AN ECONOMIC ANALYSIS OF MUNGBEANS AS A CROP FOR SANDY SOILS OF CENTRAL OKLAHOMA

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AN ECONOMIC ANALYSIS OF MUNGBEANS AS A CROP

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CHAPTER I

INTRODUCTION

Problem Setting

The mungbean, a summer legume, may be grown for its forage, seed, or soil-building qualities. Mungbean forage and seeds are excellent livestock feeds, but the primary use of the seed is for producing bean sprouts used primarily in oriental foods. It is estimated that the United States uses about 11 million pounds of mungbeans annually for commercial sprouting. The bean supply for sprouting came from China and other Asiatic countries prior to World War II. Importation of mungbeans was stopped during World War II and there was a demand for sprouting beans produced in the United States. Mungbeans attracted wide attention and were grown in several states.

It was discovered that Oklahoma soils and climate were suitable for mungbean production. Oklahoma farmers were offered a guaranteed price to encourage production of mungbeans. Mungbean production was tried by farmers throughout Oklahoma on about every kind of soil during this introductory period. Wheat growers were especially interested in mungbeans as an added source of revenue and as a possible soil-improving crop for wheat land. After a trial period, mungbean production primarily settled on the sandy and medium textured wheat-producing soils of central Oklahoma.

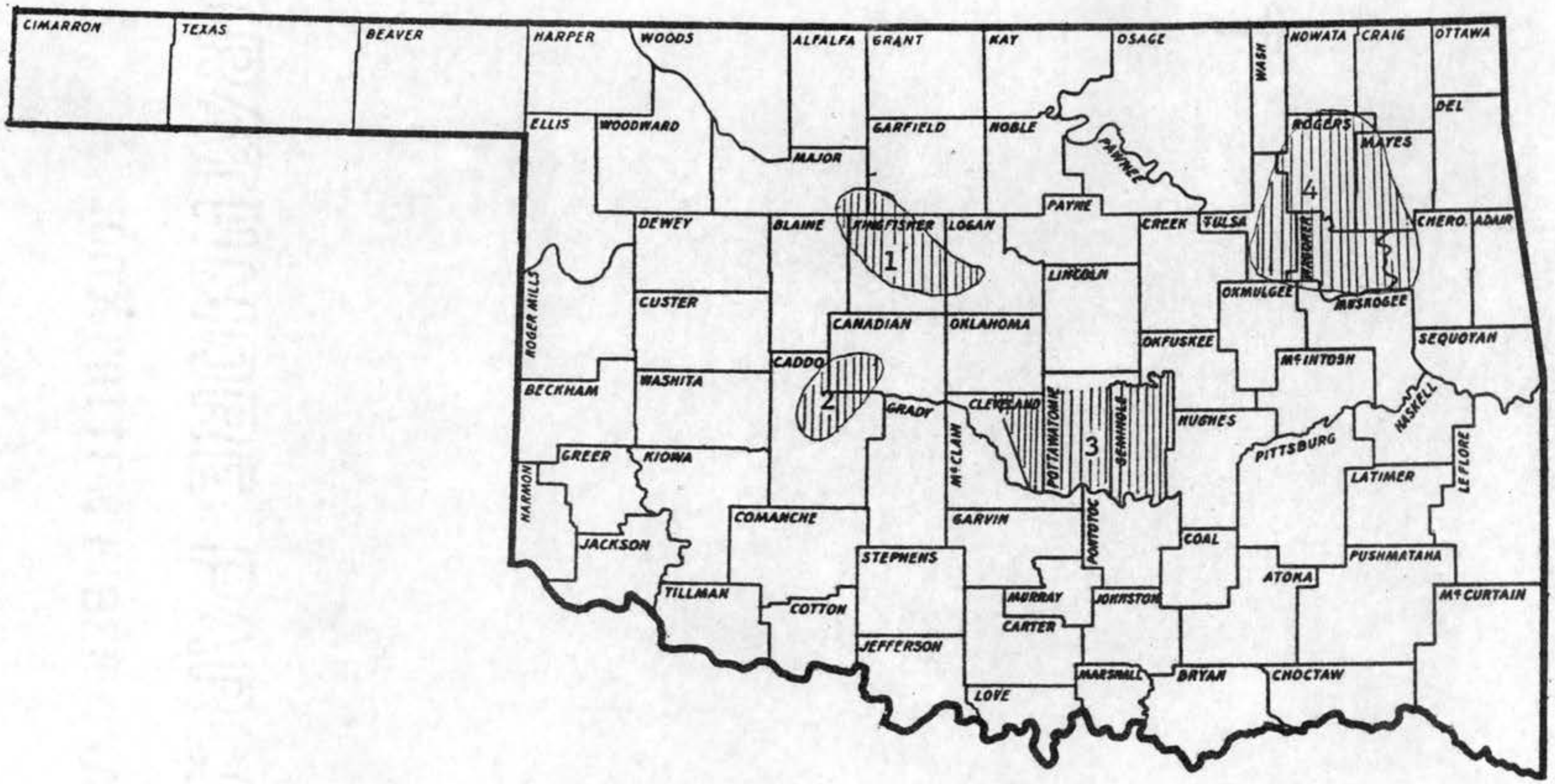

Figure 1. The Principal Mungbean Producing Areas of Oklahoma

The currently important mungbean growing areas in Oklahoma are shown in Figure 1. Production characteristics of mungbeans common to the four producing areas are as follows:

1. Mungbeans are grown mostly in a double cropping system with wheat production.
2. Acres planted and percentage of acres harvested fluctuate widely from year to year.
3. Mungbean production is generally confined to the sandy type soils except in Area 4 where they are grown on the eastern prairie wheat soils.
4. Areas 1, 2, and 3 are located in the 28 to 32-inch annual rainfall belt. The cluster of counties in Area 4 is near the 40-inch annual rainfall line.

It is estimated that Oklahoma mungbean growers produce 90 percent of the total mungbeans grown in the United States for bean sprouts. The acres, yield, production, price, and farm value of mungbeans in Oklahoma for the years 1943 through 1958 were estimated by Oklahoma Crop and Livestock Reporting Service (1) (Table I).

Previous Research

There has been no prior study of the economics of mungbeans as a crop enterprise for Oklahoma and objective data on resource requirements have not been compiled for estimating costs and returns for mungbean production in the state. Research pertaining to mungbean seed and forage yields and their feeding values for various classes of livestock has been conducted at the Oklahoma Agricultural Experiment Station and these results have

TABLE I

OKLAHOMA MUNGBEAN PRODUCTION, 1943-1958

Year	Acreage Planted	Acreage Harvested	Yield Per Harvested Acre	Production	Season Average Price	Farm Value
	Thousand Acres		Pounds	Thousand Pounds	Cents Per Pound	Thousand Dollars
1943	45	35	180	6,300	8.0	504
1944	75	55	200	11,000	14.5	1,595
1945	169	110	220	24,200[a]	10.0	2,420
1946	110	70	210	14,700	8.0	1,176
1947	62	40	250	10,000	8.0	800
1948	64	50	320	16,000	5.4	864
1949	31	22	400	8,800	4.0	352
1950	40	31	450	13,950	4.0	558
1951	30	16	250	4,000	6.0	240
1952	20	8	150	1,200	18.0	216
1953	28	20	325	6,500	8.5	552
1954	18	7	120	840	12.0	101
1955	38	25	280	7,000	7.0	490
1956	32	12	200	2,400	14.0	336
1957	28	20	380	7,600	6.5	494
1958	35	27	550	14,850	4.5	668
Average	51.6	34.2	273[b]	9,334	7.6[b]	710

[a]Slightly more than one-half estimated to be of sprouting quality.

[b]Average yield and price are weighted by acres and production.

Source: "Annual Mungbean Production Report", Oklahoma Crop and Livestock Reporting Service, Oklahoma City, Oklahoma.

been published (2 through 15). The feeding experiments also provided data that are useful in estimating a dollar value on mungbean forage and seed for livestock feed.

In summarizing experimental feeding trials with mungbean seed and forage, Morrison (16) reported the following results:

A. Forage of Mungbeans as a Feed.

1. In tests at the Oklahoma Station, mungbean hay proved satisfactory for dairy cows. It was of slightly lower value than good quality alfalfa hay.

2. In an Arkansas trial, chopped mungbean hay equaled alfalfa hay for dairy heifers.

3. In Oklahoma tests, mungbeans made satisfactory ensilage without preservative. About 285 pounds of mungbean ensilage equaled 100 pounds of good quality alfalfa hay for milk production with dairy cows. Three pounds of the more common types of ensilage are usually considered equivalent in feeding value to one pound of alfalfa hay.

B. Mungbean Seed as a Feed. Extensive trials with mungbean seed at Oklahoma State University showed their value to be as follows:

1. Dairy Cows.-When forming 30 percent of the concentrate mixture, 100 pounds of mungbeans satisfactorily replaced 50 pounds of corn and 50 pounds of cottonseed meal (41 percent protein).

2. Beef Fattening.-When mungbeans were substituted for cottonseed meal as the protein supplement for fattening calves, the gains were equal and 100 pounds of mungbeans were equal

in feeding value to 60 pounds of cottonseed meal plus 64 pounds of corn and 13 pounds of ensilage.

3. Lamb Fattening.-Mungbeans were digested about as well by lambs as common protein supplements when no more than 0.35 pound per head per day was fed.
4. Swine.-Ground mungbeans could replace cottonseed meal in the trio-supplemental mixture for swine.
5. Poultry.-Mungbeans were satisfactory when forming not more than 30 percent of the mash feed, provided the mash contained proper protein, mineral, and vitamin supplements.
6. Turkeys.-Mungbeans replaced two-thirds of the soybean meal and cottonseed meal in rations for turkey poults.

Heller (5) gave the percentage chemical composition of mungbean seed as 23.31 protein, 9.31 water, 59.85 nitrogen free extract, 1.02 fat, 3.64 fiber, and 2.87 percent ash.

