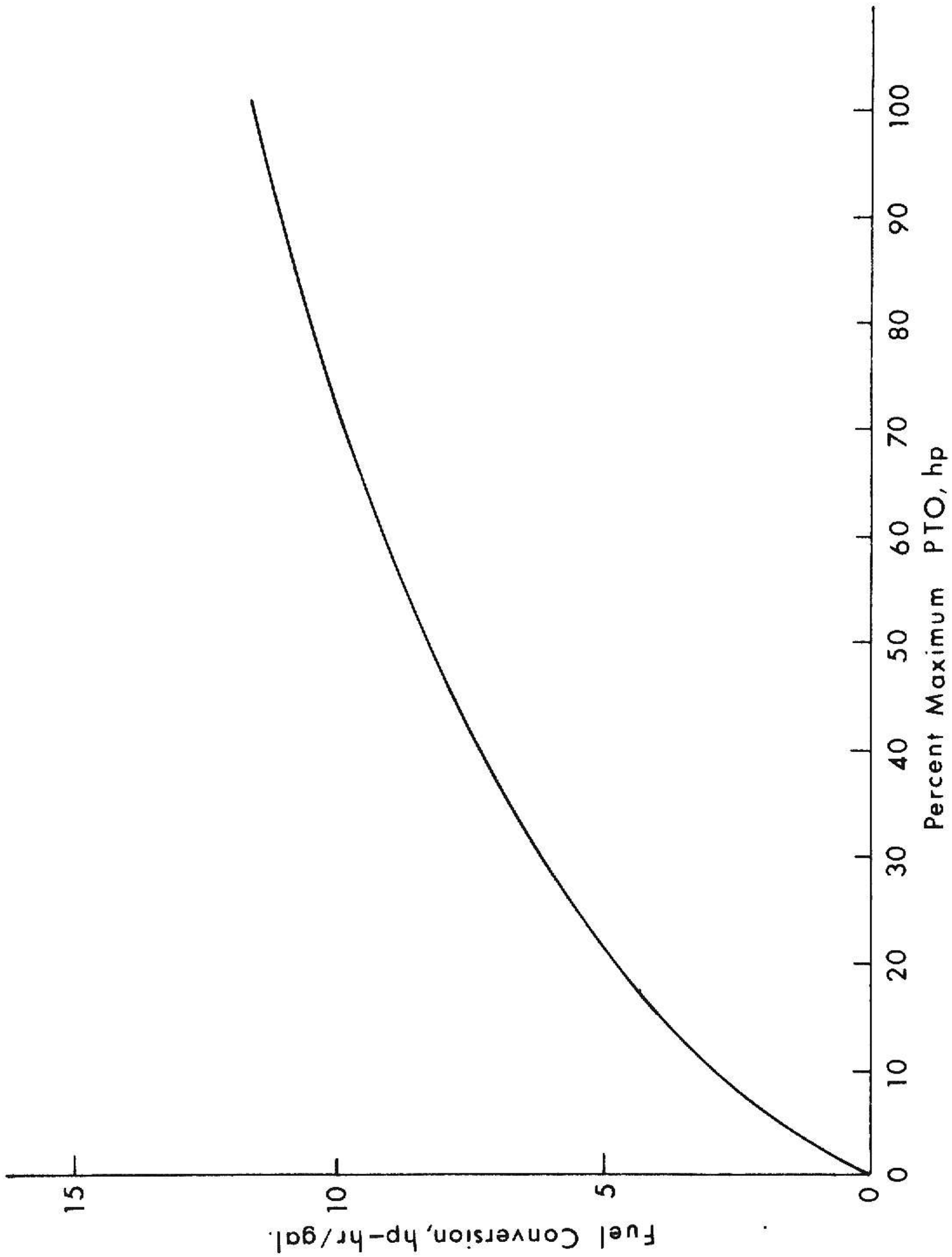

Figure 1.
Power-Outlet Fuel Conversion for Tractors
Horsepower Hours Per Gallon
Agricultural Engineers Yearbook, 1969, p. 283.

REPAIR AND MAINTENANCE COSTS

Life time repair and maintenance costs are based on a percent of the original cost of the tractor and implements. It was assumed that the machines were approximately five years old and thus, the original costs were based on 1968 prices. Farm Facts[17] and Kansas Agriculture[18] provided the original cost data. The cost provided on a tandem disk was for twelve (12) foot and 12 to 14 foot disks. A deduction of two-hundred dollars was necessary in order to arrive at the cost of a nine (9) foot tandem disk. Based on the data, in 1968 a 12 foot disk sold for $1075.00 while the average price of 12 to 14 disks was $1175.00. Thus, a cost of $875.00 seemed a reasonable estimate of a nine (9) foot tandem disk.

The total lifetime repair and maintenance costs were divided by the estimated average hourly life of the equipment resulting in the hourly repair and maintenance cost. The hourly cost was multiplied by the time per acre required for the various operations to arrive at the average cost per acre. The cost per acre could have also been found by dividing the cost per hour by the field capacity of the implement per hour (refer to Table 1). Repair and maintenance costs for the various operations can be found in Table 4.

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17. Farm Facts, Kansas State Board of Agriculture, 1968-1969

18. Kansas Agriculture, loc. cit.

Repair and maintenance cost per acre could not be determined for the tractor as it is used in performing all of the various operations and thus the cost per acre would be related only to the operation which the tractor was performing. The cost per acre for the tractor can be found in Table 5.

The cost of grease, oil, and filters was assumed to be 15 percent of the fuel cost and is reported in Table 5 relating to the various operations.

Table 5 presents total variable costs by operations and also by kind or type of cost compiled from the summaries on cost per acre from the other tables. The table has two spring-tooth harrowing operations because of the difference in fuel consumption due to the difference in the condition of the soil. The table further shows the repair and maintenance costs per acre for the tractor for each operation and also the total repair and maintenance cost of the tractor for establishing one acre of rye.

SEED COST

Cost of rye seed must be included as a variable cost to determine the total variable cost of establishing the rye strip-crop barriers. The cost of rye seed was found to be $2.60 per bushel which was obtained from a seed dealer in Manhattan, Kansas. Thus, the cost of the seed to establish one acre of rye, if 1.25 bushels per acre were planted, was determined to be $3.25.

Table 4.
Repair and Maintenance Cost of Equipment

	Equipment			
	Tractor	Tandem Disk	Spring-tooth Harrow	Grain Drill
Original Cost (dollars)	5475.00	875.00	295.00	1175.00
R&M* Cost as Percent of Orginal Cost (percent)	120.00	120.00	120.00	100.00
Average Life of Equipment (hours)	12000.00	2500.00	2500.00	1200.00
R&M Cost Per Hour (cents)	54.75	42.00	14.16	97.92
Time Per Acre (hours)	———	0.278	0.185	0.294
Cost Per Acre (cents)	———	11.676	2.620	28.788

* Repair and Maintenance Cost

Table 5.
Total Variable Cost of Equipment Per Acre

	Tandem Disk	Spring-tooth Harrow (first)	Spring-tooth Harrow (second)	Grain Drill	Total Cost Per Acre (cents)
Fuel Cost (cents)	21.714	16.694	13.677	16.751	68.836
Grease and Oil Cost (cents)	3.257	2.504	2.052	2.475	10.288
Repair and Maintenance Cost (cents)	11.676	2.620	2.620	28.788	45.704
Time Per Acre (hours)	0.278	0.185	0.185	0.294	
R&M Cost Per Hour for Tractor (cents)	0.55	0.55	0.55	0.55	
R&M Cost Per Acre for Tractor (cents)	15.290	10.175	10.175	16.170	51.810
Total Cost Per Operation (cents)	51.937	31.993	28.524	64.184	176.638

The total variable cost was found to be $5.02 per acre for establishing the rye strip-crop barriers. The total variable cost did not allow for any labor expense as it was assumed that the labor was either supplied by the operator or by labor hired on a monthly salary. It did not allow for the loss of land from production as this varies with the type of crop that is being produced.

