An Economics Workbook

From Agronomic Data to Farmer Recommendations

C I M M Y T

ECONOMICS PROGRAM

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Contents

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How to Use This Workbook

This workbook is designed to be used with the manual, ***From Agronomic Data to Farmer Recommendations.*** Completely Revised Edition. CIMMYT Economics Program (1988). It can be used in the classroom or for individual study.

The exercises are presented in the same order as the themes of the manual. Each exercise is keyed at the bottom of the page to the appropriate chapter or section and pages of the manual.

A separate answer booklet is available. It is best to work through an entire exercise before checking the answer in the booklet.

Abbreviations Used in the Workbook

The $ sign is not intended to represent any particular currency, and several different currencies are assumed in the exercises.

Additional abbreviations include ha (hectare), kg (kilogram), and 1 (liter).

Exercise 1

On-Farm Research

For each of the following pieces of information derived from on-farm research, indicate who is the most appropriate audience: researchers, farmers, or policymakers.

a. The most economic amount of fertilizer for maize in this area is 2 bags of 18-46-0 and 1½ bags of urea per hectare.

____

b. The efficiency of fertilizer utilization in this area is limited by acid soils.

____

c. Fertilizer is most efficient if it is applied within 3 weeks of planting, but fertilizer is often not available in the government shop until at least 1 month after planting.

____

Goals of the Farmer

Determine which of the farmer's goals or interests (listed in the second column) is implied in each question in the first column.

Question		Goal/Interest
1. If I change my weeding practices, will my chance of failure in a year of low rainfall increase or decrease?	____	A. In order to provide for the the needs of their families, farmers manage systems of various crops and animals.
2. If I change my weeding practices, how much more yield will I get, and how much more money will I have to spend?	____	B. Farmers are interested in the economic return from a new practice.
3. If I change my weeding practices, will I have to make many other changes as well?	____	C. Farmers are concerned about risks.
4. If I change my weeding practices in maize, will I still be able to grow beans?	____	D. Farmers are interested in making stepwise changes in their practices.

Exercise 3

On-Farm Experiments

Decide whether each of the following experiments is designed so that an economic analysis of the results is possible. If an analysis cannot be done, what changes in the experiment would make it possible?

a. A trial in which 4 levels of nitrogen are tested, including the level used by farmers. The nonexperimental variables (variety, seeding rate, weed control, etc.) are representative of farmers' practice.

b. A trial in which 5 levels of nitrogen and 3 levels of phosphorus are applied to the crop. A treatment is included that represents farmers' current fertilizer practice. Researchers prepare the plot where the experiment will be planted and use seeding rates, weed control, and pest control methods identical to those used on the experiment station.

c. An experiment that examines 2 *new* varieties and 2 *new* seeding rates (above and below the farmers' usual rate). Farmers prepare the plot and control the weeds and insects following representative practices.

On-Farm Experiments, pp. 5-7

Experimental Locations and Recommendation Domains

The farmers of a tentative recommendation domain plant a maize-maize rotation and prepare their fields with tractors. Their maize plants show evidence of nitrogen deficiency. Which one(s) of the fields listed below would be appropriate for a fertilizer experiment for the domain?

Field	Previous crop	Method of land preparation	Field size (ha)
A	Maize	Ox plow	3
B	Maize	Tractor	2
C	Tobacco	Tractor	1
D	Maize	Tractor	15

The Partial Budget

Fill in the blanks in the partial budget below with the titles of budget items (a-c) or numbers (d-f).

	Treatment		
	1 (No fertilizer)	2 (100 kg urea/ha)	3 (200 kg urea/ha)
Average yield (kg/ha)	1,500	2,100	2,400
a. ________________ (kg/ha)	1,200	1,680	1,920
Gross field benefits ($/ha)	600	840	960
Cost of fertilizer ($/ha)	0	80	160
Cost of labor to apply fertilizer ($/ha)	0	20	20
b. ________________ ($/ha)	0	100	e. ______
c. ________________ ($/ha)	600	d. ______	f. ______

Marginal Analysis

Calculate the marginal rate of return between Treatment 1 and Treatment 2.

	Treatment	
	1	2
Total costs that vary ($/ha)	150	200
Net benefits ($/ha)	430	470

Variability

Each of the following situations is an example of how variability affects the interpretation of experimental results. For each situation, indicate the type of variability:

1) Variability between locations (different recommendation domains)
2) Variability due to unpredictable factors
3) Variability due to economic factors

a. The response to fertilizer was better last year, when there were good rains, than it is this year.

____

b. Fertilizer use was economic last year when the price of fertilizer was 30% lower than it is this year.

____

c. The response to fertilizer on one farmer's field is different from that on a neighboring field because of differences in crop rotation.

____

Identifying Variable Inputs

List all variable inputs associated with the different treatments in each of the following experiments.

a. Insect Control Experiment

Treatment 1: No insect control (farmers' practice)
Treatment 2: Insecticide X (granular) applied in hole at planting
Treatment 3: Insecticide Y (granular) applied at 20 days

b. Fertilizer Experiment

Treatment 1: 100 kg urea at planting (farmers' practice)
Treatment 2: 100 kg urea at 30 days
Treatment 3: 50 kg urea at planting; 50 kg urea at 30 days
Treatment 4: 75 kg urea at planting; 75 kg urea at 30 days

c. Weed Control by Planting Method Experiment (Maize)

Treatment 1: 30,000 plants/ha, planted randomly; one hand weeding (farmers' practice)
Treatment 2: 30,000 plants/ha, planted randomly; one application of pre-emergence herbicide A
Treatment 3: 50,000 plants/ha, planted in rows; one hand weeding
Treatment 4: 50,000 plants/ha, planted in rows; one application of pre-emergence herbicide A

Identifying Variable Inputs, p. 14

Exercise 9

Field Price and Field Cost of Purchased Inputs

Insecticide A costs $10 for a 2.5-kg bag. Treatment 1 in an experiment requires 5 kg/ha of Insecticide A and Treatment 2 calls for 10 kg/ha of Insecticide A.

a. What is the *field price* of Insecticide A?

b. What is the *field cost* of Insecticide A in Treatment 1?

c. What is the *field cost* of Insecticide A in Treatment 2?

Costs That Vary, pp. 13-14

Field Prices of Fertilizer and Nutrients

The following data are from one research area:

Cost of 45 kg ammonium sulphate in shop	$740
Cost of 45 kg triple superphosphate in shop	$1,620
Cost of transporting a 45-kg bag from shop to farm	$95

(Ammonium sulphate is 21% N; triple superphosphate is 46% P_2O_5.)

Calculate:

a. The field price of ammonium sulphate

b. The field price of triple superphosphate

c. The field price of N

d. The field price of P_2O_5

Exercise 11

Equipment

Two types of land preparation were examined in an experiment.