Ligon (8) stated that feeding test results indicated that mungbeans could replace vegetable sources of protein, but were not substitutes for animal source proteins.

Current research at the Oklahoma Agricultural Experiment Station includes mungbean breeding and culture. In breeding work, research is designed to measure, evaluate and improve yield, plant type, seed quality for sprouts, non-lodging, non-shattering, and disease resistance. Cultural work includes row width, rate of seeding, time of planting, seed bed preparation, chemical weed control, defoliation, fertilizer, and double cropping with small grains.

Time and Area of Study

This study was based on data obtained from personal interviews with mungbean growers during the period September 25, 1956 through April 1, 1958, and on secondary data. The study was confined to Area 1 as shown in Figure 1. The area is located in north central Oklahoma principally within Logan and Kingfisher counties. It is the major mungbean producing area of the state. Mungbeans are grown mostly in a double cropping system with wheat on sandy soils. These soils are inherently low in fertility, have a very low moisture storage capacity, give up the stored moisture readily to growing crops, and have a rapid intake rate of moisture. Wind erosion is a major hazard on these soils which are predominately used for small grain production.

Objectives

The major purpose of this study was to evaluate the economic importance of mungbeans in the major mungbean producing area of Oklahoma. Farmers interested in maximizing profits are faced with the necessity of choosing among alternative enterprises for the use of available resources. If they are to make rational economic decisions they must have data relevant to physical input requirements of such resources as soil, labor, machinery, seed, fertilizer, insecticides, and other resources required for mungbean production. Physical output or yield data are also needed. Based upon expected prices and the input-output data, estimates of production costs and returns were determined for alternative uses of farm resources.

The specific objectives of this study were to:

1. Gain insight into the resource situations of the mungbean growers in the major mungbean production area of Oklahoma.
2. Determine the cultural practices of mungbean production in this area.
3. Gather data on resource requirements for mungbean production and yields for the major production area.
4. Assemble price data.
5. Estimate costs and returns and evaluate mungbean production as an alternative use of farm resources in this major mungbean production area of Oklahoma.

CHAPTER II

RESEARCH METHOD

The budget procedure was followed in the analysis of mungbeans as an alternative crop for the major mungbean producing area of the state.

Source of Data

Data used for this study were obtained from the following sources:

1. Survey of mungbean growers.
2. Oklahoma Crop and Livestock Reporting Service.
3. Agricultural researchers.
4. Mungbean seed processors and dealers.
5. Farm equipment dealers and other agribusinessmen serving mungbean growers.
6. Research data.

The Production Area

Information on Oklahoma mungbean production and the important bean producing areas of the state was obtained from the Oklahoma Crop and Livestock Reporting Service (1). This agency also supplied a list of the major mungbean seed buyers in Oklahoma. These buyers furnished data about mungbean production areas in Oklahoma which were very useful in determining the area to select for this study.

Farm Resources

The resource situation for mungbean growers was determined from a survey of mungbean producers in the area studied. This data revealed the amount of pasture and cropland owned and rented, and the total land operated; the acres and yield of each crop; the kind of machinery and equipment used; labor requirements; and other information pertaining to the mungbean producers' resource situation.

Cultural Practices

Cultural practices used in mungbean production and those integrated practices of wheat production were obtained by a survey of farmers. This data included row spacing, rate of seeding, fertilization, inoculation, insect control, cropping system, as well as all tillage operations from seed bed preparation to harvesting. Cultural practices for wheat and mungbeans were also gathered from qualified agricultural scientists.

Harvesting and Marketing Practices

Information on mungbean harvesting and marketing practices and problems came from the farm survey and mungbean seed buyers and handlers.

Input Data

Input data for labor, power, and machinery used in producing and marketing mungbeans and wheat were obtained from the farm surveys. Seeds, fertilizers, insecticides, and other material input data were determined by the farm survey and opinions of qualified agricultural scientists. Data on fuel and oil requirements for power and machinery were obtained from published research, machinery dealers, farmers, and agricultural engineers (17).

Output Data

Yield data for wheat and mungbeans were obtained from farmers, the Oklahoma Crop and Livestock Reporting Service (1), research data, and estimates of agricultural researchers.

Price Data

Price data were obtained from several sources. Prices for farm labor and custom machine work were based on information from the mungbean growers. Prices paid for planting seeds, fertilizers, and other materials were obtained directly from the farmers, and from farm supply agencies. Fuel and oil prices were based on data collected from wholesalers servicing the area studied. Estimated prices of new machinery were based upon information from farm implement dealers in the area, and published research data (17). Mungbean price data published by the Oklahoma Crop and Livestock Reporting Service (1) were used in predicting prices that Oklahoma mungbean growers might receive for sprouting beans. Wheat prices were taken from price projections by the United States Department of Agriculture (18).

The Farm Survey Method

It was felt that information from farmers who have grown mungbeans regularly would be better than that from farmers who have grown them only occasionally.

A list of consistent mungbean growers was obtained from each mungbean seed processor and dealer in Crescent, Dover, Hennessey, Guthrie, Kingfisher, and Ames. Separate lists of bean growers with their farm locations were procured from sixteen dealers. Most of the names appeared on three or more of the individual lists. From these lists a sample of 25 producers was stratified on the basis of location to insure distribution over the principal area. Twenty usable schedules were taken by personal interview.

Order of Analysis

Chapter III is devoted to an analysis of data gathered for this study. In this chapter references are directed toward data on mungbean and wheat production characteristics and resource inputs in relation to yields or outputs. Price and supply relationship of Oklahoma mungbean production are developed in Chapter IV. In Chapter V, partial budgets are presented and used to estimate costs and returns and to evaluate the economics of mungbean production as an alternative use of farm resources in this principal mungbean producing area. The summary and major conclusions of the study are given in Chapter VI.

CHAPTER III

DERIVATION, REVIEW AND ANALYSIS OF BUDGETING DATA

Land Resources

The land resources of mungbean growers were determined from the survey of mungbean growers (Table II). The 20 farms averaged 548 total acres per farm of which 430 acres were cropland. Of the 430 average acres of cropland for all farms, 241 acres were owned and 189 were rented. Pasture lands were grouped according to whether they were open or wooded and each farmer estimated the percentage of his wooded pasture land which was productive pasture. The average open pasture land for all farms was 64 acres, including 28.3 acres owned and 35.3 acres rented. The average wooded pasture land was nine acres owned and 25 acres rented or a total of 34 acres per farm for all farms. This wooded pasture land averaged 38 percent open. Thus, the 34 acres were equivalent to 13 acres of open pasture. Other land (roads, farmsteads and wasteland) averaged 20 acres per farm for all farms, including 12 acres owned and eight acres rented.

A typical farm based on data in Table II would consist of 430 acres of cropland, pasture land equivalent to 77 open acres, 20 acres other, and 21 acres of wooded land for a total of 548 acres.

Cropland Use

Present cropland organization for the 20 survey farms is given in Table III. All farmers interviewed usually grew mungbeans as a double

TABLE II

AVERAGE ACRES ALL FARMS, AVERAGE ACRES AND RANGE FOR FARMS REPORTING, AND PERCENTAGE OF FARMS REPORTING, BY LAND USES AND TENURE CLASSES: 20 FARMS IN THE PRINCIPAL MUNGBEAN PRODUCING AREA OF OKLAHOMA - 1957

Kind of Land	Average Acres, All Farms	Percentage of Farms Reporting	Acres for Farms Reporting	
			Average[a]	Range
Cropland				
Owned	241	95	253	110-1034
Rented	189	65	291	65-653
Total	430	100	430	110-1034
Pasture Land Open				
Owned	28.3	50	57	14-119
Rented	35.3	25	141	2-447
Total	64	55	116	16-482
Pasture Land Wooded				
Owned	9	45	20	3-44
Rented	25	25	100	2-265
Percent Open	38	--	38	0-90
Total Equivalent to 100 Percent Open Pasture	13	60	46	--
Other Land				
Owned	12	95	12.8	5-30
Rented	8	55	13.6	5-23
Total	20	100	20	6-35
All Land Operated				
Crop	430	100	430	110-1034
Pasture Equivalent to 100 Percent Open	77	85	90	3-482
Other	20	100	20	6-35
Wooded Land Equivalent to 100 Percent Wooded	21	--	--	--
Total	548	100	547	160-1280

[a]The total average acres for farms reporting for each kind of land is not a total of the components because of differences in farms reporting.

TABLE III

AVERAGE ACRES GROWN AS SINGLE CROP AND AS DOUBLE CROP FOR ALL FARMS, PERCENTAGE OF FARMS REPORTING, AND AVERAGE ACRES AND YIELD FOR FARMS REPORTING, BY CROPLAND USE AND CROPPING SYSTEM; 20 FARMS IN THE PRINCIPAL MUNGBEAN PRODUCING AREA, 1957

Crop	Average Acres All Farms		Acres and Yield for Farms Reporting					
			Single Crop			Double Crop		
	Single Crop	Double Crop	Percentage of Farms Reporting	Average Acres Per Farm	Average Yield[a]	Percentage of Farms Reporting	Average Acres Per Farm	Average Yield
Mungbeans	95	3,330	10	47.5	364 lbs.	100	166.5	364 lbs.
Wheat	4,763	0	100	238	14.8 bu.	0		
Oats	287	0	40	36	25 bu.	0		
Barley	207	0	20	41.6	21.4 bu.	0		
Rye	372	0	20	93	12 bu.	0		
Rye and Vetch	1,610	40	55	146	10 bu. rye and 103 lb. vetch	5	40	pasture
Sweet Sorghum	255	100	35	36	5 ton ensilage or 1.4 tons hay	5	100	.8 tons hay
Grain Sorghum	135	20	25	27	19.7 bu.	5	20	20 bu.
Sudan	112	422	15	37	.6 tons hay pasture	35	60	pasture
Millet	70	0	10	35	1.6 tons hay	0		
Cotton	120	0	20	30	233 lbs. lint	0		
Peanuts	23	0	5	23	400 lbs.	0		
Cowpeas	0	208	0	0		20	52	329 lbs.
Watermelons	61	0	25	12	7,000 lbs.			
Watermelons for Seed	200	0	5	200	110 lbs.			
Alfalfa	87	0	15	29	2 tons			

[a]Average yields were weighted by acres and production.

crop, and averaged 166.5 acres of double crop mungbeans per farm. The 3,330 acres of double crop mungbeans for all farms yielded an average of 364 pounds of beans per acre. Only two farmers normally grew mungbeans as a single crop.