ALLOWANCES FOR LAND LOST FROM PRODUCTION

The cost of using rye strip-crop barriers must include the loss of yield that occurs from taking land from production to use it to establish the barriers. The cost does not apply to crops planted several feet apart such as melons, but it does apply to crops planted in rows close together such as tomatoes, snap beans, and dry edible beans. Melon crops are usually planted 10 to 12 feet apart because they spread over a large area as they grow. Because melons spread over a large area they will grow into the barriers and thus the barriers do not take land out of production. By the time the melon vines reach the barriers, the barriers are fairly mature and thus consume very little water so they don't hinder the melon crop. Although the barriers are mature, they still offer the vines protection from the wind and this is very important since wind can oscillate and lift the vines causing small fruit to drop and a subsequent decrease in yield. This is one of the values of using the barriers.

Because tomatoes, snap beans, and dry edible beans are closely planted. The land used to establish the barriers has to be taken into account as a cost due to loss of production. Therefore, the width, height (H), and spacing of the barriers, or the area of protection needs to be known in order to determine the land taken from production so that an evaluation of the barriers may be made. The width of the barrier was assumed to be thirty (30) inches. This was based on research done by Hagen[19] in the wind tunnel and research done by Downes, Knierem, and Gilbart[20] in a field study of rye strip-crop barriers. The spacing of the barriers was assumed to be 10H (10 times the height of the barrier). This means that the area of protection offered by a barrier is 10 times its height. Downes, Knierem, and Gilbart[21], Drullinger and Schmidt[22], and Hayes[23] all used 10H in their work. Because research

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19. Hagen, L. J. Narrow Crop Strip Barrier Systems for Wind Erosion Control, Annual Research Report, Soil Erosion Research, Manhattan, Kansas, 1970.

20. Downes, J., Knierem, J. and Gilbart, D. Windbreaks for Muskmelons, Sodus Horticultural Experiment Station, Annual Progress Report, January, 1965.

21. Ibid.

22. Drullinger, R. H. and Schmidt, B. L. Wind Erosion Problems and Controls in the Great Lakes Region, Journal of Soil and Water Conservation, March-April, 1968.

23. Hayes, loc. cit.

has been conducted on the basis of 10H, 10H was assumed to be the protected area in this study. The height of the barrier was assumed to be thirty (30) inches. This was based on the actual observance of barriers in use and the height maintenance was 30 inches. The height would vary from year to year depending upon the growing conditions but rye will usually reach approximately 30 inches. Also; Downes, Knierem, and Gilbart[24] used a height of 30 inches in their work.

Assuming a height of 30 inches, a width of 30 inches, and a protected area of 10H or 300 inches, it was calculated that one-eleventh of the land was devoted to the rye strip-crop barriers. Thus, the yield from the area actually in production of the vegetable crop would have to be 109.1 percent greater than before to cover the loss of land from production. If a field is eleven (11) acres and produces a crop of 33000 pounds then if rye strip-crop barriers are established in the field and they occupy one acre of the field, the remaining ten acres must produce at least 33000 pounds in order for the land being taken out of production to be justified.

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24. Downes, loc. cit.

Chapter 3

BUDGET ANALYSIS AND COMPARISON

The budget method of analyzing a choice of two alternative producing methods has two parts: its costs and its benefits. The cost sector consists of added costs and reduced receipts while the benefit sector is divided into reduced costs and added receipts resulting from the proposed change in method of producing a crop. This was the method used in analyzing the budgets presented in this study.

ADDED COSTS

The added costs were the outlays of money which result from a change in method. In this study, the change in method was the establishment of rye strip-crop barriers in the production of tomatoes, snap beans, dry edible beans, and melons. So, the added costs were the added variable costs of establishing the rye strip-crop barriers which were the added variable costs of using the equipment and the cost of rye seed for establishing the barriers. It follows that the added costs were the same no matter what crop was produced.

REDUCED RECEIPTS

Reduced receipts were considered as the loss of receipts due to land taken from production of a vegetable crop and used to establish the rye strip-crop barriers. Reduced receipts then, was the market value of the product which could have been produced on the land occupied by the barriers. The reduced receipt was figured by multiplying the average yield per acre times the price per pound received and then dividing this be eleven (11). It was divided by eleven because one-eleventh of the total area was devoted to the rye strip-crop barriers. The formula was:

$$\text{Reduced Receipts} = \frac{\text{Average Yield x Price /Lb.}}{11} \quad (6)$$

where

Reduced receipts is found in dollars per acre,
Average yield is found in pounds per acre, and
Price/lb. is in cents per pound

The reduced receipts for tomatoes, snap beans, and dry edible beans can be found in Tables 7, 10, and 13, respectively. The tables show the reduction in income in dollars per acre at various yields per acre and various prices per pound. To use the tables, one must know the average yield per acre and what price per pound is received for the product. First, find the average yield per acre in the left hand column and then follow the row across until the proper price per pound column is reached. At this point, the reduced receipts from using rye strip-crop barriers can be found in dollars per acre.

REDUCED COSTS

Reduced costs are costs that are not incurred due to the change in method. The reduced cost is the purchase of the vegetable seed. This study did not include labor costs as part of the reduced costs because it was assumed that the labor was either furnished by the operator of the farm or by hired labor whose salary was on a monthly basis. Therefore, labor was considered a fixed cost.

The reduced costs for snap beans was found to be $2.33 per acre. This was calculated using the wholesale prices obtained from a catalog of the Midwest Seed Growers[25], and based on the assumption that there were 60 pounds of seed planted per acre[26]. The wholesale prices were used because most vegetable producers purchase their seed from wholesale outlets rather than retail outlets. The average price used was calculated by averaging the price per 100 pounds of six varieties of snap beans produced in Kansas. The six varieties used were: Harvester, Spartan Arrow, Topcrop U.S. No. 1, Provider, Burpee's Stringless Greenpod, and

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25. Midwest Seed Growers, 1972 Flower and Vegetable Catalog, 1972.

26. Rudy-Patrick Seed Company, Vegetable Seeds, Constable-Hodgins Printing and Lithographing Co., Inc.

Contender. After the average price was determined for 100 pounds, it was divided by 100 to get the price per pound. The price per pound was then multiplied by 60 pounds per acre and this was then divided by eleven to determine the reduced costs per acre which was found to be $2.33 for snap beans. The general formula used for determining the reduced cost per acre was:

$$\text{Reduced Cost Per Acre} = \frac{\text{Price/Lb. x Pounds/Acre}}{11} \quad (7)$$

where

Reduced costs per acre were given in dollars per acre,
Price/lb. was the average price paid for seed, and
Pounds/acre was the amount of seed planted per acre (60).

The reduced costs for dry edible beans was calculated in the same manner as for snap beans. Only three varieties were given in the wholesale price catalog of the Midwest Seed Growers[27] and they all had identical costs which were $45.00 per 100 pounds. Therefore, the average cost per pound was found to be $0.45. The reduced cost of dry edible beans was determined than by multiplying $0.45 times 60 pounds per acre and dividing this value by eleven. This is the same method as formula (7). It was calculated that the reduced cost for dry edible beans was $2.46 per acre.

Reduced costs were not calculated for melons or tomatoes. Since there was no loss of land in melon production, no decrease in the seed needed to plant the crop

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27. Midwest Seed Growers, loc. cit.

was assumed. Tomatoes are normally transplanted and the cost of seed is low enough to justify not including it as a reduced cost. The cost of setting the tomatoes was considered a fixed cost due to the assumptions of labor mentioned previously. If, hybrid tomatoes were being produced, then the cost of seed would be large enough to include in the budget as a reduced cost.

ADDED RECEIPTS

The added receipts in the study were estimates of the income necessary to offset the added cost and reduced receipts minus reduced costs. This estimate was a minimum dollar value which the change in method must yield over and above the previous method. If the barriers were to be profitable. Any value less than the estimated added receipts value indicated that the barriers were not as profitable as using no barriers. This, in other words, means that the barriers are not yielding a profit over the other method of using no barriers. Therefore, if that was the case, the use of rye strip-crop barriers should be abandoned. Any value over the estimated added receipts value means that the barriers are providing a profit above the profit of the previous method, in which case, rye strip-crop barriers should be adopted.