Treatment 1: One plowing and two harrowings with a tractor
Treatment 2: Plowing with a horse

Data

Tractor plowing	$200/ha
Tractor harrowing	$100/ha
Horse plowing	$ 35/day (horse can plow ¼ ha in one day)

Calculate the costs of land preparation for each treatment.

Equipment and Machinery, p. 16

Labor

In the analysis of a weed control experiment, it was found that five 6-hour days are required to hand weed 1 acre (0.4 ha). The local wage rate was $35 for a 6-hour day, and the farmer was also expected to provide the laborer with one meal, valued at about $10. Calculate the cost of weeding 1 hectare.

Exercise 13

Total Costs That Vary

Calculate the total costs that vary for each of the following experiments.

a. Insect Control Experiment

Treatment 1: No insect control (farmers' practice)
Treatment 2: 10 kg/ha Insecticide X (granular), applied at planting
Treatment 3: 8 kg/ha Insecticide Y (granular), applied at 20 days

Data

Field price of Insecticide X	$3.00/kg
Field price of Insecticide Y	$1.20/kg
Labor to apply Insecticide X at planting	1.5 days/ha
Labor to apply Insecticide Y at 20 days	1.0 days/ha
Cost of labor	$5.00/day

Total Costs That Vary, pp. 18-19

Total Costs That Vary

b. Fertilizer Experiment

Treatment	Kg N/ha at planting	Kg N/ha at 30 days
1	40	0
2	0	40
3	20	20
4	30	30

Data

Market price of urea	\$21.50/kg
Cost of transporting urea	\$1.50/kg
Percentage N in urea	46%
Labor to apply fertilizer at planting	0.5 day/ha
Labor to apply fertilizer at 30 days	0.5 day/ha
Cost of labor	\$160/day

Total Costs That Vary

c. Weed Control by Planting Density Experiment (Maize)

Treatment	Planting	Weeding
1	30,000 plants/ha (random planted)	1 hand weeding
2	30,000 plants/ha (random planted)	2.5 kg/ha Herbicide A
3	50,000 plants/ha (row planted)	1 hand weeding
4	50,000 plants/ha (row planted)	2.5 kg/ha Herbicide A

Data

Price of seed (1 kg of seed contains 2,500 seeds)	$40/kg
Labor to random plant 30,000 plants/ha	2 days/ha
Labor to row plant 50,000 plants/ha	3 days/ha
Labor to hand weed	12 days/ha
Price of Herbicide A	$1,000/kg
Labor to apply Herbicide A	2 days/ha
Labor to haul water to mix with herbicide	1 day/ha
Sprayer rental	$600/ha
Cost of labor	$500/day

Pooling the Results From the Same Recommendation Domain

A variety by fertilizer experiment was planted in one research area consisting of two recommendation domains. Recommendation Domain A was defined as those farmers who had very sandy soils, while Recommendation Domain B consisted of those farmers who had clay-loam soils.

Yield data from nine locations are presented below. Find the average yields for each treatment for each recommendation domain.

		Treatment yield (kg/ha)			
Location	Recommendation domain	1 Local variety, no fertilizer	2 Improved variety, no fertilizer	3 Local variety with fertilizer	4 Improved variety with fertilizer
1	A	960	910	1,560	1,380
2	A	1,010	620	1,820	1,450
3	B	1,820	1,650	2,240	2,920
4	A	570	490	980	820
5	B	2,270	2,420	2,750	3,300
6	B	1,900	1,740	2,190	2,840
7[a]	A	200	200	200	200
8	B	2,430	2,010	2,740	3,210
9	A	890	620	1,480	1,370

[a] Trial lost due to drought. Yield estimated to be 200 kg/ha across treatments.

Recommendation Domain A

	Treatment			
	1	2	3	4
Average yield (kg/ha)	____	____	____	____

Recommendation Domain B

	Treatment			
	1	2	3	4
Average yield (kg/ha)	____	____	____	____

Exercise 15

Assessing Experimental Results Before Economic Analysis

In one research area, farmers sometimes planted late because they had to wait to rent an ox plow. Researchers decided to test the alternative of partial tillage using an ox-drawn ripper tine, which would open a furrow into which farmers could plant. The tine made tillage and planting quicker, but more weeding was required after tillage. Experiments in eight locations gave the following yield results:

Method	Average yield (kg/ha)
Plow	3,258
Tine	3,015

After carefully examining the data and results of the statistical analysis, and reviewing the observations made at each location, agronomists concluded that there was no yield difference between the two treatments.

Use the following information to decide which practice should be recommended to farmers.

	Method	
	Plow	Tine
Tillage time	2 days/ha	1 day/ha
Equipment and labor for tillage	$5.60/day	$4.75/day
Planting time	5 days/ha	2 days/ha
Weeding time	20 days/ha	35 days/ha
Wage rate for planting or weeding	$1.20/day	$1.20/day

Adjusted Yield

Because of their careful application of fertilizer in an experiment on potatoes, researchers decided to reduce yields by 5% to estimate the yields that would be expected if farmers had managed the fertilizer. They also estimated that the effect of small plot size warranted another 5% reduction. Harvesting date and method were the same as those of the farmers. Thus the experimental yields were adjusted downward by 10%.

Use the data presented below to calculate the average yields and the adjusted yields for each treatment.

	Yield (kg/ha)		
Treatment	A	B	C
Location 1	11,560	14,710	18,500
Location 2	12,340	16,230	18,450
Location 3	9,400	13,760	16,150
Average yield (kg/ha)			
Adjusted yield (kg/ha)			

Exercise 17A

Field Price

In a maize-growing region, farmers received $80 for a 50-kg bag of grain in the local market. The cost of transporting a 50-kg bag of grain to market averaged $5. Harvesting took about 8 days per hectare, and average yields in the area were 2,400 kg/ha. A worker was able to shell about 400 kg of maize in one day. The wage rate was $40 per day. What is the field price of maize?

Field Price of the Crop, pp. 25-27

Field Price

Wheat farmers harvested their crop with rented combine harvesters. The combine operators charged $550/ha, regardless of yield. Farmers sold their wheat at a government warehouse in town and had to pay trucking costs of $0.16/kg. The official buying price of the wheat was $2.20/kg, but because of discounts for quality farmers usually received 5% less than the official price. Average wheat yields in the area were 2,000 kg/ha. What is the field price of wheat?

Exercise 18

Gross Field Benefits

The average yields from a maize experiment are shown below.

	Treatment			
	1	2	3	4
Average yield (kg/ha)	1,740	2,430	1,420	2,790

Because of plot size, differences in management, and time of harvest researchers decided to adjust yields from all treatments downward by 20%. Maize was sold in town for $12.00/kg. Transport costs from farm to town were $0.60/kg and the cost of harvesting and shelling was $0.80/kg.

Fill in the first three lines of the partial budget.