Wheat was the principal crop on the 20 farms. All farmers grew wheat and averaged 238 acres per farm. The total of 4,763 acres of wheat for all farms was the largest of any crop grown and comprised 55 percent of the total cropland. The 4,763 acres of wheat averaged 14.8 bushels per acre yield.

The 1,610 total acres of rye and vetch grown as a mixture was second to wheat in total single crop acres for all farms. Fifty-five percent of the farmers grew rye and vetch. Rye and vetch averaged 146 acres per farm for the farmers growing the crop. Seed was harvested from 52 percent of the rye and vetch acreage, with average yields per harvested acre of 10 bushels of rye and 103 pounds of vetch.

Rye, oats, and barley followed in that order in total acres grown as single crops by the farmers surveyed. Oats and barley were normally harvested for grain as were all acres of wheat. Fifty-two percent of the rye was normally harvested for grain. Oats, barley and rye were not typical as individual crops. For the purpose of this study, oats, barley, rye and rye with vetch were grouped as other small grains. One or more of these were grown by all farmers. They grew a total of 2,476 acres and averaged 124 acres per farm. Twenty-nine percent of the total cropland was devoted to this category of other small grain production.

The total acreage for any crop grown as a single crop other than wheat and small grains was low. A total of 255 acres of sweet sorghum was grown on 35 percent of the farms. About one-fourth of the sweet sorghum was harvested for ensilage and the rest was harvested for hay. Sudan was used for both pasture and hay. One-half of the sudan acreage was used solely for pasture. One cutting of hay was taken from one-half of the sudan before it was pastured.

Mungbeans was the only crop typically grown as a double crop on the survey farms. Thirty-five percent of the farmers grew sudan as a double crop. They grew only a total of 422 acres. It was interesting that only 20 percent of the farmers normally grew a total of 208 acres of cowpeas as a double crop, since cowpeas are almost a perfect substitute for mungbeans as far as production requirements and soil protecting qualities are concerned. The 4,090 total acres of all crops grown as double crops amounted to 48 percent of the total cropland for all farms. This double cropping of almost one-half of the total cropland was feasible because of the soil moisture relationship of these sandy soils.

The typical farm with 430 acres of cropland would have 238 acres of wheat followed with 166.5 acres of double crop mungbeans, 124 acres of other small grains, 58 acres of other crops, and about 10 acres of cropland not specified. Fifty-five percent of the total cropland would be used for wheat which is comparable to wheat allotments and 29 percent would be used for other small grain production. Small grain production would utilize 84 percent of the total cropland of the farms surveyed. Double crop mungbeans would be grown on 70 percent of the wheat acreage each year or on 38 percent of the total cropland. This latter percentage could be more typical if there were not wheat allotments. Without exception, all mungbeans grown as a double crop followed wheat.

Mungbean Production Experience of Farmers

The ten-year period 1947 through 1956 was used to measure the mungbean growing experience and the production constancy of the farmers surveyed. This period was further removed from war year production influences and most farmers had had a few years of experience in mungbean production prior to this period on which to base their actions during this 10 years. The farmers interviewed averaged growing mungbeans 9.4 years of the 10-year period. The range in the number of crops of mungbeans grown in the period was from six to 10.[1] Seventy-five percent of the farmers grew beans in each of the 10 years. Ten percent grew mungbeans nine years, and the other 15 percent were evenly divided between those growing eight, seven and six crops in the 10-year period. These farmers were even more constant in growing mungbeans in the last part of the 10 years. They averaged growing mungbeans 98 percent of the time for the last six years of the period and 94 percent of the time for the entire 10-year period.

Most of the mungbean experience of these farmers during this period was with double crop mungbean production following wheat. They averaged 9.1 years and ranged from six to 10 years of double crop mungbean production in the ten years. Single crop bean production ranged from zero to five crops and averaged 2.25 crops in the ten years. Two farmers grew single crop beans in five of the ten years.

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[1]Crops of mungbeans are synonymous with years and the two are used interchangeably.

Factors That Influenced Acreage of Mungbeans Planted

All farmers interviewed reported that insufficient moisture for seed bed preparation would be the major factor that would keep them from planting some double crop mungbeans each year. Indications were that they would be willing to gamble on a favorable mungbean price on some acreage each year. In reporting the factors that influence the number of acres of double crop mungbeans to plant each year, the farmers gave moisture after wheat harvest, price outlook, wheat yields, other crop failures, and soil bank possibilities in order of importance. Ninety percent gave moisture as the most important, five percent gave mungbean price outlook as most important, and five percent of the farmers said that the land retirement with the Soil Bank program might be the most important thing in future years in determining acres of double crop mungbeans planted. Over one-third of the farmers surveyed named the mungbean price outlook as the second most important determinant of double crop mungbean acreage.

Mungbean Production Constancy of Survey Farmers

The average acreage of mungbeans grown by the 20 farmers interviewed amounted to 18 percent of the 1949-1958 state average total harvested acres. These mungbean growers reported that they normally harvested over 90 percent of their planted acres of mungbeans. The average percentage of planted acres of mungbeans harvested for the state was about 65 percent during this period. All survey farmers reported that 1956 was the poorest mungbean production year that they had experienced, yet they planted their normal acreage in 1956. Survey farmers harvested 56 percent of their planted acres in 1956 compared with 38 percent of planted acres reported harvested for the state. The 38 percent was the lowest percentage of planted acres harvested for any year for Oklahoma. Two farmers reported a complete crop failure on all of their 1956 mungbean acreage and most of them reported 1956 as the only year with a crop failure on any portion of their double crop mungbean acreage.

Mungbean Yield Experience of Farmers Surveyed

Farmers were asked to give the highest and lowest average mungbean yields experienced in any one year. The yields (Table IV) were based on the total acres grown by the individual for the particular year. Mungbean data for 1956 were obtained for acres planted, acres harvested, and seed yields per harvested acre. Since all survey farmers experienced their lowest yield of mungbean seed in 1956 the harvested acreage data for that year were used to compute the lowest seed yield per planted acre. Standard deviations for mungbean hay yields were not computed. The hay yields represented hay salvaged after the bean seeds were harvested.

Mungbean Hay

Farmers differed as to whether hay should be saved after mungbean seed was harvested. Some thought the mungbean residue had a higher value when returned to the soil. Others thought it had more value as hay. Sixty-five percent of the farmers surveyed saved hay from part of their acreage about half of the time, or, they averaged saving hay from about 38 percent of their mungbean acreage. The total acreage saved annually for hay by all farmers averaged 935 acres or 28 percent of the 3,330 total double crop mungbean acreage grown by all farmers. Thus, saving hay after bean harvest was not considered to be a typical practice in this study.

TABLE IV

MUNGBEAN SEED AND HAY YIELD DATA - 20 FARMERS IN THE PRINCIPAL MUNGBEAN PRODUCTION AREA OF OKLAHOMA, 1957

Double Crop Yields				
	Pounds Per Acre			
Seed	Range	Median	Mean[a]	Standard Deviation
Highest Yield	400-1100	650	697	209
Average Yield	300- 500	350	372	69
Lowest Yield Per Planted Acre	0- 250	65	84	74
Lowest Yield Per Harvested Acre	0- 290	100	130	73
Hay				
Highest Yield	666-3200	1000	1400	
Average Yield	400-2000	666	896	
Lowest Yield	200-1000	660	564	

[a]The mean is the simple average.

Rank of Crops

Each farmer was asked to rank the crops that he grew in order of profit per acre. Seventy percent of the farmers gave wheat as their most profitable crop (Table V), but indicated that they considered mungbeans almost equal to wheat. Twenty percent of the farmers considered wheat second in order of profit, and 10 percent of them listed it as the third most profitable crop per acre. Fifteen percent of the farmers considered single crop mungbeans as their most profitable crop and 65 percent ranked mungbeans second. Ten percent ranked them third and 10 percent placed mungbeans fourth in order of profit per acre. Most of the farmers ranked wheat first and mungbeans second in profit per acre. Farmers had experienced a $1.95 per bushel ten year average June price for wheat at the time they gave the ranking of crops. No other crop was close to the ranking of wheat or mungbeans in profit per acre (Table V).

TABLE V

FARMERS' RANKING OF CROPS ACCORDING TO PROFIT PER ACRE, TWENTY SURVEY FARMERS, 1957

Crop	Rank According to Profit Per Acre			
	1st	2nd	3rd	4th
		Percent		
Wheat	70	20	10	0
Mungbeans	15	65	10	10
Cotton	0	10	10	0
Watermelons	5	5	5	0
Alfalfa	5	0	5	0
Sweet Potatoes	5	0	0	0
Grain Sorghum	0	0	15	10
Vetch and Rye	0	0	10	15
Cowpeas	0	0	5	5
Sudan	0	0	5	0

Farmers' Anticipated Changes in Acreage of Double Crop Mungbean Production

Thirty percent of the farmers indicated that they would grow a greater acreage of double cropped mungbeans in the future (Table VI). These farmers anticipated that they would plant 1,440 acres in future years. This would be 415 more acres or an increase of 40 percent over the present 1,025 acres. Fifteen percent of the farmers indicated that they would decrease their double cropped mungbean acreage by 23 percent, or to 730 acres. Fifty percent planned no change in their mungbean acreage and five percent were undecided on mungbean acreage for the future. If anticipations are realized, the double cropped mungbean acreage will be increased by 200 acres or by six percent. The average double crop mungbean acreage per farm was considerably larger for farmers planning to decrease acreage than for farmers planning to increase mungbeans. However, there was no definite pattern of mungbean acreage per farm being associated with intended change in acreage. The data does indicate intended stability of double crop mungbean production in the future for the survey farms.