The added receipts necessary for rye strip-crop barriers to be profitable for tomatoes was calculated by making them equal to the added costs plus the reduced receipts but reduced costs were not considered as they were negligible.

The added receipts for tomatoes can be found in Table 8 for various prices and average yields per acre. Table 9 corresponds to Table 8, but gives the increase yields needed to yield the dollar values found in Table 8. Both Table 8 and 9 give the minimum values which are necessary for the barriers to be profitable.

The added receipts for snap beans was calculated by subtracting the reduced cost from the added costs and adding this to the reduced receipts. Therefore, the added receipts were equal to the reduced receipts plus $2.69. The $2.69 was derived from subtracting the reduced costs ($2.33) from the added costs ($5.02). Table 11 gives the minimum added receipts for various combinations of price per pound and average y eld per acre. Table 12 corresponds to Table 11 in that it gives the increase in yield, in pounds per acre, needed to produce a value equal to the added receipts which correspond to the various prices and average yields found in Table 11.

Table 14 gives the minimum added receipts values for dry edible beans calculated the same way as values for snap beans. The only difference was that the added costs minus the reduced cost in dry edible beans was found to be $2.56. This was because the seed cost for dry edible beans was higher than for snap beans. Table 15 corresponds to Table 14 and gives the increase in yield needed to produce the various added receipts at the different price and average yield combinations.

ANALYSIS AND COMPARISON

After defining the four factors used in analyzing a budget, an example will be given for each crop. Whenever yield data was available, the example included a comparison of costs and benefits and discussion of profitability.

MELONS

In determining the feasibility of using rye strip-crop barriers in the production of melon crops, only the cost of establishing barriers need to be considered since as stated previously, the barriers do not take land from the production of melons. Therefore, the increase in yield and receipts must be large enough to off-set the added costs of $5.02 per acre. The reduced receipts which were the opportunity cost of land and the reduced costs from seed cost on land not planted to melon were not considered because there was no land loss from production. Table 6 gives the increase in yield needed at the various product prices to off-set the added cost of $5.02 per acre. Figure 2 also shows similar information as well as showing that the higher the price per pound, the smaller the increase in yield needed to cover the

Table 6.
Increase in Yield Needed to Cover Cost of Using Rye-Strip-Crop Barriers in Melon Production

Price Per Pound (cents	Increase In Yield (pounds)
1.00	502.00
1.50	334.67
2.00	251.00
2.50	200.80
3.00	167.33
3.50	143.43
4.00	125.50
4.50	111.56
5.00	100.40
5.50	91.27
6.00	83.67
6.50	77.23
7.00	71.71
7.50	66.93
8.00	62.75
8.50	59.06
9.00	55.78
9.50	52.84
10.00	50.20

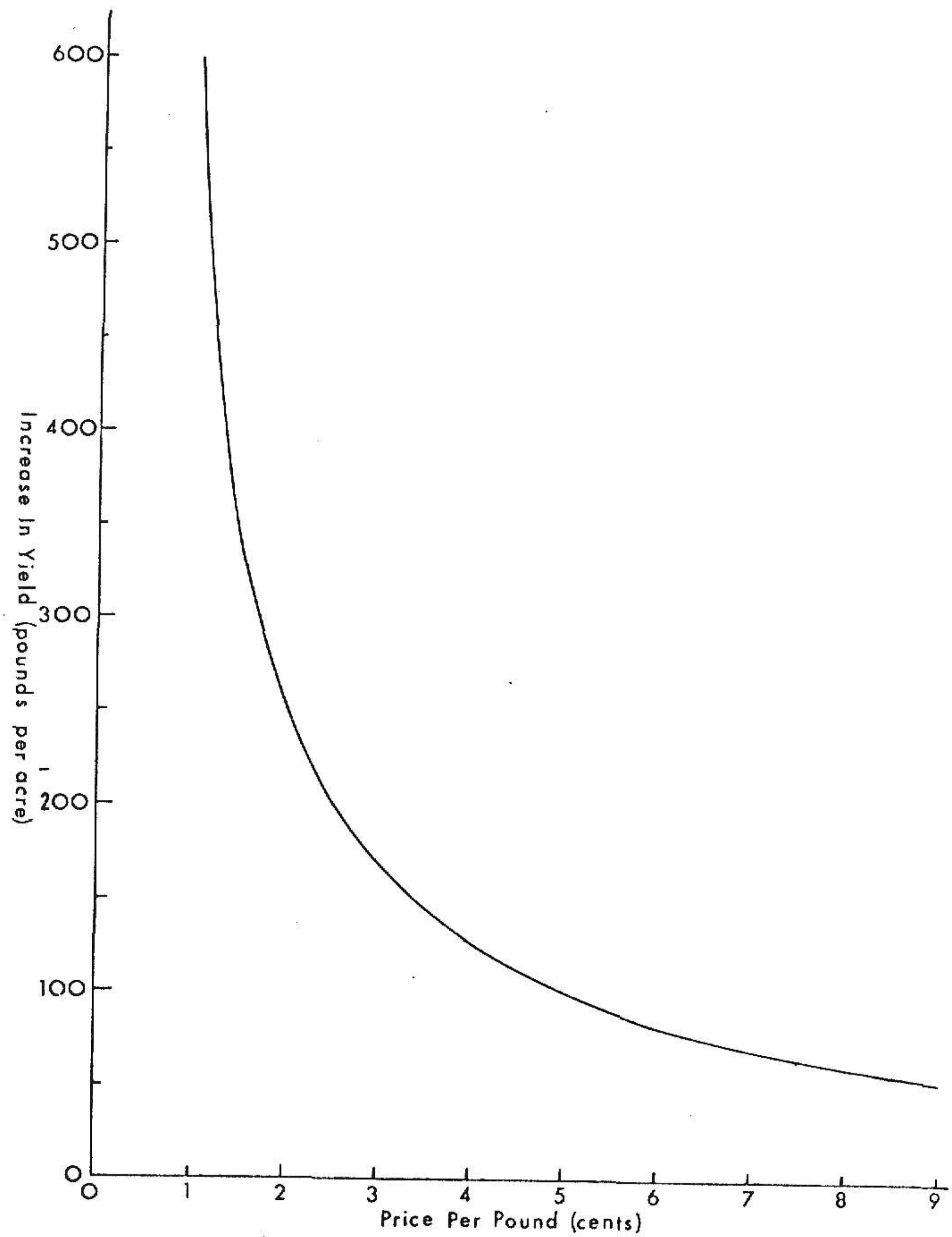

Figure 2.
Relationship Between
Price Per Pound and Increase in Yield

added cost of establishing the rye strip-crop barriers. Using either Table 6 or Figure 2, at a price of three cents per pound, the increase in the yield would have to be 167.33 pounds per acre to off-set the cost of establishing barriers of $5.02 per acre.

Research conducted by Downes, Knierem, and Gilbart[28] in 1963 revealed that rye strip-crop barriers increased total yield of melons 7,355 pounds per acre with the majority of the increase coming in the last three weeks of the growing season. From Figure 2, rye strip-crop barriers increased the yield more than the amount needed to cover the cost of establishing the barriers. In other research conducted by the same group and using either one or two plants per hill revealed that with one plant per hill, an increase of 2,784 pounds per acre resulted, and where two plants per hill were planted, an increase in yield of 11,973 pounds per acre was realized. In both of these cases, the increase in yield was large enough to cover the added cost even if the price per pound was one cent as seen in Figure 2.

TOMATOES

If in the production of tomatoes, a producer has an average yield of 20,000 pounds per acre and the price he

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28. Downes, J., Knierem, J., and Gilbart, D. Influence of Fumigation, Windbreaks, Mushroom Compost and Plant Population on Yields and Size of Muskmelons, Sodus Experiment Station Annual Report, 1963, East Lansing, Michigan.

receives for his crop is 14 cents per pound, then by using Table 7 and finding the average yield per acre of 20,000 pounds in the left hand column, the reduced receipts from the land lost in production can be found by following the row across to the right until the 14 cent column is reached. The value found at the intersection of the 20,000 pound row and the 14 cent column is $254.54, which is the result of using rye strip-crop barriers in the production of tomatoes. This is the result of taking one-eleventh of the land out of production and using it for the establishment of the rye strip-crop barrier.