	Treatment			
	1	2	3	4
Average yield (kg/ha)				
Adjusted yield (kg/ha)				
Gross field benefits ($/ha)				

Gross Field Benefits, p. 27

Exercise 19A

Partial Budgets

Complete the partial budget for an insecticide experiment, using the following data.

Treatment	Insecticide A (One application = 8 kg/ha, as a foliar insecticide)	Insecticide B (One application = 4 kg/ha, in the hole at planting)
1	0	0
2	1 application	0
3	2 applications	0
4	1 application	1 application

Data

Sale price of maize	$0.32/kg	Price of Insecticide B	$4.50/kg
Harvesting cost	$0.03/kg	Labor required to apply Insecticide A	1 day/ha
Shelling cost	$0.02/kg	Labor required to apply Insecticide B	0.5 day/ha
Transport from field to sale point	$0.04/kg	Yield adjustment	20%
Cost of labor	$6.00/day		
Price of Insecticide A	$1.50/kg		

Partial Budget

	Treatment 1	Treatment 2	Treatment 3	Treatment 4
Average yield (kg/ha)	2,717	2,635	2,917	3,233
Adjusted yield (kg/ha)	______	______	______	______
Gross field benefits ($/ha)	______	______	______	______
Insecticide cost ($/ha)	______	______	______	______
Application cost ($/ha)	______	______	______	______
Total costs that vary ($/ha)	______	______	______	______
Net benefits ($ha)	______	______	______	______

Net Benefits, p. 28

Partial Budgets

Exercise 19B

Partial Budgets

Construct a partial budget with the following data.

Treatment	Weeding	Fertilizer	Average yield (kg/ha)
1	1 hand weeding	0	2,000
2	1 hand weeding	50 kg N/ha	2,500
3	2 hand weedings	50 kg N/ha	3,000

Data

Field price of maize	$15.00/kg
Price of urea (46% N) in town	$17.00/kg
Cost of transport of fertilizer	$1.40/kg
Cost of labor	$100.00/day
Labor for one hand weeding	12 days/ha
Labor for applying fertilizer	1 day/ha
Yield adjustment	10%

Net Benefits, p. 28

Partial Budgets

Net Benefits, p.28

Including All Gross Benefits in the Partial Budget

An experiment looked at the response of wheat to different levels of nitrogen. Use the following information to calculate gross field benefits for all of the treatments of the experiment, and complete the partial budget.

- Both grain and straw are important products for the farmers.
- Farmers sell their wheat immediately after harvest for $4.00/kg. Harvesting and threshing costs total $0.30/kg, and transport to place of sale costs $0.20/kg.
- Wheat straw is baled and sold as animal feed. Farmers receive $5.10 for a 18-kg bale. The purchaser of the straw, not the farmer, pays transport costs. The farmer pays the cost of baling ($0.60/bale).
- It is estimated that researchers obtain higher wheat yields than farmers because researchers manage the crop with greater precision and harvest earlier (15% adjustment). It is estimated that researchers get higher straw yields as well, because of precise management (10% adjustment).
- The field price of nitrogen is $10/kg. The fertilizer is all applied at planting, at a cost of $200/ha.

Partial Budget

	Treatment			
	1 0 Kg N/ha	2 50 kg N/ha	3 100 Kg N/ha	4 150 Kg N/ha
Grain yield (kg/ha)	1,500	2,100	2,400	2,500
Straw yield (kg/ha)	1,800	2,520	2,880	3,000
Adjusted grain yield (kg/ha)				
Adjusted straw yield (kg/ha)				
Gross field benefits, grain ($/ha)				
Gross field benefits, straw ($/ha)				
Total gross field benefits ($/ha)				
Cost of nitrogen ($/ha)				
Cost of application ($/ha)				
Total costs that vary ($/ha)				
Net benefits ($/ha)				

Including All Gross Benefits in the Partial Budget

Dominance Analysis

The last two lines of a partial budget from a fertilizer experiment are presented below. Do a dominance analysis to show which are the dominated treatments.

	Treatment								
	1	2	3	4	5	6	7	8	9
N (kg/ha)	0	50	100	0	50	100	0	50	100
P_2O_5 (kg/ha)	0	0	0	25	25	25	50	50	50
Total costs that vary ($/ha)	0	450	900	300	700	1,150	550	950	1,400
Net benefits ($/ha)	1,990	2,380	2,620	1,900	2,790	2,810	1,570	2,690	2,870

Exercise 22

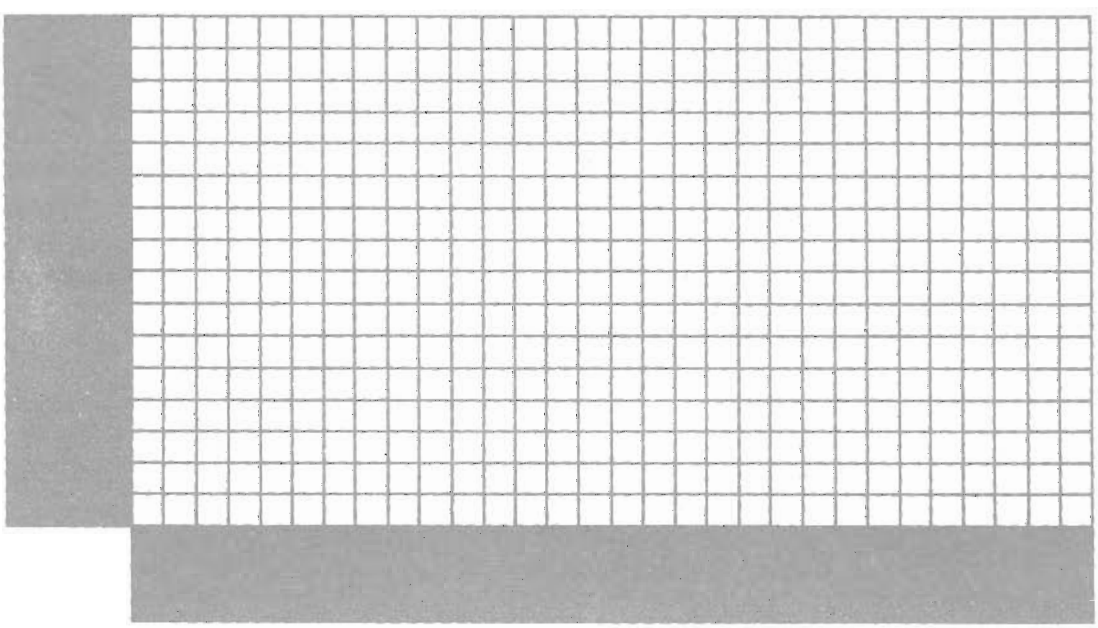
Net Benefit Curve

Perform a dominance analysis and draw the net benefit curve for each of the following experiments.