TABLE VI

FARMERS' ANTICIPATED CHANGES IN ACRES OF MUNGBEANS GROWN AS A DOUBLE CROP IN FUTURE YEARS, TWENTY SURVEY FARMS, 1957

	Indicating An Increase in Acres	Indicating A Decrease in Acres	Indicating No Change in Acres	Undecided	Total
Percent of farmers	30	15	50	5	100
Present Acres	1,025	945	1,215	145	3,330
Anticipated Acres	1,440	730	1,215	145	3,530
Change in Acres	+ 415	-215	0		+ 200
Percent Change in Acres	+ 40	- 23	0		+ 6

Mungbean Production Characteristics and Problems

Soils Suitable for Double Crop Mungbean Production

Farmers interviewed considered sandy loam soil best for double crop mungbean production. However, some of them emphasized that sandy soil could be too low in fertility or too shallow for good mungbean production. These farmers all preferred a sandy loam top soil and a depth of 18 to 24 inches to a red sandy clay subsoil for mungbean production. Not all survey farmers had the preferred soil. Their top soils ranged from fine loamy sands to fine sandy loams with variable depths of six to 12 inches. Their subsoils ranged from fine sand to sandy clay loam. Those soils with sandy clay loam subsoil varied from eight to 20 inches in depth to the sandy clay.

Crop Rotation

No farmer in the survey sample reported a definite crop rotation for his farm, but all farmers reported a common crop sequence of wheat followed by double crop mungbeans. This sequence of mungbeans following wheat and wheat following mungbeans was repeated several years on the same land by some farmers. Thirty-five percent of the farms normally grew double crop mungbeans or cowpeas on all of their wheat acres. On 65 percent of the farms the acreage of wheat exceeded the mungbean acreage, and double crop mungbeans were planted on the wheat land where wind erosion was more of a problem in establishing a stand of wheat. If the wind erosion hazards were about the same on all wheat land, mungbeans were usually shifted each year so that no wheat land would go more than one year without a crop of mungbeans. The acreage of mungbeans or mungbeans and cowpeas was less than one-half of the wheat acreage on only two farms. The farmers growing vetch reported that wheat following vetch yielded more wheat, but volunteer vetch in the wheat was a problem. Most of the vetch growers normally planted wheat on vetch land after two or three vetch crops. Researchers suggest that volunteer vetch can be controlled in wheat by a light spraying with 2-4-D herbicide, but this has not been practiced in this area.

Mungbean Varieties

Sixty percent of the survey farmers grew the Oklahoma No. 12 variety of mungbeans and forty percent of them grew the Jumbo variety. The Jumbo variety was popular west of U. S. Highway 81 and the Oklahoma No. 12 was popular east of Highway 81. Research result s have shown that the Oklahoma No. 12 variety was higher in seed yields and faster in maturity than the Jumbo. The Jumbo mungbean yielded more forage compared with the Oklahoma

No. 12, but was 10 to 14 days later in maturity. Some of the markets paid a higher price for the larger seeded Jumbo bean than for the smaller seeded Oklahoma No. 12. A new mungbean variety Kilooga (19) which has been released has a medium sized seed and has a seed yield equal to Oklahoma No. 12.

Row Spacing

Row spacing of mungbeans ranged from seven to 42 inches among farmers surveyed. About 70 percent of the beans were grown in rows spaced eight inches apart. One farmer planted all of his beans in 40-inch rows. Many of the farmers had used various row widths in trying to determine optimum spacing. The general opinion was that wider row spacings resulted in higher mungbean yields in dry summers, but failed to provide as much protection against wind erosion for the wheat following the mungbeans. They preferred eight or 16-inch rows for summers with normal or above normal moisture. The farmers expressed a need for research to determine the best width of row spacing for mungbeans on sandy soils.

Insects and Diseases

Eighty percent of the survey farmers reported no mungbean disease or insect problems had been experienced. Twenty percent of the farmers reported some nematode and root rot problems. Plant pathologists suggested that root-knot nematodes can become a serious problem with cowpea and mungbean production once the soil becomes infested. They also suggested that these nematodes are not as serious on wheat and other small grain or grasses and that the damage to mungbeans usually can be greatly reduced by growing two or three crops of small grains if nematode host plants are not grown on the soil for this period.

Fertilizers

Only one of the sample farmers used commercial fertilizer regularly on his mungbeans. He used from 50 to 100 pounds of 10-20-10 fertilizer per acre in accordance with the sandiness of the soil. He felt that sandier soils responded to higher rates of fertilization for mungbean production. Twenty-five percent of the farmers had used commercial fertilizer on only one mungbean crop. Most of the farmers used fertilizers on wheat in their wheat-mungbean double cropping system. Soil scientists suggested that about 100 pounds of a 13-39-0 or an equivalent rate of 16-48-0 fertilizer be applied on wheat at seeding time and that no fertilizer be applied on the summer bean crop.

Inoculant

Only 45 percent of the growers inoculated mungbeans. Researchers thought it rather important to inoculate all mungbean seed before planting so the plants could function properly in their nitrogen fixing role.

Advantages and Disadvantages of Double Crop Mungbeans

Farmers surveyed indicated advantages and disadvantages of growing double crop mungbeans following wheat. Five percent of the farmers reported that continuous double crop mungbeans after wheat tended to loosen the sandy soil and made it more difficult to till and handle. Five percent of the growers indicated that mungbeans after wheat helped spread Johnson grass or interfered with its control. Farmers reported some reduction in pasture from wheat following mungbeans, but they were unable to give an approximate average wheat pasture yield or an approximate percentage reduction of pasture yields for wheat following mungbeans. Farmers reported wheat pasture from single crop wheat was quite variable due to wind erosion hazards in establishing the wheat and variability of fall rainfalls. They seeded single crop wheat about two weeks earlier than the wheat following mungbeans which resulted in more fall pasture if a stand of wheat was secured.

The farmers held varied opinions as to the effect of double crop mungbeans on yields of wheat grain following the mungbeans. Twenty percent of the farmers expected a two-bushel per acre decrease for wheat following mungbeans compared with a good stand of wheat following wheat, but they expected poor stands of wheat without the mungbeans to result in about equal yields for wheat following wheat and wheat following mungbeans. Ten percent of the farmers expected a two bushel per acre reduction in wheat yields following mungbeans in extra dry years. They expected about three extra dry years out of a ten-year period. These farmers expected about equal yields of wheat following mungbeans and wheat following wheat over a period of years as a result of better stands of wheat following mungbeans. Seventy percent of the survey farmers expected no decrease in yields of wheat following mungbeans, even for the dry years when a good stand of wheat following wheat was obtained. These farmers expected a better stand of wheat following mungbeans to result in higher longtime wheat yields than single crop wheat. All farmers reported mungbeans as a soil stabilizer against wind erosion and almost a necessary aid in establishing a stand of wheat on the sandier soils.

Sixty-five percent of the survey farmers were not growing double crop mungbeans on all of their wheat acres for one or more of the following reasons:

1. Some of their wheat land was not so sandy that it needed the stabilizing effects of the mungbeans.
2. They could handle a portion of their sandy soil without mungbeans by seeding wheat just after a rain.
3. They were willing to gamble on establishing a stand of wheat on some of their sandy soil without a summer crop of mungbeans.
4. They were not always able to get all of their wheat land seeded to mungbeans because of a shortage of moisture after wheat harvest.

Harvesting and Marketing Problems

The survey farmers listed bean shattering as the principal harvesting problem. The beans pop out of the hulls when overripe. This shattering problem results in a very short harvesting period if preharvest and harvest losses are to be avoided. This problem is especially serious following rains after the beans are mature and ready for harvesting.

Price instability was the principal marketing problem listed by the mungbean growers.

Labor and Machinery Requirements

The following information was secured from each farmer interviewed:

1. A list of jobs or operations performed in growing wheat and mungbeans.
2. Time when the operation was performed.
3. The size of machinery and equipment used in doing each operation.
4. The size of crew or number of men used in doing each job.
5. Times over or the number of times that each operation was performed.

All growers interviewed plowed their mungbean ground with a moldboard plow each year (Table VII). The size of moldboard plows ranged from 2x14" to 4x14". Fifty-one percent of the mungbean ground was plowed with the 3x14" size moldboard plow. The three 14 inch bottom moldboard was specified as the typical plow size. The typical size power unit was a three plow tractor. Thirteen percent of the single crop wheat land was plowed with a one-way plow and 87 percent was plowed with a moldboard plow. The 3x14" plow was also typical for plowing single crop wheat land. For wheat land following mungbeans, the moldboard plow was not used by any of the mungbean growers because it destroyed the soil stabilizing effect of the mungbeans. Twenty-five percent of the wheat acreage following mungbeans was plowed shallow with a one-way 50 percent of the time. Fifty-eight percent of the acreage of wheat following mungbeans was disked shallow 79 percent of the time. Therefore, seed bed operations for wheat following mungbeans would be equivalent to a one time over operation on 12 percent of the land with a one-way, and 45 percent of the land with a disk. Since 58 percent of the land was covered by a tillage operation, the eight foot tandem disk was specified as the typical operation before planting wheat following mungbeans. The survey farmers reported mungbean stubble on the sandy soils as an ideal seed bed for wheat if grass and weeds in the stubble did not require the disk operation.

Table VII shows all operations performed by the survey farmers, but shows only the most common size of equipment used for each operation other than moldboard plowing and trucking. Spring toothing was the typical operation after moldboarding for mungbeans and single crop wheat.