The added cost is the same for all of the various crops, so, $5.02 must be added to the reduced receipts in order to arrive at the total variable cost of extablishing barriers. The sum of the added cost and the reduced receipts was found to be $259.56 ($5.02 + $254.54). The cost sector of the budget may be equal to but cannot be greater than the benefit sector in the new method is going to be profitable.

The benefit sector has only added receipts in the budget for tomato production as reduced costs are negligible. The added receipts must be equal to at least $259.56 per acre to off-set increase in costs (Table 8) assuming an average yield of 20,000 pounds per acre, and a price per pound of 14 cents. Table 8 gives the needed minimum added receipts from tomatoes for various prices

Table 7.
Reduced Receipts Resulting From the Use of
Rye Strip-Crop Barriers in Tomato Production

Yield Per Acre (pounds)	Price Received Per Pound (cents)												
	6	8	10	12	14	16	18	20	22	24	26	28	30
10000	54.54	72.73	90.91	109.09	127.27	145.45	163.64	181.82	200.00	218.18	236.36	254.54	272.73
11000	60.00	80.00	100.00	120.00	140.00	160.00	180.00	200.00	220.00	240.00	260.00	280.00	300.00
12000	65.45	87.27	109.09	130.91	152.73	174.54	196.36	218.18	240.00	261.82	283.64	305.45	327.27
13000	70.91	94.54	118.18	141.82	165.45	189.09	212.73	236.36	260.00	283.64	307.27	330.91	354.54
14000	76.36	101.82	127.27	152.73	178.18	203.64	229.09	254.54	280.00	305.45	330.91	356.36	381.82
15000	81.82	109.09	136.36	163164	190.91	218.18	245.45	272.73	300.00	327.27	354.54	381.82	409.09
16000	87.27	116.36	145.45	174.54	203.64	232.73	261.82	290.91	320.00	349.09	378.18	407.27	436.36
17000	92.73	123.64	154.54	185.45	216.36	247.27	278.18	309.09	340.00	370.91	401.82	432.73	463.64
18000	98.18	130.91	163.64	196.36	229.09	261.82	294.54	327.27	360.00	392.73	425.45	458.18	490.91
19000	103.64	138.18	172.73	207.27	241.82	276.36	310.91	345.45	380.00	414.54	449.09	483.64	518.18
20000	109.09	145.45	181.82	218.18	254.54	290.91	327.27	363.64	400.00	436.36	472173	509.09	545.45
21000	114.54	152.73	190.91	229.09	267.27	305.45	343.64	381.82	420.00	458.18	496.36	534.54	572.73
22000	120.00	160.00	200.00	240.00	280.00	320.00	360.00	400.00	440.00	480.00	520.00	560.00	600.00
23000	125.45	167.27	209.09	250.91	292.73	334.54	376.36	418.18	460.00	501.82	543.64	585.45	627.27
24000	130.91	174.54	218.18	261.82	305.45	349.09	392.73	436.36	480.00	523.64	567.27	610.91	654.54
25000	136.36	181.82	227.27	272.73	318.18	363.64	409.09	454.54	500.00	545.45	590.91	636.36	681.82
26000	141.82	189.09	236.36	283.64	330.91	378.18	425.45	472.73	520.00	567.27	614.54	661.82	709.09
27000	147.27	196.36	245.45	294.54	343.64	392.73	441.82	490.91	540.00	589.09	638.18	687.27	736.36
28000	152.73	203.64	254.54	305.45	356.36	407.27	458.18	509.09	560.00	610.91	661.82	712.73	763.64
29000	158.18	210.91	263.64	316.36	369.09	421.82	474.54	527.27	580.00	632.73	685.45	738.18	790.91
30000	163.64	218.18	272.73	327.27	381.82	436.36	490.91	545.45	600.00	654.54	709.09	763.64	818.18
31000	169.09	225.45	281.82	338.18	394.54	450.91	507.27	563.64	620.00	676.36	732.73	789.09	845.45
32000	174.54	232.73	290.91	349.09	407.27	465.45	523.64	581.82	640.00	698.18	756.36	814.54	872.73
33000	180.00	240.00	300.00	360.00	420.00	480.00	540.00	600.00	660.00	720.00	780.00	840.00	900.00
34000	185.45	247.27	309.09	370.91	432.73	494.54	556.36	618.18	680.00	741.82	803.64	865.45	927.27
35000	190.91	254.54	318.18	381.82	445.45	509.09	572.73	636.36	700.00	763.64	827.27	890.91	954.54
36000	196.36	261.82	327.27	392.73	458.18	523.64	589.09	654.54	720.00	785.45	850.91	916.36	981.82
37000	201.82	269.09	336.36	403.64	470.91	538.18	605.45	672.73	740.00	807.27	874.54	941.82	1009.09
38000	207.27	276.36	345.45	414.54	483.64	552.73	621.82	690.91	760.00	829.09	898.18	967.27	1036.36
39000	212.73	283.64	354.54	425.45	496.36	567.27	638.18	709.09	780.00	850.91	921.82	992.73	1063.64
40000	218.18	290.91	363.64	436.36	509.09	581.82	654.54	727.27	800.00	872.73	945.45	1018.18	1090.91

and average yields, to cover the cost of planting rye and the opportunity cost of land. Table 9 gives the corresponding increases in yields needed to produce the added receipts found in Table 8.

For use of rye strip-crop barriers to be profitable, under the condition of this study, the yield would have to be increased by 1855.56 pounds per acre which amounts to a value of $259.56 per acre. This is based on the assumption of an average yield of 20,000 pounds per acre and a price of 14 cents per pound as used in the example.

Research by Downes, Knierem, and Gilbart[29] in 1965, found that rye strip-crop barriers increased the yield of tomatoes by four percent. They observed that mid-season yield on the plots protected by the barriers were consistently increases over the yields of the controlled plots. The late yields were decreased in the protected plots compared to the controlled plots.

The four percent increase would not be enough to cover the cost of using rye strip-crop barriers. Multiplying the average yield per acre (20,000) by the percent increase (4%) gives a value of 800 pounds per acre. Multiplying the 800 pounds per acre by the price per pound ($0.14) yields a value of $112.00 which

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29. Downes, J., Knierem, J., and Gilbart, D. Quality and Yields of Tomatoes and Muskmelons in Relation to Rye Strip Windbreaks, Sodus Experiment Station Annual Report, 1965, East Lansing, Michigan.

Table 8.
Added Receipts
Needed to Off-Set the Increase in Costs From the Use of
Rye Strip-Crop Barriers in Tomato Production