a. Nitrogen by Phosphorus Experiment

	Treatment			
	N (kg/ha)	P_2O_5 (kg/ha)	Total costs that vary	Net benefits ($/ha)
1.a/	0	0	0	640
2.	40	0	38	692
3.	80	0	70	722
4.	40	30	83	704
5.	40	60	128	688
6.	80	30	115	735
7.	80	60	160	731

a/ Farmers' practice



Net Benefit Curve, p. 31

Net Benefit Curve

b. Tillage by Weed Control Experiment

Treatment	Land preparation	Weed control	Total costs that vary ($/ha)	Net benefits ($/ha)
1	Plow	Herbicide	623	1,190
2	Pre-emergence herbicide	No weeding	390	1,480
3	Pre-emergence herbicide	Hand weeding	586	1,150
4	Plow	No weeding	124	1,210
5	Plow	Hand weeding	320	1,280

Net Benefit Curve, p. 31

Exercise 22

Net Benefit Curve

c. Seed Rate by Fertilizer Experiment

Treatment	Seed rate	Fertilizer	Total costs that vary ($/ha)	Net benefits ($/ha)
1	Experimental	Experimental	172	797
2	Experimental	Farmers'	35	812
3	Farmers'	Experimental	137	821
4	Farmers'	Farmers'	0	832

Net Benefit Curve, p. 31

Marginal Rate of Return

Refer to the data in Exercise 22, and for each experiment calculate marginal rates of return between the nondominated treatments.

a. Nitrogen by Phosphorus Experiment

b. Tillage by Weed Control Experiment

c. Seed Rate by Fertilizer Experiment

Partial Budgets and Marginal Rates of Return

The following are the results of a nitrogen experiment (0, 50, 100, and 150 kg N/ha.).

For recommendation domain A:

a. Construct a partial budget.
b. Do a dominance analysis.
c. Draw a net benefit curve.
d. Calculate marginal rates of return.

		Treatment yields(kg/ha)[a]			
Recommendation domain	Experiment no.	1	2	3	4
A	1	1,000	1,850	2,200	2,250
A	2	900	1,860	2,100	2,400
B	3	1,900	2,400	2,500	2,600
A	4	1,300	2,200	2,400	2,500
B	5	2,000	2,600	2,600	2,700
A	6	1,100	2,100	2,400	2,500
A	7	1,400	2,050	2,600	2,600
B	8	1,700	2,200	2,100	2,200
A	9[b]	-	-	-	-

[a] Treatment — Kg N/ha

Treatment	Kg N/ha
1	0
2	50
3	100
4	150

[b] Abandoned because of drought

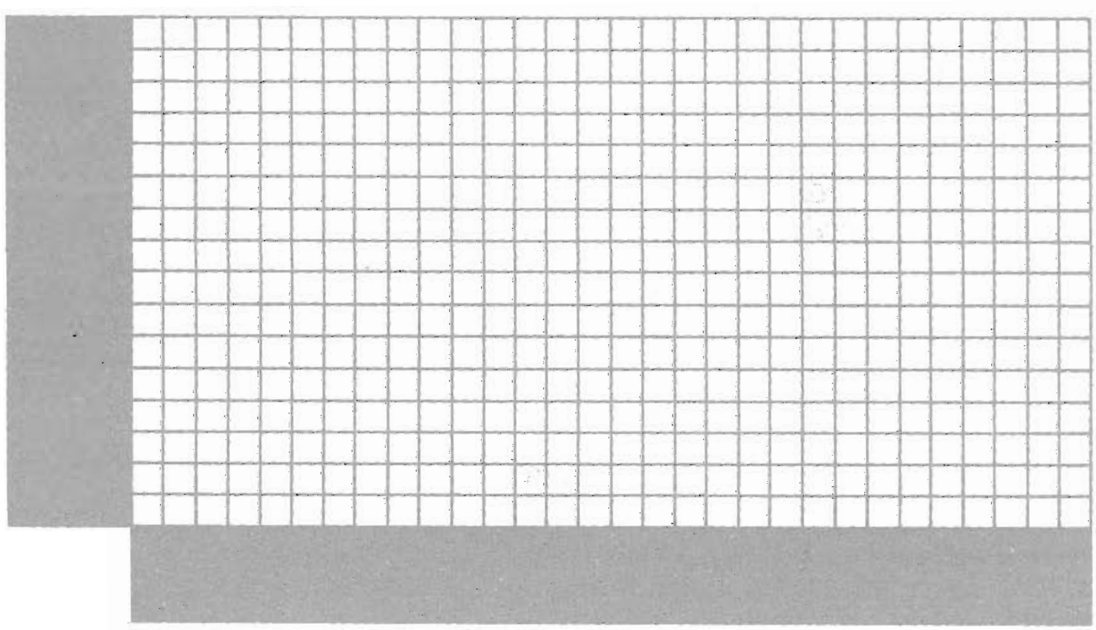
Data

Yield adjustment	15%
Maize sale price	$6.50/kg
Shelling cost	$0.50/kg
Harvest cost	$0.75/kg
Cost of transporting maize to market	$1.00/kg
Wage rate	$150/day
Urea (46% N)	$4.00/kg
Transport (urea)	$0.30/kg
Fertilizer application	2 days/ha

(Fertilizer is applied in a single application for all treatments.)

The Net Benefit Curve and the Marginal Rate of Return, pp. 30-33

Partial Budgets and Marginal Rates of Return



The Net Benefit Curve and the Marginal Rate of Return, pp. 30-33

Exercise 25

Minimum Acceptable Rate of Return

a. To estimate the minimum rate of return acceptable to farmers, a range of 50% to 100% per crop cycle may be considered acceptable, if no other information is available.

For each of the following possible recommendations, indicate whether a minimum rate of return closer to 50% or 100% would be most appropriate.

1. Herbicides, where farmers are currently weeding with hoes

____

2. A new herbicide, where farmers are already using herbicide

____

3. A change in seeding rate (but same seeding method)

____

4. Using a seed drill, where farmers are currently seeding by broadcasting

____

b. In one research area it was common to borrow money from shopkeepers for agricultural purposes. The shopkeepers charged a flat rate of 8% per month. If the agricultural cycle is about 6 months, what would be a reasonable estimate for a minimum rate of return?

____

____

____

c. Farmers in a certain region have access to a government bank that caters to small- and medium-scale farmers. The bank's loan rate is 24% per year. The bank also charges a flat rate of 15% of the value of the loan for crop insurance and a 10% service charge. If farmers can get loans to buy fertilizer, and if there are about 5 months from planting to the sale of the harvest, what would be a reasonable estimate for a minimum rate of return?