Eight percent of the mungbean acreage was planted with row planters, and seven percent was planted with especially rigged planters that planted

TABLE VII

MACHINERY USED FOR MUNGBEAN AND WHEAT PRODUCTION, TWENTY SURVEY FARMS, KINGFISHER AND LOGAN COUNTIES, OKLAHOMA, 1957, WITH TYPICAL OPERATIONS SPECIFIED

Operation	Size of Equipment	Portion of Total Acres of Crop Covered and Typical Operations Specified					
		Mungbeans		Wheat Single Crop		Wheat Following Mungbeans	
		Percent Covered	Typical Operations	Percent Covered	Typical Operations	Percent Covered	Typical Operations
Plow Moldboard	4x14"	31		27			
Plow Moldboard	3x16"	9		8			
Plow Moldboard	3x14"	51	Typical	44	Typical		
Plow Moldboard	2x16" and 2x14"	9		8			
One-way	7'			13		25	
Springtooth	12'	79	Typical	98	Typical		
Disc Tandem	8'	16		2		58	Typical
Harrow Spike	3-section	5					
Plant as Moldboard		7					
Plant	2-row	8					
Plant, drill	16x8"	85	Typical	100	Typical	100	Typical
Cultivator, row	2-row	12					
Cultivator, rotary hoe	12'	22					
Combine, push type	12'	59	Typical		Typical		Typical
Combine, pull type	7'	26					
Combine, custom hire	12'	15					
Trucking Grain	1 1/2 to 2 ton	60	Typical		Typical		Typical
Trucking Grain	1/2 to 1 ton	40					

and plowed in one operation. Eighty-five percent of the mungbean ground was planted with a grain drill. Therefore, planting with a 16x8" grain drill was the typical planting operation for mungbeans, single crop wheat, and wheat following mungbeans.

Twelve percent of the mungbean acreage was cultivated with row cultivators and 22 percent was cultivated with rotary hoes one or more times. Thus, 34 percent of the mungbean acreage was cultivated an average of 1.3 times. Cultivation was not considered a typical operation for mungbean production since total mungbean cultivation was equivalent to a one time over on only 44 percent of the mungbean acreage.

Only 15 percent of the mungbean acreage was combined by custom operators. The 12 foot self-propelled type combine was the typical harvesting machine for mungbeans and was so specified for wheat for comparative purposes. All farmers surveyed reported that they hauled the mungbeans from the combine to the market receiving point. However, part of their wheat was hauled by custom trucks because the volume of wheat grain per hour of combining exceeded the capacity of the farm truck. For comparative purposes, the one and one half ton truck was specified as the typical grain hauling equipment for mungbeans and wheat.

The combined operations for growing mungbeans and wheat following mungbeans differ from the operations for growing single crop wheat just about by the planting and harvesting of the beans (Table VIII). The moldboard plowing for mungbeans sufficed for the wheat following mungbeans. The 1.6 springtoothings for mungbeans and the one disking for wheat after mungbeans was equal in times over to the 2.6 springtooth operations for single crop wheat.

TABLE VIII

SPECIFIED TYPICAL OPERATIONS, TIME PERFORMED, AND TIMES OVER FOR WHEAT AND MUNGBEAN PRODUCTION IN LOGAN AND KINGFISHER COUNTIES, TWENTY SURVEY FARMS, 1957

		Mungbeans		Wheat Single Crop		Wheat Following Mungbeans	
Operation	Size of Equipment	Time Performed	Times Over	Time Performed	Times Over	Time Performed	Times Over
Plow Moldboard	3x14"	June 10-25	1	June 10-25	1		
Springtooth	12'	June 10-25	1.6	July to September	2.6		
Disc Tandem	8'					September	1
Plant, Drill	16x8"	June 25 to July 10	1	Sept. 10-20	1	September 20 to October 10	to 1
Combine	12'	Sept. 1-15	1	June 5-20	1	June 5-20	1
Trucking Grain	1 1/2 ton	Sept. 1-15	1	June 5-20	1	June 5-20	1

The timing of operations for double crop mungbeans and wheat differs some from the timing of operations for single crop wheat. The springtooth operations for mungbeans were done immediately following the moldboard plowing for the purpose of firming the seed bed for planting mungbeans. The springtooth operations for single crop wheat were performed over a three month period in order to control weeds and wind erosion and prepare the seed bed for wheat. The timing of the disking operation for wheat following mungbeans was about the same as the final springtoothing for single crop wheat. The planting of wheat following mungbeans was about ten days later than for single crop wheat.

The per acre labor and machine time for each operation in wheat and mungbean production was calculated from the appropriate machine and crew size associated with the times over, and acres covered in ten hours (Appendix Tables I, II, and III). The machine hours per acre for a one time over operation was calculated from the acres covered in 10 hours for each operation. Except for grain hauling, man hours were assumed to be 120 percent of machine operating time to allow for time spent for greasing and servicing machinery, for break downs, and for to and from field time. The preharvest time per planted acre was adjusted to 111 percent for harvested acre time to compensate for abandoned acres.

The typical operations for producing single crop mungbeans or wheat were the same. However, the total per acre time required for mungbeans as estimated (Appendix Table I) was less for man hours and machine hours than for single crop wheat (Appendix Table II). The springtooth operation averaged 1.6 times for mungbeans and 2.6 times for wheat. This extra time over with the springtooth for wheat resulted in a higher total preharvest labor and machine time for single crop wheat than for mungbeans. This extra springtooth operation was necessary for wheat in order to control weeds and prevent wind erosion because of the length of time between moldboard plowing and planting. Mungbeans were planted immediately after the springtooth operation. The per acre machine time for combining mungbeans was greater than for combining wheat, but the per acre machine time for trucking mungbeans was less than for the wheat. The total per acre machine time for combining and seed hauling was the same for mungbeans and single crop wheat, but the labor requirement per acre for combining and grain hauling was more for single crop wheat than for mungbeans. The total per acre machine hours and man hours were greater for producing single crop wheat than for producing mungbeans.

The total harvesting operations were the same for wheat following mungbeans and single crop wheat, but the per acre preharvest labor and machinery requirements were considerably less for wheat following mungbeans. The total per acre preharvest machine time of .70 hours for wheat following mungbeans (Appendix Table III) was only 42 percent of the total per acre preharvest machine time of 1.68 hours for single crop wheat (Appendix Table II). The .84 man hours per acre preharvest total time (Appendix Table III) was also 42 percent of the 2.01 man hours per acre total preharvest time for single crop wheat (Appendix Table II). The 58 percent less per acre total preharvest labor and machinery requirement for wheat following mungbeans compared with single crop wheat represented the extent that the seed bed operations for mungbeans sufficed for the seed bed operations for wheat following mungbeans.

The combined per acre requirements of Appendix Tables I and III would show the estimated per acre labor and machinery requirements for double crop mungbeans and wheat to be only 1.01 man hours and .77 machine hours more than for single crop wheat. Of this extra labor and machine time for the double crop wheat and mungbeans, .83 of the 1.01 man hours and .63 of the .77 machine hours were for planting, combining and trucking the mungbeans.

Other Inputs

Table IX gives the non-labor, power and machinery per acre inputs as assumed for this study. The amount of mungbean seed used per acre by the survey farmers varied with the width of row spacing. The twenty pounds assumed for this study was based on eight inch row spacings. The use of mungbean inoculant was not a typical practice for the survey farmers, but its use was recommended by agronomists. The kind and amount of fertilizer assumed were about what the survey farmers were using, but some below the amount recommended by soil scientists. The 65 pounds of 16-48-0 and 80 pounds of 13-39-0 supply the same amount of plant nutrients per acre. The 16-48-0 was used in budgeting for this study. The 16-48-0 had a lower per acre cost advantage of $.26 and a 15 pound per acre weight handling advantage under the 13-39-0 fertilizer.

TABLE IX

SEEDS, FERTILIZER, AND MATERIALS FOR WHEAT AND MUNGBEAN PRODUCTION WITH PER ACRE QUANTITIES ASSUMED FOR THIS STUDY, TWENTY SURVEY FARMS, 1957

Item	Unit	Quantity Per Acre		
		Mung-beans	Wheat Single Crop	Wheat Following Mungbeans
Mungbean Seed	Pounds	20		
Inoculant	Package for 100 lbs. Mungbean Seed	.2		
Wheat Seed	Bushels		1	1
Fertilizer 16-48-0	Cwt.		65	65
Fertilizer 13-39-0	Cwt.		80	80

Output Data

The normal per acre wheat yield reported by the sample survey farmers ranged from 12 to 20 bushels. The median yield was 15 bushels as was the modal. The sample average yield was 14.75 bushels, and the weighted average yield was 14.8 bushels. The weighted average yield was used in budgeting for this study. Wheat yields for wheat following mungbeans were assumed to be the same as for wheat yields following wheat.

Since the farmers surveyed were unable to give an approximate average wheat pasture yield for single crop wheat or an approximate percentage reduction of wheat pasture yield for wheat following mungbeans, wheat pasture was not used in the cost and return budgets. Lagrone, Strickland,

and Plaxico (20) estimated wheat pasture yields of .4 animal unit months per acre for sandy soils in southwestern Oklahoma. Based on a .4 A.U.M. per acre and a rental value of $5.00 per A.U.M., wheat pasture would have a $2.00 per acre value. Using $2.00 as the per acre value for wheat pasture for single crop wheat and assuming a 30 percent reduction in pasture for wheat following mungbeans the wheat following mungbeans would have a wheat pasture value of $1.40 per acre. The 60 cents per acre difference in value of wheat pasture for single crop wheat and wheat following mungbeans could be a realistic assumption and should be kept in mind when examining the budget tables which show no return for wheat pasture.

The normal per acre mungbean yield of the survey farms ranged from 300 to 500 pounds, with a median yield of 375 pounds and a modal yield of 300 pounds. The simple average yield was 372 pounds and the weighted average yield was 364 pounds of beans per acre. The weighted average yield was assumed the yield for budgeting in this study.