Yield Per Acre (pounds)	Price Received Per Pound (cents)												
	6	8	10	12	14	16	18	20	22	24	26	28	30
10000	59.56	77.75	95.93	114.11	132.29	150.47	168.66	186.84	205.02	223.20	241.38	259.56	277.75
11000	65.02	85.02	105.02	125.02	145.02	165.02	185.02	205.02	225.02	245.02	265.02	285.02	305.02
12000	70.47	92.29	114.11	135.93	157.75	179.56	201.38	223.20	245.02	266.84	288.66	310.47	332.29
13000	75.93	99.56	.23.20	146.84	170.47	194.11	217.75	241.38	265.02	288.66	312.29	335.93	359.56
14000	81.38	106.84	132.29	157.75	183.20	208.66	234.11	259.56	285.02	310.47	335.93	361.38	386.84
15000	86.84	114.11	141.38	168.64	195.93	223.20	250.47	277.75	305.02	332.29	359.56	396.84	414.11
16000	92.29	121.38	150.47	179.56	208.66	237.75	266.84	295.93	325.02	354.11	383.20	412.29	441.29
17000	97.75	128.66	159.56	190.47	221.38	252.29	283.20	314.11	345.02	375.93	406.84	437.75	468.66
18000	103.20	135.93	168.66	201.38	234.11	266.84	299.56	332.29	365.02	397.75	430.47	463.20	495.93
19000	108.66	143.20	177.75	212.29	246.84	281.38	315.93	350.47	385.02	419.56	454.11	488.66	523.20
20000	114.11	150.47	186.84	223.20	259.56	295.93	332.29	368.66	405.02	441.38	477.75	514.11	550.47
21000	119.56	157.75	195.93	234.11	272.29	310.47	348.66	386.84	425.02	463.20	501.38	539.56	577.75
22000	125.02	165.02	205.02	245.02	285.02	325.02	365.02	405.02	445.02	485.02	525.02	565.02	605.02
23000	130.47	172.29	214.11	255.93	297.75	339.56	381.38	423.20	465.02	506.84	548.66	590.47	632.29
24000	135.93	179.56	223.20	266.84	310.47	354.11	397.75	441.38	485.02	528.66	572.29	615.93	659.56
25000	141.38	186.84	232.29	277.75	323.20	368.66	414.11	459.56	505.02	550.47	595.93	641.38	686.84
26000	146.84	194.11	241.38	288.64	335.93	383.20	420.47	477.75	525.02	572.29	619.56	666.84	714.11
27000	152.29	201.38	250.47	299.56	348.66	397.75	446.84	495.93	545.02	594.11	643.20	692.29	741.38
28000	157.75	208.66	259.56	310.47	361.38	412.29	463.20	514.11	565.02	615.93	666.84	717.75	768.66
29000	163.20	215.93	268.66	321.38	374.11	426.84	479.56	532.29	585.02	637.75	690.47	743.20	795.93
30000	168.66	223.20	277.75	332.29	386.84	441.38	495.93	550.47	605.02	659.56	714.11	768.66	823.20
31000	174.11	230.47	286.84	343.20	399.56	455.93	512.29	568.66	625.02	681.38	737.75	794.11	850.47
32000	179.56	237.75	295.93	354.11	412.29	460.47	528.66	586.84	645.02	703.20	761.38	819.56	877.75
33000	185.02	245.02	305.02	365.02	425.02	475.02	545.02	605.02	665.02	725.02	785.02	845.02	905.02
34000	190.47	252.29	314.11	375.93	437.75	489.56	561.38	623.20	685.02	746.84	808.66	870.47	932.29
35000	195.93	259.56	323.20	386.84	450.47	504.11	577.75	641.38	705.02	768.66	832.29	895.93	959.56
36000	201.38	266.84	332.29	397.75	463.20	518.66	594.11	659.56	725.02	790.47	855.93	921.38	986.84
37000	206.84	274.11	341.38	408.64	475.93	533.20	610.47	677.75	745.02	812.29	879.56	946.84	1014.11
38000	212.29	281.38	350.47	419.56	488.66	547.75	626.84	695.93	765.02	834.11	903.20	972.29	1041.38
39000	217.75	288.66	359.56	490.47	501.38	562.29	643.20	714.11	785.02	855.33	926.84	997.75	1068.66
40000	223.20	295.93	368.66	441.38	514.11	576.84	659.56	732.29	805.02	877.75	950.47	1023.20	1095.93

Table 9.
Increased Yield (Pounds Per Acre)
Needed to Produce Added Receipts

Yield Per Acre (pounds)	Price Received Per Pound (cents)												
	6	8	10	12	14	16	18	20	22	24	26	28	30
10000	993.67	972.75	960.20	951.83	945.86	941.38	937.89	935.10	932.82	930.92	929.31	927.93	926.73
11000	1084.67	1063.75	1051.20	1042.83	1036.86	1032.38	1028.89	1026.10	1023.82	1021.92	1020.31	1018.93	1017.73
12000	1175.67	1154.75	1142.20	1133.83	1127.86	1123.38	1119.89	1117.10	1114.82	1112.92	1111.31	1109.93	1108.73
13000	1266.67	1245.75	1233.20	1224.83	1218.86	1214.38	1210.89	1208.10	1205.82	1203.92	1202.31	1200.93	1199.73
14000	1357.67	1336.75	1324.20	1315.83	1309.86	1305.38	1301.89	1299.10	1296.82	1294.92	1293.31	1291.93	1290.73
15000	1448.67	1427.75	1415.20	1406.83	1400.86	1396.38	1392.89	1390.10	1387.82	1385.92	1384.31	1382.93	1381.73
16000	1539.67	1518.75	1506.20	1497.83	1491.86	1487.38	1483.89	1481.10	1478.82	1476.92	1475.31	1473.93	1472.73
17000	1630.67	1609.75	1597.20	1588.83	1582.86	1578.38	1574.89	1572.10	1569.82	1567.92	1566.31	1564.93	1563.73
18000	1721.67	1700.75	1688.20	1679.83	1673.86	1669.38	1665.89	1663.10	1660.82	1658.92	1657.31	1655.93	1654.73
19000	1812.67	1791.75	1779.20	1770.83	1764.86	1760.38	1756.89	1754.10	1751.82	1749.92	1748.31	1746.93	1745.73
20000	1903.67	1882.75	1870.20	1861.83	1855.86	1851.38	1847.89	1845.10	1842.82	1840.92	1839.31	1837.93	1836.73
21000	1994.67	1973.75	1961.20	1952.83	1946.86	1942.38	1938.89	1936.10	1933.82	1931.92	1930.31	1928.93	1927.73
22000	2085.67	2064.75	2052.20	2043.83	2037.86	2033.38	2029.89	2027.10	2024.82	2022.92	2021.31	2019.93	2018.73
23000	2176.67	2155.75	2143.20	2134.83	2128.86	2124.38	2120.89	2118.10	2115.82	2113.92	2112.31	2110.93	2109.73
24000	2267.67	2246.75	2234.20	2225.83	2219.86	2215.38	2211.89	2209.10	2206.82	2204.92	2203.31	2201.93	2200.73
25000	2358.67	2337.75	2325.20	2316.83	2310.86	2306.38	2302.89	2300.10	2297.82	2295.92	2294.31	2292.93	2291.73
26000	2449.67	2428.75	2416.20	2407.83	2401.86	2397.38	2393.89	2391.10	2388.82	2386.92	2385.31	2383.93	2382.73
27000	2540.67	2519.75	2507.20	2498.83	2492.86	2488.38	2484.89	2482.10	2479.82	2477.92	2476.31	2474.93	2473.73
28000	2631.67	2610.75	2598.20	2589.83	2583.86	2579.38	2575.89	2573.10	2570.82	2568.92	2567.31	2565.93	2564.73
29000	2722.67	2701.75	2689.20	2680.83	2674.86	2670.38	2666.89	2664.10	2661.82	2659.92	2658.31	2656.93	2655.73
30000	2813.67	2792.75	2780.20	2771.83	2765.86	2761.38	2757.89	2755.10	2752.82	2750.92	2749.31	2747.93	2746.73
31000	2904.67	2883.75	2871.20	2862.83	2856.86	2852.38	2848.89	2846.10	2843.82	2841.92	2840.31	2838.93	2837.73
32000	2995.67	2974.75	2962.20	2953.83	2947.86	2943.38	2939.89	2937.10	2934.82	2932.92	2931.31	2929.93	2928.73
33000	3086.67	3065.75	3053.20	3044.83	3038.86	3034.38	3030.89	3028.10	3025.82	3023.92	3027.31	3020.93	3019.73
34000	3177.67	3156.75	3144.20	3135.83	3129.86	3125.38	3121.89	3119.10	3116.82	3114.92	3113.31	3111.93	3110.73
35000	3268.67	3247.75	3235.20	3226.83	3220.86	3216.38	3212.89	3210.10	3207.82	3205.92	3204.31	3202.93	3201.73
36000	3359.67	3338.75	3326.20	3317.83	3311.86	3307.38	3303.89	3301.10	3298.82	3296.92	3295.31	3293.93	3292.73
37000	3450.67	3429.75	3417.20	3408.83	3402.86	3398.38	3394.89	3392.10	3389.82	3387.92	3386.31	3384.93	3383.73
38000	3541.67	3520.75	3508.20	3499.83	3493.86	3489.38	3485.89	3483.10	3480.82	3478.92	3477.31	3475.93	3474.73
39000	3632.67	3611.75	3599.20	3590.83	3584.86	3580.38	3576.89	3574.10	3571.82	3569.92	3568.31	3566.93	3565.73
40000	3723.67	3702.75	3690.20	3681.83	3675.86	3671.38	3667.89	3665.10	3662.82	3660.92	3659.31	3657.93	3656.73

is far below the needed added receipts of $259.56 per acre. Likewise, 800 pounds per acre increase is far below the needed increase of 1855.56 pounds per acre found in Table 9. Therefore, on the average the added receipts are not large enough to cover the cost sector of the budget and thus, the method was not considered profitable. This does not mean that all cases where rye strip-crop barriers are employed in the production of tomatoes they will prove to be unprofitable.