____

____

____

____

____

The Minimum Acceptable Rate of Return, pp. 34-37

Interpreting Net Benefit Curves

The following are the results of 40 fertilizer trials planted over 3 years in one recommendation domain. There is a significant response to both nitrogen and phosphorus. Conduct a dominance analysis, draw the net benefit curve, and use marginal analysis to make a recommendation to farmers. Check the analysis by using the method of residuals. The minimum rate of return is assumed to be 50%.

Treatment	N (kg/ha)	P_2O_5 (kg/ha)	Total costs that vary($/ha)	Net benefits ($/ha)
1.a/	40	0	99	500
2.	40	40	190	480
3.	80	0	198	610
4.	80	40	277	520
5.	120	0	285	675
6.	120	40	364	580
7.	80	80	372	420
8.	120	80	451	350

a/ Farmers' practice

Exercise 26B

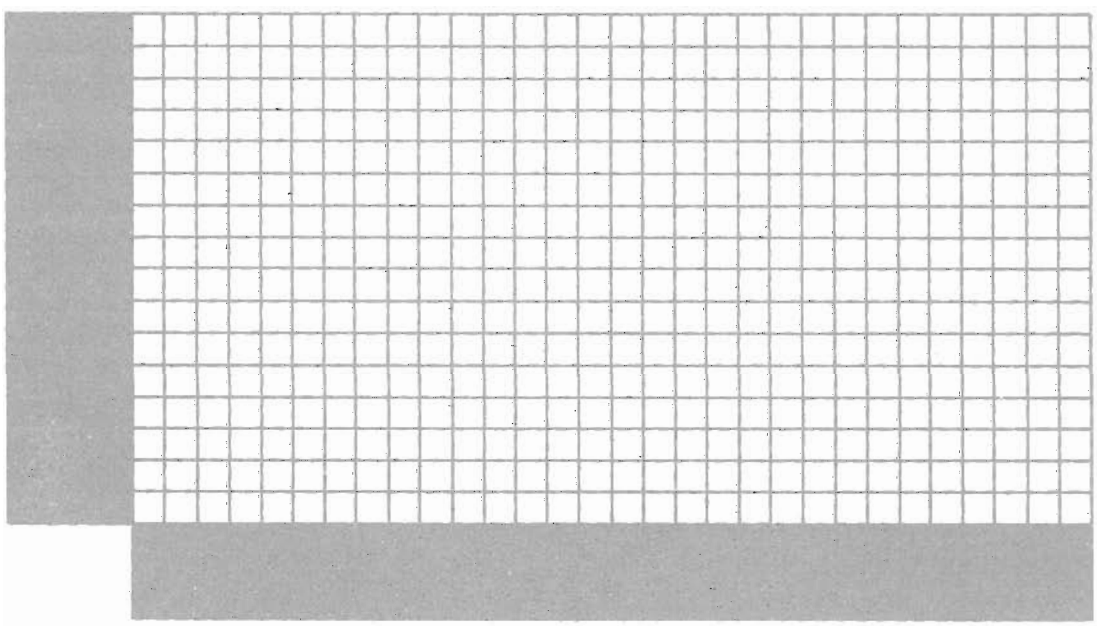
Interpreting Net Benefit Curves

The following are the results of 5 nitrogen by phosphorus experiments planted in 1 year in a single recommendation domain. Statistical analysis shows significant response to both nitrogen and phosphorus. Conduct a dominance analysis, draw the net benefit curve, and use marginal analysis to help decide what levels of fertilizer researchers should experiment with next year. Check the analysis by using residuals. The minimum rate of return is assumed to be 100%.

Nitrogen by phosphorus experiment

Treatment	N (kg/ha)	P_2O_5 (kg/ha)	Total costs that vary ($/ha)	Net benefits ($/ha)
1.[a]	0	0	0	800
2.	50	0	50	950
3.	100	0	100	965
4.	50	50	100	945
5.	100	50	150	1,065
6.	100	75	175	1,075
7.	100	100	200	1,040

[a] Farmers' practice

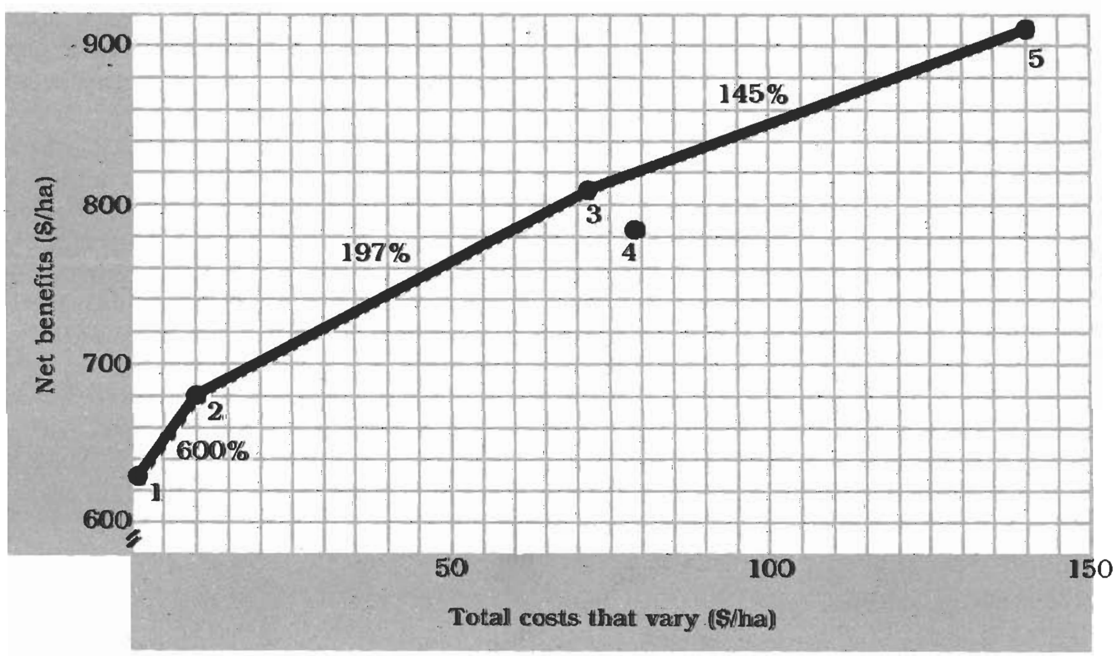


Interpreting Net Benefit Curves

The following are results of 25 trials planted over 2 years in one recommendation domain. The trials were designed to look at the effects of improved variety, weed control, and fertilization. If the minimum rate of return is 100%, what should be recommended to farmers? If farmers are likely to adopt recommendations in steps, what should be recommended to farmers?