Mungbean hay was not included in the cost and return budgets since hay was saved from only 28 percent of the harvested mungbean acres.

Price Data

The United States Department of Agriculture's (18) index of prices paid by farmers for production items was 249 for 1956 and 248 for the long time projected index. Therefore, the 1956 prevailing prices of the area were used as the assumed prices paid by farmers for this study (Table X). The 1956 prices paid were based on data obtained from the farmers surveyed and from supply agencies selling directly to farmers in the area.

The assumed price that farmers would receive for wheat was the United States Department of Agriculture's (18) long term projected price for wheat in Oklahoma.

The 1946-57 twelve year weighted average price received for mungbeans by Oklahoma farmers was used as the assumed price for the study. This price was based on the seasonal average prices by years as reported by the Oklahoma Crop and Livestock Reporting Service (Table I). The 1943-1958 weighted average price of mungbeans was 7.6 cents per pound, but it was assumed that a price based on the 1946-57 data would be the projected price to use for this study.

Table X

ASSUMED PRICES FOR THE STUDY

Item	Unit	Price
Prices Paid by Farmers[a]		
Gasoline for truck	gallon	$ .26
Gasoline for tractor	gallon	.185
Lubricant	pound	.20
Motor oil	quart	.25
Oil filter for truck	cartridge	1.90
Oil fiter for tractor	cartridge	1.20
Labor	hour	1.00
Fertilizer 16-48-0	hundred pounds	5.75
Fertilizer 13-39-0	hundred pounds	5.00
Seed wheat	bushel	2.15
Seed mungbeans	pound	.12
Inoculant for mungbeans	pkg. for 100# seed	.55
Prices Received by Farmers		
Wheat[b]	bushel	1.60
Mungbeans[c]	pound	.066
Wheat pasture	animal unit month	5.00

Source of data:

[a]Twenty farmers surveyed and farm supply agencies, 1957.

[b](18).

[c](1).

CHAPTER IV

STATISTICAL ANALYSIS OF MUNGBEAN SUPPLY AND DEMAND DATA

The relationship between the value of three specified dependent variables (Y_i) and unit changes in various selected independent variables (X_i) were expressed through regression analyses. The major objectives of the analyses were: (1) to establish if there was a relationship and to obtain a measure of the relationship, and (2) to provide a basis for making predictions of the dependent variables from the related independent variables.

The three dependent variables considered were, (1) planted acres of mungbeans, (2) yield of mungbeans per harvested acre, and (3) price of mungbeans. Ten factors or independent variables thought to have a relationship with one of the dependent variables were selected and a correlation analysis was made of this time series data in order to measure the interdependency of the factors. Except for the time variables, the raw data and the log of the raw data for each variable were included in the correlation analysis (Table XI). These correlation results will be commented on under description of data in later analyses in this chapter.

The specific data used in the correlation and regression analyses are presented in Appendix Table XI.

Supply

Supply may be thought of as a fixed stock or as a flow concept usually expressed as a willingness of suppliers to sell for a given price

TABLE XI

SIMPLE CORRELATIONS BETWEEN SELECTED FACTORS, MUNGBEAN DATA, 1943-1948

	Variables																						
	X_1	X_1'	X_2	X_2'	X_3	X_3'	X_4	X_4'	X_5	X_5'	X_6	X_6'	X_7	X_8	X_8'	X_9	X_9'	X_{10}	X_{10}'	Y_1	Y_1'	Y_2	Y_2'
	Correlation Coefficients																						
X_1	1.	.970	.250	.270	.629**	.634**	-.130	-.106	-.209	-.133	.008	-.179	-.278	.501*	.447	.333	.402	-.658**	-.664**	.731**	.636**	-.180	-.067
X_1'		1.	.169	.212	.666**	.679**	-.127	-.107	-.323	-.251	-.047	-.248	-.247	.394	.368	.350	.430	-.717**	-.725**	.639**	.582*	-.220	-.108
X_2			1.	.704	.234	.199	-.318	-.419	.250	.327	.335	.401	-.142	.806**	.762**	-.275	-.350	-.052	.041	.566*	.585*	.472	.512*
X_2'				1.	.099	.059	-.124	-.235	.408	.479	.340	.220	.035	.532*	.588*	-.377	-.452	-.327	-.277	.385	.497*	.618*	.741**
X_3					1.	.996	-.111	-.149	-.417	-.384	-.109	-.094	-.539*	.303	.256	.528*	.511*	-.503*	-.507*	.555*	.556*	-.361	-.261
X_3'						1.	-.076	-.107	-.454	-.423	-.121	-.126	-.531*	.263	.215	.502*	.501*	-.512*	-.524*	.526*	.525*	-.385	-.284
X_4							1.	.947	-.009	-.051	-.327	-.510*	.126	-.420	-.435	-.263	-.211	.110	-.104	-.272	-.219	-.026	.043
X_4'								1.	.076	.021	-.328	-.499*	.079	-.479	-.488*	-.223	-.163	.149	-.052	-.313	-.277	-.070	-.018
X_5									1.	.966	-.055	-.009	.269	.229	.284	-.459	-.589*	.206	.198	-.178	-.135	.765**	.699**
X_5'										1.	-.034	-.012	.281	.251	.303	-.412	-.553*	.125	.131	-.135	-.111	.744**	.696**
X_6											1.	.887	-.460	.281	.268	-.130	-.117	.188	.300	.457	.499*	-.003	.048
X_6'												1.	-.477	.302	.255	-.010	-.044	.433	.585*	.399	.424	-.019	-.021
X_7													1.	-.254	-.220	-.441	-.421	-.137	-.131	-.614*	-.683**	.360	.247
X_8														1.	.969	.028	-.033	-.232	-.144	.784**	.741**	.322	.337
X_8'															1.	-.006	-.085	-.312	-.220	.698**	.705**	.412	.435
X_9																1.	.969	-.215	-.177	.354	.277	-.727**	-.712**
X_9'																	1.	-.244	-.218	.361	.266	-.834**	-.804**
X_{10}																		1.	.967	-.256	-.224	.093	.005
X_{10}'																			1.	-.203	-.191	.085	-.020
Y_1																				1.	.948	-.156	-.052
Y_1'																					1.	-.044	.093
Y_2																						1.	.966
Y_2'																							1.

X_1 = Deflated Price of Mungbeans in (t-1)
X_1' = Log of X_1
X_2 = Rainfall at Planting (June 10 to July 10)
X_2' = Log of X_2
X_3 = Deflated Seasonal Average Price of Cowpeas in (t-1)
X_3' = Log of X_3
X_4 = Percent of Wheat Abandoned in Kingfisher County in (t)
* Statistically different from zero at the 5 percent level
** Statistically different from zero at the 1 percent level

X_4' = Log of X_4
X_5 = Rainfall Growing Season (July 11-Sept. 15)
X_5' = Log of X_5
X_6 = Mungbean Production in (t-1)
X_6' = Log of X_6
X_7 = Time in Years (1943= 1)
X_8 = Mungbean Production Plus Imports in (t) (1000 lbs.)
X_8' = Log of X_8

X_9 = Deflated Price of Mungbeans in (t)
X_9' = Log of X_9
X_{10} = Yield of Mungbeans per Harvested Acre in (t-1)
X_{10}' = Log of X_{10}
Y_1 = Acres of Mungbeans Planted in (t)(1000 Acres)
Y_1' = Log of Y_1
Y_2 = Yield of Mungbeans per Harvested Acre in (t)
Y_2' = Log of Y_2

Source of Data: See Appendix Table XI source.

at a given time at a given place. Annual supply as used in the price analysis of this study is a stock made up of annual mungbean production in the United States, carry over stock from the previous year, and imports for the current year.

Planted Acres

Based on the physical characteristics of the production area, planned mungbean production and actual production may be quite different in an individual year. Since actual production is subject to weather and other variations in the current year, the assumption was made that planted acres was a better indication of mungbean growers' willingness to produce than was actual production. Based on this assumption, the mungbean producers' supply response may be expressed as: $Y = f(X_1, X_2, X_3, \ldots, X_n)$; where Y is acres planted and X_1 through X_n are factors that producers would consider in determining acres to plant.

Description of Data

It was assumed that there were five major factors which would be considered by producers in making decisions on acres of mungbeans to plant.

Deflated Price of Mungbeans in the Previous Year (t-1).[2]--At mungbean planting time farmers have little if any information as to what the price of mungbeans will be at harvest time. It was considered that the price of mungbeans for the previous year would be the most important factor in the grower's decision to plant a given acreage. The farmers interviewed indicated that they did not consider the previous year price to be a good

[2](t-1) is used to indicate the previous year.

indication of mungbean prices for the current year. These farmers ranked mungbean price for the previous yeas as the second most important factor influencing planted acres of mungbeans. The coefficient of correlation between planted acres and price of mungbeans was statistically significant at the 99 percent level of confidence and was positive as was expected (Table XI).

Rainfall At Planting Time June 10-July 10.--Sufficient moisture to allow for plowing, preparing a seedbed, and planting is essential in order to establish a stand of mungbeans. Since mungbeans were grown as a double crop following wheat, the rainfall from June 10 to July 10 was selected as the effective moisture for planting mungbeans. The survey farmers gave moisture for this period as the most important factor influencing planted acres of mungbeans. There was a significant positive correlation between June 10 to July 10 rainfall and planted acreage of mungbeans (Table XI).

Deflated Price of Cowpeas in the Previous Year (t-1).--Cowpea production would be an alternative use for mungbean resources. Cowpeas and mungbeans are competitive enterprises. Cowpeas substitute for mungbeans as a summer legume and soil stabilizer. Cowpea prices were assumed to reflect the relative profitableness of an alternative enterprise. It was expected that cowpea prices would be negatively correlated with planted acres of mungbeans. When the price of cowpeas was high relative to price of mungbeans, producers would be expected to shift resources from mungbean production to cowpea production. However, this was not true as the correlation analysis showed a significant positive correlation between price of cowpeas and planted acres of mungbeans. This could result from the cowpea price factor being related to other factors which influence planted acres of mungbeans. Analysis showed a high correlation between the price of cowpeas in (t-1) and the price of mungbeans in (t-1). Favorable weather that would result in a high yield of cowpeas would also result in a high yield of mungbeans. Thus, the supply and the price of these two crops would be expected to have a positive interrelationship in the correlation analysis.