SNAP BEANS

The same procedure will be followed in the example of snap beans as was used in the tomato example. An average yield of 4,000 pounds per acre and a price of eitht (8) cents per pound will be assumed. In Table 10, one can follow the average yield per acre column down to the 4,000 pound row and then across the row to the right until the eight cents per pound column is reached. At the intersection of the 4,000 pound row and the eight cent column, Table 10 shows that reduced receipts are $29.09 per acre due to the use of rye strip-crop barriers in the production of snap beans. Adding the cost of $5.02 per acre for planting rye to the reduced receipts of $29.09 per acre results in a total of $34.11 per acre which must be offset by increased production if the rye strip-crop barriers are to be profitable.

Table 10.
Reduced Receipts Resulting From Use of
Rye Strip-Crop Barriers in Snap Bean Production

Yield Per Acre (pounds)	Price Per Pound (cents)						
	4	6	8	10	12	14	16
3000	10.91	16.36	21.82	27.27	32.73	38.18	43.64
3100	11.27	16.91	22.54	28.18	33.82	39.45	45.09
3200	11.64	17.45	23.27	29.09	34.91	40.73	46.54
3300	12.00	18.00	24.00	30.00	36.00	42.00	48.00
3400	12.36	18.54	24.73	30.91	37.09	43.27	49.45
3500	12.73	19.09	25.45	31.82	38.18	44.54	50.91
3600	13.09	19.64	26.18	32.73	39.27	45.82	52.36
3700	13.45	20.18	26.91	33.64	40.36	47.09	53.82
3800	13.82	20.73	27.64	34.54	41.45	48.36	55.27
3900	14.18	21.27	28.36	35.45	42.54	49.64	56.73
4000	14.54	21.82	29.09	36.36	43.64	50.91	58.18
4100	14.91	22.36	29.82	37.27	44.73	52.18	59.64
4200	15.27	22.91	30.54	38.18	45.82	53.45	61.09
4300	15.64	23.45	31.27	39.09	46.91	54.73	62.54
4400	16.00	24.00	32.00	40.00	48.00	56.00	64.00
4500	16.36	24.54	32.73	40.91	49.09	57.27	65.45
4600	16.73	25.09	33.45	41.82	50.18	58.54	66.91
4700	17.09	25.64	34.18	42.73	51.27	59.82	68.36
4800	17.45	26.18	34.91	43.64	52.36	61.09	69.82
4900	17.82	26.73	35.64	44.54	53.45	62.36	71.27
5000	18.18	27.27	36.36	45.45	54.54	63.64	72.73

The benefits of using rye strip-crop barriers in snap beans includes both the reduced costs of seed and the added receipts from the protection provided by the barriers. The reduced cost amounts to $2.33 per acre, and so to find the minimum added receipts required to cover the cost of using rye strop-crop barriers, $2.33 is subtracted from $34.11. The minimum added receipts per acre required to cover the cost sector of the budget can be found in Table 11 for various combinations of average yields and prices per pound.

Table 11 shows that for 4,000 pounds per acre and eight cents per pound, the minimum added receipts has a value of $31.78 per acre. This is the minimum value needed to cover the cost of using rye strip-crop barriers. If the increase in yield, that will produce a value of $31.78 per acre is desired, it can be found in Table 12 where the corresponding row and column intersect. Table 12 shows that 397.25 pounds per acre are required to produce a value of $31.78 per acre if the price is eight cents per pound and the average yield per acre is 4,000 pounds.

No work was found that related the effect of rye strip-crop barriers on the yield of snap beans, however, some work done in Nebraska on the effect of artificial barriers (snow fence) on the yield of snap beans was found.

Table 11.
Added Receipts
Needed to Off-Set Planting and Opportunity Cost of Land
From Use of Rye Strip-Crop Barriers
in the Production of Snap Beans

Yield Per Acre (pounds)	Price Per Pound (cents)						
	4	6	8	10	12	14	16
3000	13.60	19.05	24.51	29.96	35.42	40.87	46.33
3100	13.96	19.60	25.23	30.87	36.51	42.14	47.78
3200	14.33	20.14	25.96	31.78	37.60	43.42	49.23
3300	14.69	20.69	26.69	32.69	38.69	44.69	50.69
3400	15.05	21.23	27.42	33.60	39.78	45.96	52.14
3500	15.42	21.78	28.14	34.51	40.87	47.23	53.60
3600	15.78	22.33	28.87	35.42	41.96	48.51	55.05
3700	16.14	22.87	29.60	36.33	43.05	49.78	56.51
3800	16.51	23.42	30.33	37.23	44.14	51.05	57.96
3900	16.87	23.96	31.05	38.14	45.23	52.33	59.42
4000	17.23	24.51	31.78	39.05	46.33	53.60	60.87
4100	17.60	25.05	32.51	39.96	47.42	54.87	62.33
4200	17.96	25.60	33.23	40.87	48.51	56.14	63.78
4300	18.33	26.14	33.96	41.78	49.60	57.42	65.23
4400	18.69	26.69	34.69	42.69	50.69	58.69	66.69
4500	19.05	27.23	35.42	43.60	51.78	59.96	68.14
4600	19.42	27.78	36.14	44.51	52.87	61.23	69.60
4700	19.78	28.33	36.87	45.42	53.96	62.51	71.05
4800	20.14	28.87	37.60	46.33	55.05	63.78	72.51
4900	20.51	29.42	38.33	47.23	56.14	65.05	73.96
5000	20.87	29.96	39.05	48.14	57.23	66.33	75.42

Table 12.
Increased Yields Needed to Produce
Added Receipts if Rye Strip-Crop Barriers are Used
in the Production of Snap Beans

Yield Per Acre (pounds)	Price Per Pound (cents)						
	4	6	8	10	12	14	16
3000	340.00	317.50	306.38	299.60	295.17	291.93	289.56
3100	349.00	326.67	316.12	310.87	304.25	301.00	298.62
3200	358.25	335.67	324.50	317.80	313.33	310.14	307.69
3300	367.25	344.83	333.62	326.90	322.42	319.21	316.81
3400	376.25	353.83	342.75	336.00	331.50	328.29	325.88
3500	385.50	363.00	351.75	345.10	340.58	337.36	335.00
3600	394.50	372.17	360.89	354.20	349.67	346.50	344.06
3700	402.50	381.17	370.00	363.30	358.75	355.57	353.19
3800	412.75	390.33	379.12	372.30	367.83	364.64	362.25
3900	421.75	399.33	388.12	381.40	376.92	373.78	371.38
4000	430.75	408.50	397.25	390.50	386.08	382.86	380.44
4100	440.00	417.50	406.38	399.60	395.17	391.93	389.56
4200	449.00	426.67	416.12	408.70	404.25	401.00	398.62
4300	458.25	435.67	424.50	417.80	413.33	410.14	407.69
4400	467.25	444.83	433.62	426.90	422.42	419.21	416.81
4500	476.25	453.83	442.75	436.00	431.50	428.29	425.88
4600	485.50	463.00	451.75	445.10	440.58	437.36	435.00
4700	494.50	472.17	460.89	454.20	449.67	446.50	444.06
4800	502.50	481.17	470.00	463.30	458.75	455.57	453.19
4900	512.75	490.33	479.12	472.30	467.83	464.64	462.25
5000	521.75	499.33	488.12	481.40	476.92	473.78	471.38

The work was conducted by Bagley and Gowen[25] near Kearney, Nebraska. The results of their work showed that barriers increased snap bean yields by 13 percent one to four barriers heights leeward and 23 percent five to nine barrier heights leeward of the barrier. Therefore, it will be assumed that the average increased yield was 18 percent.