Treatment	Variety[a]	Weed control[a]	Fertilization[a]	Total costs that vary ($/ha)	Net benefits ($/ha)	Marginal rate of return
1	0	0	0	0	625	
						600%
2	1	0	0	10	685	
						197%
3	1	1	0	72	807	
4	1	0	1	79	782 D	145%
5	1	1	1	141	907	

a/ 0 = Farmers' practice, 1 = Improved practice)



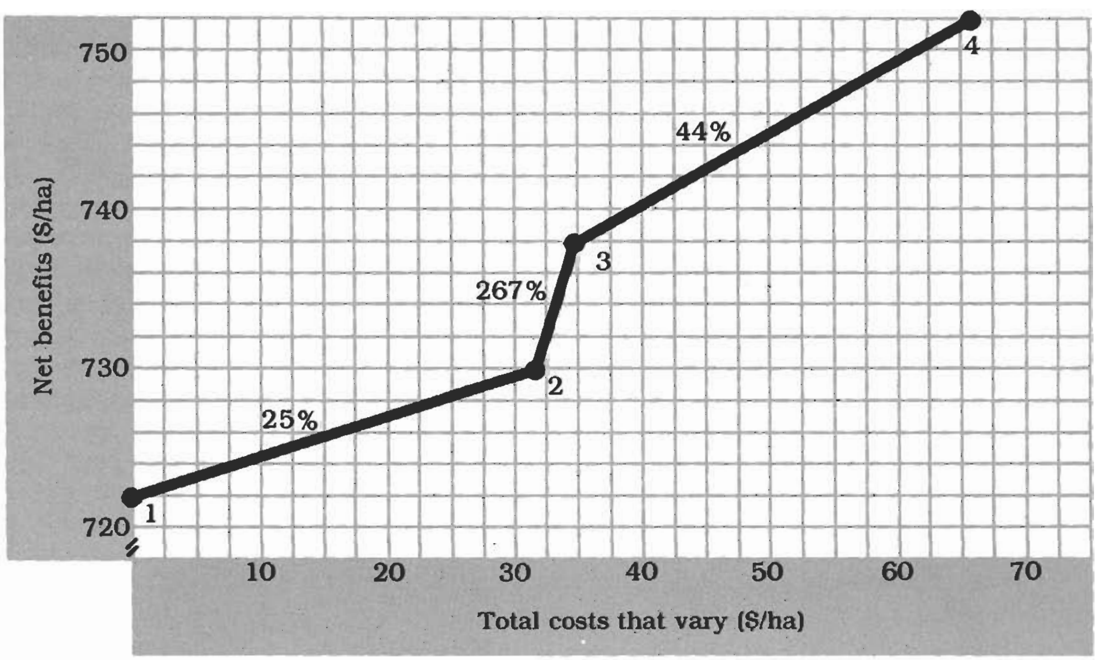
Exercise 26D

Interpreting Net Benefit Curves

In one recommendation domain researchers planted 6 insecticide experiments. The response to insecticide was statistically significant. The results of the partial budget are shown below. If the minimum rate of return is 100%, what should researchers do the following year? Check the interpretation by calculating residuals.

Treatment	Total costs that vary ($/ha)	Net benefits ($/ha)	Marignal rate of return
1. No insect control [a]	0	722	
			25%
2. Insecticide A (at planting)	32	730	
			267%
3. Insecticide B (granular)	35	738	
			44%
4. Insecticide A + Insecticide B	67	752	

[a] Farmers' practice

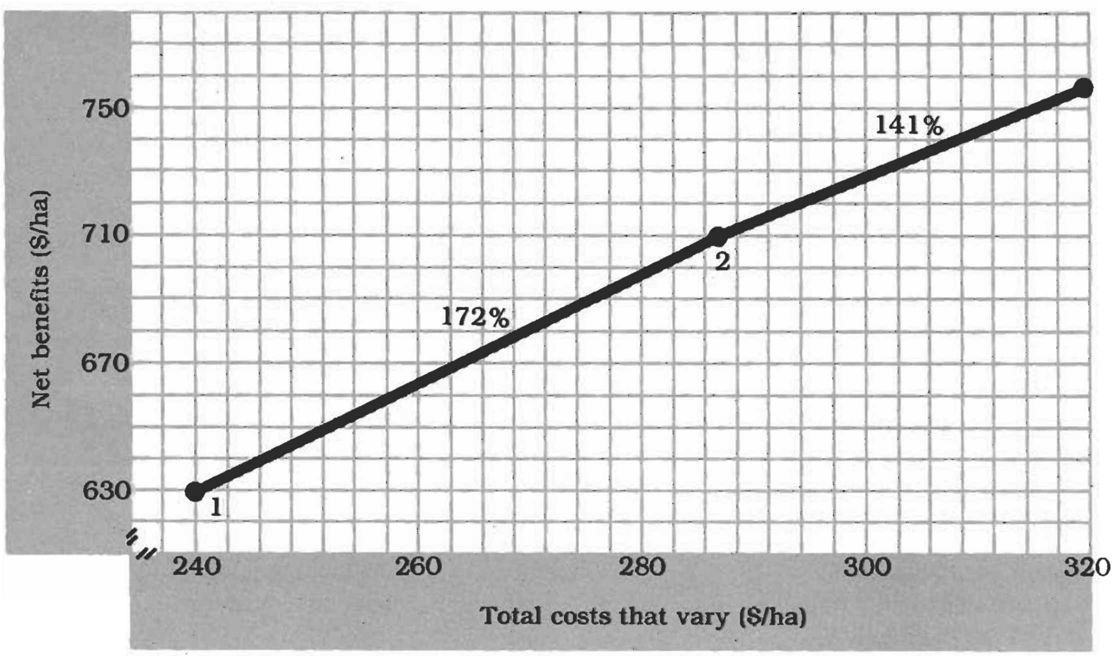


Interpreting Net Benefit Curves

Researchers planted 10 seeding method by fertilizer experiments in wheat in one recommendation domain where farmers were broadcasting their wheat and applying about 40 kg N/ha. The results of the marginal analysis are shown below. The minimum rate of return is 100%. What should researchers recommend to farmers?

Treatment	Seeding method	Fertilization Kg N/ha	Kg P_2O_5/ha	Total costs that vary ($/ha)	Net benefits ($/ha)	Marginal rate of return
1	Broadcast	0	0	240	630	
						172%
2	Drill	60	0	287	711	
						141%
3	Drill	60	30	319	756	

(Farmers' practice = broadcast seeding and 40 kg N/ha)



Exercise 27

Partial Budgets and Complete Budgets

To demonstrate the value of partial budgets, perform dominance analysis and marginal analysis on the following two data sets drawn from the same set of experiments. Yields and gross benefits are identical for both data sets. The only difference is that Data Set 2 also includes costs that do not vary between treatments. Assume a minimum rate of return of 100%.