Percentage of Wheat Abandoned in Kingfisher County.--It was thought that as more acres of wheat were abandoned more mungbeans would be planted. Kingfisher County was chosen as the base county for wheat abandonment data to be used in the analysis. Instead of the expected positive correlation there was a negative non-significant correlation between planted acres of mungbeans and the percentage of wheat abandoned. The wheat abandonment factor could be related to the rainfall factor that was positively correlated with planted acres of mungbeans.

Yield of Mungbeans Per Harvested Acre in the Previous Year (t-1).--A high yield of mungbeans per harvested acre would likely encourage growers to plant more mungbeans the following year if the higher yield was marketed without causing a much lower price. It was expected that a high yield per acre would result in a larger planted acreage the following year. But, the correlation between planted acres and yield per harvested acre for the previous year was negative as well as being low (Table XI).

Other Data.--There were two variables other than the five already described that were significantly correlated with planted acres of mungbeans. Mungbean production plus imports had a high positive correlation with planted acres of mungbeans. This would be expected since production is the product of acres planted and yield. However, production manifested in September would not likely have influenced the acreage of mungbeans planted the previous June. The time variable was used in some equations and found to be of little importance in the analysis of planted acreage of mungbeans.

Regression Analysis

Regression equations were fitted to the data thought to influence planted acres of mungbeans. The equations were of the following form:

$$Y_1 = b_o + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_{10}$$

where

Y_1 = estimated planted acres of mungbeans

X_1 = deflated price of mungbeans in (t-1)

X_2 = rainfall from June 10 to July 10

X_3 = deflated price of mungbeans in (t-1)

X_4 = percentage of wheat abandoned in Kingfisher County in (t)[3]

X_{10}= yield of mungbeans per harvested acre in (t-1)

Some of the equations were fitted to the raw data and others were fitted to the log of the raw data. The equations seemed to fit the raw data better, so only the linear equations were used in this analysis.

The results of six alternative predictive equations pertaining to planted acres of mungbeans are presented in Table XII. The R^2 values indicate the portion of total mungbean planted acreage variation explained by the independent variables of the particular equation. The b_i values are the regression coefficients that measure the effect on (Y_1) planted

[3](t) is used to indicate the current year.

acres, per unit change in the (X_i) independent variable. The S_b value represents the standard deviation of the (b_i) regression coefficient. The student t-test was used to determine whether the b_i values were statistically significant at the .80, .90, .95, or .99 level of confidence.

TABLE XII

SELECTED STATISTICS RELATED TO ALTERNATIVE EQUATIONS FOR PREDICTING PLANTED ACRES OF MUNGBEANS

Values[a]	Equations[b]					
	12.1	12.2	12.3	12.4	12.5	12.6
R^2	.77	.70	.71	.70	.75	.67
b_o	84.37	18.54	32.00	14.61	57.39	53.52
X_1 Deflated price of mungbeans in (t-1)						
b	6.2395**	5.1949**	4.6522*	5.1995**	6.9580**	6.9528**
S_b	1.8357	1.2172	1.6347	1.2547	1.6171	1.6716
X_2 Rainfall June 10-July 10 in (t)						
b	4.3934^{xx}	5.4654*	5.3776*	5.1811*	4.9281*	4.6661*
S_b	2.1626	2.0389	2.1015	2.2085	1.9714	2.1361
X_3 Deflated price of cowpeas in (t-1)						
b	9.7987		5.3136			
S_b	10.2404		10.3144			
X_4 Percentage of wheat abandoned in Kingfisher County in (t)						
b	-.1933			-.1907		-.1776
S_b	-.4364			-.4551		-.4345
X_{10} Yield of mungbeans per harvested acre in (t-1)						
b	$.1016^{x}$				$.0878^{x}$	$.0873^{x}$
S_b	.0602				.0562	.0581

[a](t) indicates current year and (t-1) indicates previous year.

[b]x Significant at .80 level xx Significant at .90 level.
* Significant at .95 level ** Significant at .99 level.

Equation 12.1 provided the maximum R^2 and equation 12.6 had the lowest R^2 of the six equations (Table XII). The parameter associated with the X_1

variable was consistent with logical expectations in that it had a positive relationship with planted acres of mungbeans. This indicates that a higher price for mungbeans in (t-1) resulted in more planted acres of mungbeans in the current year and a lower price of mungbeans in (t-1) resulted in fewer acres of mungbeans being planted. The b values of the X_1 variable were significant at the .99 level of confidence in five of the six equations. The X_2 variable was logically consistent in that June 10-July 10 rainfall was positively associated with planted acres of mungbeans. The b values of the X_2 variable were significant at the .95 level of confidence in five of the six equations.

The X_3 parameter would suggest that a higher price for cowpeas in (t-1) would result in more acres of mungbeans being planted. This is not consistent with economic logic. A negative relationship was expected between the price of one competitive crop and the planted acres of the other one. The b values of the X_3 variable were not significant at the .80 level of confidence in either of the two equations and the S_b values were higher than the b values in both equations 12.1 and 12.3.

The parameter associated with the X_4 variable showed a negative relationship between abandoned wheat acres and planted acres of mungbeans. One would expect a large planted acreage of mungbeans to be associated with a large acreage of abandoned wheat. The b values associated with the X_4 variable were not significant at the .80 level in any of the equations and the S_b value was larger than the b value in each of the equations. The X_{10} parameter indicated a positive relationship between yield of mungbeans per harvested acre in (t-1) and planted acres of mungbeans in (t). This is logically consistent with expectations. The b values of the X_{10}

variable were significant at the 80 percent level of confidence in each of the three equations involving the X_{10} variable.

Conclusions

Of the six regression equations, two would be acceptable and four would be unacceptable. Equations 12.1 and 12.3 would be rejected because of the parameters associated with the X_3 variable. The b values in both equations indicated a positive relationship between price of cowpeas in (t-1) and planted acres of mungbeans in (t). A negative relationship would be expected between the factors. These b values not only carry the wrong sign to be in accord with logical expectations, but they are larger than the b values of the X_1 variable. This would indicate that a one cent per pound change in the price of cowpeas the previous year would result in a larger change in planted acreage of mungbeans than would a one cent per pound change in the price of mungbeans. This is not in agreement with expectations. The S_b values are larger than the b values of the X_3 variable. Equations 12.1, 12.4, and 12.6 would not be acceptable because of the parameters with respect to the X_4 variable. The b values of the X_4 variable are not statistically significant at the .80 level of confidence in any of the three equations. These b values indicate a negative relationship between the percentage of abandoned wheat acres and planted acres of mungbeans. One would expect a positive relationship between these variables.

Equations 12.2 and 12.5 seem to fit the data and are logically consistent with expectations with respect to the parameters of each of the independent variables.

In equation 12.2 the R^2 value of .70 indicates that 70 percent of the variation in planted acres of mungbeans was explained by variables X_1 and X_2. The b value of the X_1 variable indicates that a one cent per pound change in the deflated price of mungbeans in (t-1) was associated with a change of 5,195 acres planted to mungbeans in (t). The b value of the X_2 variable indicates that a one inch change in the June 10-July 10 rainfall in (t) was associated with a 5,465 acre change in the planted acreage of mungbeans in (t).

In equation 12.5 an R^2 value of .75 was obtained. Thus, 75 percent of the variation in planted acres of mungbeans was explained by the three independent variables X_1, X_2 and X_{10}. The b value of the X_1 variable indicates that a one cent per pound change in the deflated price of mungbeans in (t-1) was associated with a change of 6,958 acres in planted acres of mungbeans in (t). The b value of the X_2 variable indicates that a one inch change in June 10-July 10 rainfall in (t) was associated with a 4,928 acre change in the planted acreage of mungbeans in (t). The b value of the X_{10} variable indicates that a one pound change in mungbean yield per harvested acre in (t-1) was associated with an 88 acre change in planted acres of mungbeans in (t), or a 50 pound change in yield would be associated with a 440 acre change in planted acres.

It seems that either equation 12.2 or 12.5 would be suitable for predicting the number of acres to be planted to mungbeans any given year.

Yield Per Harvested Acre

Mungbean yield per harvested acre is one of the important factors of mungbean production. The same general procedure followed in making the analysis of planted acreage of mungbeans was used in the analysis of the mungbean yield per harvested acre.

Description of Data

The three variables thought to influence the yield of mungbeans per harvested acre were: (1) rainfall July 10 to September 15, (2) price of mungbeans in (t), and (3) planted acres of mungbeans in (t).

Rainfall July 10 to September 15.--The rainfall during the mungbean growing and development period would be expected to be the most important factor affecting the yield of mungbeans per harvested acre. July 10 to September 15 was assumed as the period in which rainfall would have the most influence on mungbean yields. The correlation between July 10-September 15 rainfall and the yield of mungbeans per harvested acre was positive and significant at the 99 percent confidence level. The logs of the data for these two variables also had a significant positive correlation (Table XI).

Deflated Price of Mungbeans in (t).--A relatively high price of mungbeans at harvest time should result in the harvesting of lower yielding beans. A relatively low price of mungbeans would result in some low yielding mungbeans being unprofitable for combining. The significant negative correlation between price of mungbeans in (t) and yield of mungbeans per harvested acre was consistent with expectations. The logs of the data for these variables yielded a higher negative correlation than the raw data.

Planted Acres of Mungbeans in (t).--The assumption was made that as the planted acreage of mungbeans increased, less productive soil would be used which would result in a lower yield per acre. The correlation analysis resulted in a negative relationship between planted acres and yield of mungbeans per harvested acre, but the coefficient of correlation was very small (Table XI).