If yield per acre is 4,000 pounds and the price is eight cents per pound, and the increase in yield is assumed to be 18 percent, the profitability of using rye strip-crop barriers can be determined as follows. The increase in yield would be 720 pounds per acre (4,000 x 0.18) from using the barrier. Multiplying the increased yield per acre (720 pounds) by the price per pound ($0.08), the estimated increase in receipts per acre is $57.60 from using the barrier. The cost of planting the barriers and opportunity cost of land if production of 4,000 pounds and price is eight cents per pound is $31.78, Table 11. The increased yield per acre of 18 percent is more than the planting and opportunity cost of land and gave an estimated $25.82 profit per acre.

DRY EDIBLE BEANS

In the analysis of use of rye strip-crop barriers on dry edible bean production an average yield of 1,000 pounds per acre and an average price of eight cents per pound was used. Table 13 gives the reduced receipts, from taking one-eleventh (1/11) of the land for rye strip-crop barriers, for various combinations of yields and prices for dry edible beans. Reduced receipts for an average yield of 1,000 pounds per acre and a price of eight cents per pound, was $7.27 per acre. The cost of planting the rye strip-crop barrier was $5.02 so the cost of using the barrier was $12.29.

Using barriers in dry edible beans reduces cost because less seed per acre is required. The reduced cost of establishing the barriers is almost off-set by the reduction in seed cost in the area occupied by the barriers.

Since the reduced cost is a benefit, it was subtracted from the cost sector so that the minimum added receipts could be calculated. Table 14 gives the minimum added receipts needed to off-set the planting cost and opportunity cost of land by using rye strip-crop barriers. Table 15 gives the minimum increase in yield necessary to produce the minimum added receipts found in Table 14.

There was no data found on the effect of barriers on the yield of dry edible beans. One hypothesis is that dry edible beans respond to barriers as snap beans do.

Table 13.
Reduced Receipts Resulting From the Use of
Rye Strip-Crop Barriers in Dry Edible Bean Production

Yield Per Acre (pounds)	Price Per Pound (cents)					
	4	5	6	7	8	9
900	3.27	4.09	4.91	5.73	6.54	7.36
950	3.45	4.32	5.18	6.04	6.91	7.77
1000	3.64	4.54	5.45	6.36	7.27	8.18
1050	3.82	4.77	5.73	6.68	7.64	8.59
1100	4.00	5.00	6.00	7.00	8.00	9.00
1150	4.18	5.23	6.27	7.32	8.36	9.41
1200	4.36	5.45	6.54	7.64	8.73	9.82
1250	4.54	5.68	6.82	7.95	9.09	10.23
1300	4.73	5.91	7.09	8.27	9.45	10.64
1350	4.91	6.14	7.36	8.59	9.82	11.04
1400	5.09	6.36	7.64	8.91	10.18	11.45
1450	5.27	6.59	7.91	9.23	10.54	11.86
1500	5.45	6.82	8.18	9.54	10.91	12.27

Table 14.
Added Receipts
Needed to Offset Planting and Opportunity Cost of Land
From Use of Rye Strip-Crop Barriers
in the Production of Dry Edible Beans

Yield Per Acre (pounds)	Price Per Pound (cents) 4	5	6	7	8	9
900	5.84	6.66	7.48	8.30	9.11	9.93
950	6.02	6.89	7.75	8.61	9.48	10.34
1000	6.21	7.11	8.02	8.93	9.84	10.75
1050	6.39	7.34	8.30	9.25	10.21	11.16
1100	6.57	7.57	8.57	9.57	10.57	11.57
1150	6.75	7.80	8.84	9.89	10.93	11.98
1200	6.93	8.02	9.11	10.21	11.30	12.39
1250	7.11	8.25	9.39	10.52	11.66	12.80
1300	7.30	8.48	9.66	10.84	12.02	13.21
1350	7.48	8.71	9.93	11.16	12.39	13.61
1400	7.66	8.93	10.21	11.48	12.75	14.02
1450	7.84	9.16	10.48	11.80	13.11	14.43
1500	8.02	9.39	10.75	12.11	13.48	14.84

Table 15.
Increased Yields Needed to Produce
Added Receipts if Rye Strip-Crop Barriers are Used
in the Production of Dry Edible Beans

Yield Per Acre (pounds)	Price Per Pound (cents)					
	4	5	6	7	8	9
900	146.00	133.20	124.67	118.57	113.88	110.33
950	150.50	137.80	129.17	123.00	118.50	114.89
1000	155.25	142.20	133.67	127.57	123.00	119.44
1050	159.75	146.80	138.33	132.14	127.62	124.00
1100	164.25	151.40	142.83	136.71	132.12	128.56
1150	168.75	156.00	147.33	141.28	136.62	133.11
1200	173.25	160.40	151.83	145.86	141.25	137.67
1250	177.75	165.00	156.50	150.28	145.75	142.22
1300	182.50	169.60	161.00	154.86	150.25	146.78
1350	187.00	174.20	165.50	159.43	154.88	151.22
1400	191.50	178.60	170.17	164.00	159.38	155.78
1450	196.00	183.20	174.67	168.57	163.88	160.33
1500	200.50	187.80	179.17	173.00	168.50	164.89

SUMMARY

This study was designed to provide the producers a method of determining whether the use of rye strip-crop barriers would be profitable. The examples were used to explain the method which the producers should follow to determine whether to use the barrier method or to continue the method presently followed. A producer may want to experiment with a small area the first year to determine what effect the barriers will have on yields so that he will have some information on added receipts. The producer will have the reduced receipts by taking the average yield per acre and the price per pound and applying them to the Table for his crop.

CHAPTER 4

SUMMARY

The study found that the cost of establishing the rye strip-crop barriers was $5.02 per acre. This included only the establishment cost and did not include the reduced values of production on land required for the barriers. The cost of establishing the barriers was the same for all crops studied as the same practice was assumed in each case, The added costs were a function of fuel; grease, oil, and filter; repair and maintenance; and seed cost.

The reduced receipts which result from the loss of yield because of the decreased land in production, was a function of the crop grown and its average yield per acre and the price received per pound. This was the opportunity cost of land. Therefore, total variable costs were the added costs plus the reduced receipts.

Since one-eleventh of the land was taken out of production, the reduced cost was the reduction in vegetable seed cost by planting only ten-elevenths of the area. Reduced seed cost was less than $0.50 per acre for tomatoes and considered to be insignificant and therefore not figured into the budget.

To get the actual cost of using rye strip-crop barriers, the reduced cost was substracted from the total variable cost.

To use the results of this study, the minimum added receipts needed to offset the cost of establishing the barriers and the opportunity cost of land were calculated. The added receipts had to be a least equal to the actual variable cost if the use of rye strip-crop barriers was to be considered profitable.

The study revealed that the use of rye strip-crop barriers were profitable in experiments of melons and snap beans but that they were unprofitable when used in tomato production using average yield and price. The use of barriers may be profitable in tomato production if a taller barrier could be used such as corn or silage sorghum. The shorter barriers such as rye does not give adequate protection for the tomato plant because of the heigh of the tomato plant.

NEED FOR FUTURE RESEARCH

Future research needs to be conducted on the effects of strip-crop barriers on the yield of vegetable crops of various kinds. More data is needed on yield response to protection so that estimates can be made on the profitability of strip-crop barriers in the production of vegetable crops.