Data Set 1, N by P Experiment

	Treatment			
Variable	**1**	**2**	**3**	**4**
Yield (kg/ha)	2,000	2,100	2,500	2,600
Adjusted yield (kg/ha)	1,600	1,680	2,000	2,080
Gross field benefits ($/ha)	5,600	5,880	7,000	7,280
Cost of N ($/ha)	0	0	350	350
Cost of P_2O_5 ($/ha)	0	300	0	300
Application cost ($/ha)	0	150	150	150
Total costs that vary ($/ha)				
Net benefits ($/ha)				

Data Set 2, N by P Experiment

	Treatment			
Variable	**1**	**2**	**3**	**4**
Yield (kg/ha)	2,000	2,100	2,500	2,600
Adjusted yield (kg/ha)	1,600	1,680	2,000	2,080
Gross field benefits ($/ha)	5,600	5,880	7,000	7,280
Tillage cost ($/ha)	1,200	1,200	1,200	1,200
Planting cost ($/ha)	400	400	400	400
Cost of seed ($/ha)	75	75	75	75
Weeding cost ($/ha)	1,600	1,600	1,600	1,600
Cost of N ($/ha)	0	0	350	350
Cost of P_2O_5 ($/ha)	0	300	0	300
Application cost ($/ha)	0	150	150	150
Total cost ($/ha)				
Net benefits ($/ha)				

Some Questions About Marginal Analysis, pp. 50-51

Marginal Analysis for Planning Experiments

In one research area maize farmers were controlling weeds by hand. Researchers were considering experimenting with a herbicide, which they felt was more effective. Calculate the yield increase required to make herbicide adoption acceptable to farmers.

Field price of maize	$30/kg
Minimum rate of return	80%
Cost of hand weeding	$1,930/ha
Cost of herbicide (including application costs)	$6,200/ha

Reviewing Experimental Results

Ten on-farm fertilizer trials in wheat looked at the farmers' practice, which is not to fertilize, and an alternative practice of applying 80 kg/ha each of N and P_2O_5. Farmers plant their wheat in January or February in rotation after maize or barley.

Review the data from the field book and decide which locations should be eliminated from the analysis. In each case, give an explanation.

Calculate the average yields for the two treatments that would appear in the partial budget.

Field Book Data

Location	Treatment yield (kg/ha)[a/] 1	2	Previous crop	Planting date	Notes
1	1,730	3,280	Maize	Jan. 2	
2	2,250	3,440	Maize	Feb. 3	
3	1,890	3,360	Maize	Jan. 20	
4	3,140	3,530	Barley	Feb. 2	Farmer applied manure to field after seeding
5	1,440	3,120	Maize	Jan. 25	
6	2,690	3,020	Maize	Jan. 8	
7	3,430	3,790	Potatoes	Jan. 10	High fertilizer dosage on previous crop
8	750	970	Barley	Feb. 14	Hail damage
9	1,440	1,590	Barley	Mar. 15	
10	2,170	4,420	Maize	Jan. 22	

a/

Treatment	Kg N/ha	Kg P_2O_5/ha
1	0	0
2	80	80

Exercise 30

Statistical Analysis and Economic Analysis

Table 1 shows the results of three exploratory 2^4 factorial experiments planted in maize. In these experiments, the four factors were tillage, plant density, nitrogen, and phosphorus. For each of the four factors, two levels were used: the farmers' practice and an alternative. The experiment had a total of 16 treatments.

Factors

T_0 = Tractor tillage
T_1 = Zero tillage

D_0 = 40,000 plants/ha
D_1 = 50,000 plants/ha

N_0 = 0 kg N/ha
N_1 = 90 kg N/ha

P_0 = 0 kg P_2O_5/ha
P_1 = 50 kg P_2O_5/ha

Table 2 shows the statistical analysis of the experiment. Table 3 shows relevant data for an economic analysis.

Use the information on the statistical analysis in Table 2 to decide how to analyze the data. Farmers currently prepare their fields with tractors, plant at 40,000 plants/ha, and use no nitrogen or phosphorus fertilizer. On the basis of the economic analysis of these exploratory experiments, make suggestions regarding the importance of continuing to experiment with each of these four factors the following year.

Table 1
Results of Exploratory Experiments

Treatment T D N P	Average yields (kg/ha)
0 0 0 0	3,230
1 0 0 0	3,970
0 1 0 0	5,300
1 1 0 0	5,830
0 0 1 0	4,100
1 0 1 0	3,600
0 1 1 0	5,300
1 1 1 0	5,600
0 0 0 1	4,330
1 0 0 1	4,170
0 1 0 1	6,170
1 1 0 1	5,370
0 0 1 1	4,100
1 0 1 1	4,030
0 1 1 1	5,500
1 1 1 1	6,200
Average	**4,800**

Table 2
Statistical Analysis of Exploratory Experiments

Source of variation	F
Location	0.47
Repetition	1.79
T	0.28
D	104.22**
N	0.01
P	4.92*
T x D	0.30
T x N	0.02
T x P	1.08
D x N	0.01
D x P	0.11
N x P	0.05

* Significant at .05
** Significant at .01

Statistical Analysis, pp. 60-62

Table 3
Economic Data

Yield adjustment	10%
Field price of maize	$0.14/kg
Minimum rate of return	100%

Total costs that vary for treatments

Treatment	Total costs that vary ($/ha)
T_0	45
T_1	26
D_0	17
D_1	26
N_0	0
N_1	95
P_0	0
P_1	35

Exercise 31

Minimum Returns Analysis

The results of an experiment planted in 24 locations over 2 years are presented in Table 1. The purpose of the experiment was to verify the advantages of improved practices in weed control, plant population, and higher levels of fertilization, in comparison with the farmers' current practice.

Table 1
Data from 36 Verification Experiments

	A Farmers' practice	B Improved weed control and plant population	C Improved weed control, plant population, and increased fertilization
Average yield (kg/ha)	1,825	2,617	3,098
Average net benefits ($/ha)	2,278	3,119	3,486
Total costs that vary ($/ha)	350	650	975

The marginal rate of return A ⟶ B = 280%
B ⟶ C = 113%

Minimum rate of return = 100%

Before making a recommendation, the researchers have decided that they will do a minimum returns analysis on the data. The first step is to calculate net benefits for individual locations. The yield data from locations 1 and 2 are presented in Table 2 as examples. Use these yields to calculate net benefits. Use the data on total costs that vary from Table 1. The field price of maize is $1.60/kg and the yield adjustment in the experiments is 10%.

Table 2
Yields (kg/ha) by Location

	Treatment		
Location	A	B	C
1	2,706	3,677	4,319
2	3,542	4,188	4,139
3			
4			
24	1,118	1,792	3,302
Average	1,825	2,617	3,098

Net Benefits ($/ha) by Location

Location	A	B	C
1	______	______	______
2	______	______	______

Minimum Returns Analysis, pp. 67-70

Minimum Returns Analysis

The rest of these calculations appear in Table 3. Use these data to do a minimum returns analysis and decide which treatment would be most appropriate to recommend to farmers.

Table 3
Net Benefits ($/ha)

Location	A	B	C
1	3,547	4,645	5,244
2	4,750	5,381	4,985
3	2,434	4,037	6,888
4	2,925	3,959	3,621
5	1,307	3,023	4,749
6	1,574	3,489	5,740
7	1,521	2,587	361
8	1,670	2,486	436
9	1,872	3,023	3,923
10	1,705	2,087	2,936
11	2,925	4,271	5,656
12	3,838	5,236	7,652
13	2,223	3,335	5,855
14	1,124	1,697	39
15	1,219	1,775	276
16	1,370	2,999	3,383
17	1,921	1,307	293
18	2,803	1,619	1,396
19	3,627	4,271	5,170
20	1,242	2,431	707
21	2,321	3,023	4,200
22	2,527	2,399	1,699
23	2,960	3,839	4,663
24	1,260	1,931	3,781

Minimum Returns Analysis, pp. 67-70

Exercise 32A

Sensitivity Analysis

1. The yield results of 10 fertilizer experiments in wheat are shown below. If the field price of wheat is \$5.50/kg, calculate gross benefits and net benefits and do a marginal analysis on the data. If the minimum rate of return is 100%, what would be the recommendation? (Farmers currently use no fertilizer.)

Treat-ment	Kg N/ha	Kg P_2O_5/ha	Adjusted yield (kg/ha)	Gross field benefits (\$/ha)	Total costs that vary (\$/ha)	Net benefits (\$/ha)	Marginal rate of return (%)
1	0	0	1,784		0		
2	150	0	2,564		2,803		
3	75	80	2,763		3,253		
4	75	160	3,340		5,105		

2. The government is considering increasing the price of wheat. If this should happen, the field price of wheat would be \$7.40/kg. Use the new field price to recalculate the gross benefits and net benefits. Identify a suitable recommendation with the higher price of wheat.

Treat-ment	Kg N/ha	Kg P_2O_5/ha	Adjusted yield (kg/ha)	Gross field benefits (\$/ha)	Total costs that vary (\$/ha)	Net benefits (\$/ha)	Marginal rate of return (%)
1	0	0	1,784		0		
2	150	0	2,564		2,803		
3	75	80	2,763		3,253		
4	75	160	3,340		5,105		

Sensitivity Analysis

In an area where farmers normally weed their maize only once, it was shown that a second hand weeding could give higher yields. Researchers *estimate* that the opportunity cost of labor is $20/day. Use the data presented below to decide if it is worth recommending the extra weeding. If the opportunity cost of labor is *really* $40/day, what should be the recommendation?

Average yield (one weeding)	2,450 kg/ha
Average yield (two weedings)	2,778 kg/ha
Yield adjustment	10%
One weeding	14 days/ha
Two weedings	24 days/ha
Field price of maize	$1.50/kg
Minimum rate of return	50%

Final Exercises

After conducting experiments for several years to explore various research issues, maize researchers in a certain area designed an experiment to be used in verifying and demonstrating to farmers the advantages of improved planting density. fertilization, and insect control. The experiment consisted of 3 treatments, all managed by the farmer, planted in a single repetition per site. The size of each plot was 200 m^2. Treatments and yields are given below.

Treatment	Planting method and density	Fertilization	Insect control	Average yield (kg/ha) across 18 sites
1 (Farmers' practice)	4 plants per hill 1 m between hills. 1 m between rows (density = 40.000 plants/ha, 16 kg seed)	Two bags of 10-30-10 and one bag ammonium sulfate. applied together at planting	None	2,425
2	3 plants per hill, 0.6 m between hills, 1 m between rows (density = 50,000 plants/ha, 20 kg seed)	Two bags of 10-30-10 and one bag ammonium sulfate applied together at, planting; two bags ammonium sulfate applied at 30 days	None	3,116
3	Same as Treatment 2	Same as Treatment 2	1 application of granular insecticide A, 10 kg/ha	3,405

Final Exercises

Use the data presented below to construct a partial budget, draw a net benefit curve, do the marginal analysis, and make a recommendation to farmers.

Labor time	
Planting, farmers' method	2 days/ha
Planting, improved method	3.5 days/ha
Fertilizer application at planting	1 day/ha
Fertilizer application at 30 days	1 day/ha
Application of insecticide	1.5 days/ha
Harvest of a field that yields 2,400 kg/ha	4 days/ha
Shelling 500 kg of maize	1 day
Inputs	
Seed	$40/kg
10-30-10 fertilizer	$450/bag
Ammonium sulfate	$380/bag
Insecticide A	$120/kg
Transport of maize to market	$1/kg
Transport of fertilizer	$30/bag
Cost of labor	$300/day
Selling price of maize at market	$15/kg
Yield adjustment	5% (trials harvested earlier than farmers normally harvest)
Minimum rate of return	60%

Final Exercises

Final Exercises

In the first year of experimentation in a wheat-growing area, researchers decided that it would be worthwhile to look at seeding rate by nitrogen interactions. Farmers were applying nitrogen at low rates (30 kg N/ha) and seeding at 120 kg seed/ha. The experiments were planted on farmers' fields. The farmers prepared their plots in the usual way, and researchers planted the experiments and applied the fertilizer. Farmers used their normal weed control methods. There were 3 seeding rates and 4 levels of nitrogen. The experiment had 3 repetitions per site and was planted at 5 sites.

Seeding rates: 120, 140, and 160 kg seed/ha

Nitrogen: 30, 60, 90, and 120 kg N/ha
(The 30 and 60 kg N/ha treatments are a single application at planting; the 90 and 120 kg N/ha treatments are split applications at planting and at 30 days.)

	Average treatment yields (kg/ha)				
Seeding rate (kg/ha)	1 30 Kg N/ha	2 60 Kg N/ha	3 90 Kg N/ha	4 120 Kg N/ha	Average
120	2,258	2,704	3,117	3,262	2,835
140	2,380	2,587	2,995	3,398	2,840
160	2,241	2,865	3,110	3,019	2,809
Average	2,293	2,719	3,074	3,226	2,828

Statistical and agronomic analysis showed increased nitrogen use to be highly significant and seeding rate not significant; there was no evidence of nitrogen by seeding rate interaction.

Final Exercises

Use the following economic data to do an analysis of this experiment that will help researchers decide which experiments are appropriate for next year.

Fertilizer application at planting	0.5 day/ha
Fertilizer application at 30 days	0.5 day/ha
Harvesting done by machine	$85/ha
Cost of labor	$10/day
Urea (46% N)	$39/50kg
Fertilizer transport	$3/50kg
Seed	$1/kg
Selling price of wheat (purchased by the people who do the harvesting)	$0.35/kg
Yield adjustment (seeding rate and fertilizer managed by researchers, lots harvested by hand)	15%
Minimum rate of return	80%