Another area that needs to be studied is the possibility of using other crops instead of rye for the barriers. Crops such as corn, silage sorghum, or possibily even sunflowers may provide a barrier superior to the rye barrier for some crops, such as tomatoes, that grow taller than the rye barrier. Research needs to be done on crops that will provide a barrier early in the spring so as to protect the crop while it is in its tender stages of growth. Taller barriers would provide for greater protection for a larger area and therefore reduce the land lost to production because the barriers could be spaced at greater distances. A narrower barrier would have the same effect of reducing the land lost to production. It may be possible to plant the barrier in rows closer together and thus maintain the same porosity of the barrier. Both, taller barriers and narrower barriers would reduce the cost of the barriers by decreasing the reduced receipts and thus reducing the total variable cost.

The use of perennial grasses such as blue stem, also needs to be studied as a possible strip-crop barrier. They would provide a barrier early and would not require establishment every year. The initial establishment cost may be greater but when budgeted over a period of several years, the yearly cost of establishment may be lower then using crops that require yearly planting.

There has been a great deal of research conducted on the effect of barriers on wind flow. There is presently research being conducted on the microclimate effects of barriers so research in this area would be repeating work already under way. The needed research is in the area of reducing the costs of the barrier and increasing the effectiveness of it.

SELECTED BIBLIOGRAPHY

Fryrear, D. Annual Crops as Wind Barriers. Master Thesis Manhattan, Kansas, Kansas State University,1962.

Hahn, Russel H. Jr., ed. Agricultural Engineers Yearbook. 16th ed., St. Joesph, Michigan, American Society of Agricultural Engineers, 1969.

Kansas State Board of Agriculture. Farm Facts 1968-1969. Topeka, Kansas, Robert R. (Bob) Sanders, State Printer, 1969.

Konstantinou, A. R. and Struxer, L. R. Shelterbelts and Crop Yields. Translated from Russian by A. Barovch, Jerusalem, Isreal Program for Scientific Translations, 1969

Koreisho, E. G. and Morozou, D. N. Manual of Afforestation and Soil Melioration. 2d ed. enlarged and revised. Translated from Russian by Prof. A. Gourevitch, Jerusalem, Isreal Program for Scientific Translations, 1966

Midwest Seed Growers. 1972 Flower and Vegetable Catalog. Kansas City, Mo. 1972.

Rudy-Patrick Seed Company. Vegetable Seeds. Kansas City, Mo., Constable-Hodgins Printing and Lithographing Co., Inc.

Shah, Syed Riaz Hussain. Studies on Wind Protection. Kemperbergerweg 11, Arnhem, Netherlands, Mededeling Nr. 60, 1962.

United States Department of Agriculture. Agricultural Statistics 1968. Washington, D. C., United States Government Printing Office, 1968

_______________, Economic Research Service. Vegetable Situtation 1970. Washington, D. C., United States Government Printing Office, 1970.

ARTICLES

Armburst, D. V. "Windblown Soil Abrasive Injury to Cotton Plants". Agronomy Journal, Vol. 60, Nov.-Dec., 1968 p. 622-625.

______, Dickerson, J. D. and Greig, J. K. "Effect of Soil Moisture on the Recovery of Sandblasted Tomato Seedlings." Journal of the American Society for Horticultural Science, Vol. 94, No. 3, May, 1969, p. 214-217.

Bagley, W. T., and Gowen, F. A. "Growth and Fruiting of Tomatoes and Snap Beans in the Shelter Area of a Windbreak." Fifth World Forestry Congress, SP/171/VII-USA, August 29 - September 10, 1960

Caborn, Dr. J. M. "The Dependence of the Shelter Effect of Shelterbelts on Their Structure." Fifth World Forestry Congress, SP/63/VII-U.K. August 29 - September 10, 1960.

Carreker, J. R. "Wind Erosion in the Southeast." Journal of Soil and Water Conservation, Vol. 21, May-June, 1966, p. 86-88

Downes, J., Knierem, J., and Gilbart, D. "Influence of Fumigation, Windbreaks, Mushroom Compost and Plant Population on Yields and Size of Muskmelons." Unpublished Annual Progress Report, Sodus Horticultural Research Station, January, 1963, p. 25-29.

______. "Windbreaks for Muskmelons." Unpublished Annual Progress Report, Sodus Horticultural Research Station, January 26, 1965.

______. "Quality and Yield of Tomatoes and Muskmelons in Relation to Rye Strip Windbreaks." Unpublished Annual Progress Report, Sodus Horticultural Research Station, January 26, 1966.

Drullinger, R. H. and Schmidt, B. L. "Wind Erosion Problems and Controls in the Great Lakes Region." Journal of Soil and Water Conservation, March-April, 1968, p. 58-59.

Fryrear, D. W. "Annual Crops as Wind Barriers." Transactions of the ASAE, Vol. 6, No. 4, 1963, p. 340-342.

Hagen, L. J. "Narrow Crop Strip Barrier Systems for Wind Erosion Control." Unpublished Annual Research Report, Soil Erosion Research, Manhattan, Kansas, 1970.

______, and Skidmore, E. L. "Turbulent Velocity Fluctuations and Vertical Flow as Affected by Windbreak Porosity." Transactions of the ASAE, Vol. 14, No. 4, 1971, p. 634-637.

Hayes, W. A. "Wind Erosion Equation Useful in Designing Northeastern Crop Protection." Journal of Soil and Water Conservation, July-August, 1965.

Lyles, L. and Woodruff, N. P. "Abrasive Action of Windblown Soil on Plant Seedlings." Agronomy Journal, Vol. 52, 1960, p. 533-536.

Skidmore, E. L. "Wind and Sandblast Injury to Seedling Green Beans." Agronomy Journal, Vol. 58, 1966, p. 311-315.

Woodruff, N. P. "Wind-Blown Soil Abrasive Injuries to Winter Wheat Plants." Agronomy Journal, Vol. 48, 1956, p. 499-502.

______, and Siddoway, F. H. "A Wind Erosion Equation." Soil Science Society of America Proceedings, Vol. 29, No. 5, Sept-Oct, 1965, p. 602-608.

Zingg, A. W. "The Intensity-Frequency of Kansas Winds." United States Department of Agriculture, Soil Conservation Service, TP-88, Washington 25, D. C., April, 1950.

RYE STRIP-CROP BARRIERS:
AN ECONOMIC ANALYSIS

by

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B. S., Kansas State University, 1970

AN ABSTRACT OF A MASTER'S THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

Department of Agricultural Economics

KANSAS STATE UNIVERSITY
Manhattan, Kansas

1972

ABSTRACT

Because vegetable crops are planted in soils highly susceptible to wind erosion and are easily damaged, this study was undertaken to determine the feasibility of using rye strip-crop barriers for vegetable production. Although the pratice of using strip-crop barriers has been adopted by some producers, no economical analysis has been made. Consquently, budgets were developed to estimate the costs and benefits of using the barriers for melons, snap beans, dry edible beans, and tomatoes.

The estimated cost of establishing the rye strip-crop barriers was $5.02 per acre. This included the variable costs (fuel; grease, oil, and filters; repair and maintenance) and the cost of rye seed and was considered the added cost. The reduced cost was a function of the vegetable produced and was determined by dividing the vegetable seed cost per acre by the land area lost to production due to the establishment of rye strip-crop barriers (e.g., the value of vegetable seed not used on the land planted to rye strip-crop barriers). The reduced receipts were also a function of the crop produced and were determined by dividing the average income per acre by the portion of land lost to production (e.g., devoted to the barriers). The added receipts needed to offset the sum of the added cost plus the reduced receipts minus

reduced cost were calculated, which was the minimum increase in income needed to cover the cost of the use of the rye strip-crop barriers.

The results indicated the use of rye strip-crop barriers should be profitable in the production of melons, snap beans, and dry edible beans. However, the use of rye strip-crop barriers in tomato production indicated that the increase in yield may not be sufficient enough to warrant their use.

It appears the use of rye strip-crop barriers is profitable in some cases, but the individual producer must decide if their use will be profitable in particular cases. If a producer knows his own variables of price and yield, the tables formulated in this study can be used to determine the profitability of using rye strip-crop barriers.