Other Data.--The only other variable that showed any significant relationship with yield of mungbeans per harvested acre was June 10 to July 10 rainfall. The rainfall for this period could logically affect mungbean yields, and the effect would probably vary greatly with the distribution of the moisture during the period. There was a positive correlation between rainfall for the periods June 10 to July 10 and July 10 to September 15. The correlation for the logs of the data for these two variables was approaching significance at the .95 level of confidence. These correlation results might have suggested that the June 10-July 10 rainfall variable should have been used in the yield per harvested acre analysis.

Regression Analysis

Four equations were fitted to the data relative to yield of mungbeans per harvested acre. These equations were expressed in the form:

$$Y_2 = b_o + b_1X_5 + b_2X_9 + b_3Y_1$$

where

Y_2 = yield of mungbeans per harvested acre

Y_5 = rainfall July 10-September 15

X_9 = deflated price of mungbeans in (t)

Y_1 = planted acres of mungbeans in (t)

The regression results are shown in Table XIII. Equations 13.1 and 13.2 were fitted to the actual data. The logs of the actual data were used in equations 13.3 and 13.4. The R^2 value is fairly high in each equation. The b values of the X_5 variable indicate a positive relationship between rainfall during July 10 to September 15 and mungbean yield per acre. The X_5 variable b values are more highly significant in equations 13.1 and 13.2. The standard error of the b values of the variable X_5 are reasonable in size in relation to the size of the b values. The negative relationship between X_9 price of mungbeans in (t) and yield of mungbeans per harvested acre was according to logical expectations. The b values of this variable are significant in each of the equations and the S_b values are reasonable in size. The b values of the Y_1 variable indicate that as more acres are planted to mungbeans yield per harvested acre increases. This is not consistent with logic.

TABLE XIII

SELECTED STATISTICS RELATED TO ALTERNATIVE EQUATIONS FOR PREDICTING MUNGBEAN YIELDS PER HARVESTED ACRE

Values[a]		Equations[b] 13.1	13.2	13.3[c]	13.4[c]
R^2		.75	.73	.79	.68
b_o		229.74	240.85	2.18	2.51
X_5 Rainfall July 10-September 15					
	b	22.0892**	21.9968**	.3392*	.3591*
	S_b	6.1951	6.1604	.1415	.1672
X_9 Deflated price of mungbeans in (t)					
	b	-11.6704**	-10.4470*	-.5062**	-.4111*
	S_b	-3.9353	-3.6838	-.1239	-.1399
Y_1 Planted acres in (t)					
	b	.4201		.2586*	
	S_b	.4564		.1006	

[a](t) denotes current year.

[b]* Significant at .95 level ** Significant at .99 level.

[c]All variables are expressed in logs in equations 13.3 and 13.4.

Conclusion

Equations 13.1 and 13.3 would be rejected due to the positive sign of the Y_1 b values. Expectations would be for a negative relationship between planted acres and yield of mungbeans. This positive relationship could be the result of an interrelationship between June 10-July 10 rainfall and planted acres of mungbeans. Equations 13.2 and 13.4 seem to fit the data and could be used for predicting the yield of mungbeans per harvested acre. Equation 13.2 seems to fit the data better than equation 13.4 in that it produces an R^2 of .73 as compared to an R^2 of .68 for equation 13.4. Equation 13.2 indicates that 73 percent of the variation in yield of mungbeans per harvested acre was explained by the price of mungbeans in (t) and the rainfall June 10-July 15.

Price of Mungbeans

Description of Data

The correlation results (Table XI) were not of much value in indicating factors having significant correlation with the price of mungbeans. Four independent variables thought to influence mungbean prices were selected and used in the price analysis.

The Log of Mungbean Production in (t-1).--It was assumed that mungbean production in (t-1) would be an indicator of mungbean carry over stock that would add to the mungbean supply for the current year. A negative relationship between mungbean price in (t) and mungbean production in (t-1) would be expected. The correlation coefficient between the variables was negative, but it was very small.

Time.--The time variable was used as a catch-all variable.

Log of Mungbean Production Plus Imports.--This variable was used as a measure of supply and was expected to have a negative influence on mungbean prices. The sign of the (r) correlation coefficient did have a negative sign, but it was rather small.

Log of Mungbean Production Plus Imports in (t-1). This variable was used as a possible measure of the mungbean carry over stock. The data for this variable were not included in the correlation analysis. There should be a negative relationship between this variable and the price of mungbeans in (t).

Regression Analysis

The data thought to influence mungbean price were fitted to regression equations in the form:

$$Y_3' = b_o + b_1X_6' + b_2X_7 + b_3X_8' + Y_{11}'$$

where

Y_3' = log of price of mungbeans in (t)

X_6' = log of mungbean production in (t-1)

X_7 = time in years 1943-1958

X_8' = log of mungbean production plus imports in (t)

X_{11}' = log of mungbean production plus imports in (t-1)

Except for the time variable all data used in the equations were expressed in logs (Table XIV). The R^2 in each equation was very low which indicated that a small percentage of the variation in mungbean prices was explained. The R^2 of .21 in equation 14.2 was highest of the four equations. The b values in all equations in Table XIV had a negative sign and were consistent with expectations. The time variable's b values are the only ones of statistical significance at the .90 level of confidence.

The S_b values are large in comparison to the b values throughout the table.

TABLE XIV

SELECTED STATISTICS RELATED TO ALTERNATIVE EQUATIONS FOR PREDICTING THE PRICE OF MUNGBEANS

		Equations[b]			
Values[a]		14.1[c]	14.2[c]	14.3[c]	14.4[c]
R^2		.064	.21	.008	.10
b_o		2.52	2.04	1.35	2.49
X_6' Log of mungbean production in (t)					
	b	-.1718		-.0144	
	S_b	-.1682		-.2657	
X_7 Time in years					
	b	-.0293[xx]	-.0229[xx]		
	S_b	-.0140	-.0125		
X_8' Log of mungbean production plus imports in (t)					
	b	-.1809	-.2396	-.1009	-.0121
	S_b	-.3294	-.3249	-.3674	-.3492
X_{11}' Log of mungbean production plus imports in (t-1)					
	b				-.3916
	S_b				-.3427

[a](t) denotes current year and (t-1) indicates previous year.

[b]xx Significant at .90 level.

[c]All variables are expressed in logs except time.

Conclusion

The data did not fit the price predictive equations in a manner to produce a suitable equation for predicting mungbean prices. The results might be due to the market structure and/or inadequate data on mungbean supplies.

CHAPTER V

BUDGET ANALYSIS

Farm managers find it necessary periodically to re-evaluate their farm resource organization in light of changing technical and economic conditions. This chapter contains a means of evaluating anticipated returns from alternative enterprises or resource combinations on farms with sandy soils in the mungbean producing area of central Oklahoma.

The farm budget utilized as a method of analysis and presentation in this chapter is one of the basic decision making aids available to farmers as well as to professional agricultural workers.

The results presented in this chapter are not necessarily applicable to an individual farm or a specific year. However, the information is presented in such a manner that adjustments may be made so that the estimates could be applied to a specific set of circumstances.

Development of Budget Data

The typical 430 acre cropland farm specified in Chapter III was the basis for budget development in this chapter. The cropland organization was basically small grain with a substantial acreage of double crop mungbeans. Wheat was considered as the number one crop according to acres and profit per acre. Mungbeans were grown as a cash crop following wheat and used to stabilize sandy soils for wheat production. The enterprises specified for budgeting were single crop wheat, single crop mungbeans, and the double crop combination of wheat and mungbeans. In calculating costs and returns for specified enterprises a level of equipment and a set of production practices were assumed. These assumptions are specified in the individual enterprise tables. The assumptions were based on data and information given in Chapter III of this study.

Costs

The budget analysis of this chapter is explained in the Appendix Tables I through X. The estimated hourly cost of repairs and lubrication for the specified machinery were calculated in Appendix Table IV. The estimated fuel and oil consumption and cost per hour for the specified power units were calculated and shown in Appendix Tables V and VI. The estimated per hour fixed cost for the specified machinery as calculated are listed in Appendix Table VII.

The estimated hourly machinery costs reported in Appendix Tables IV, V, VI and VII were used with the estimated machinery time requirements per acre (Appendix Tables I, II, and III) to calculate the estimated per acre machinery costs shown in Appendix Tables VIII, IX and X. In Appendix Table VIII the 80 cents per hour tractor operating cost was obtained by adding 18 cents per hour repair and lubrication cost (Appendix Table IV) and 55 cents per hour fuel and oil cost (Appendix Table V) to get 73 cents per hour tractor operating cost. The 73 cents raised to 110 percent resulted in the 80 cents per hour operating cost. Tractor time was assumed 110 percent of other machinery operating time, but the construction of the machinery cost tables was more easily fitted to the data by the change being applied to the per hour tractor cost. This allowed for the machine operating time per acre to be applied to total operating cost per hour to obtain the operating cost per acre for each operation. In like manner the machine fixed cost per acre for each operation was obtained by applying the machine operating time per acre to the fixed cost per hour for each operation. Therefore, the estimated per acre operating and fixed costs for the specified enterprise were obtained as reported in Appendix Tables VIII, IX, and X.

The per acre nonmachinery costs were specified in the individual enterprise cost and return budget Tables XV, XVI, and XVII. A mungbean seed cleaning and sack charge of $.50 per hundredweight of seed was not shown since the assumed mungbean price was the price paid to farmers above this cost.

Enterprise Budgets

In the calculations presented in the enterprise cost and return budgets, the costs were divided into four major categories: (1) annual enterprise nonmachinery operating expenses, (2) annual enterprise machinery operating expenses, (3) fixed machinery costs, and (4) value of labor. All of these costs were calculated in such a manner that they were allocated to an individual enterprise on a per acre basis. Except for the machinery fixed costs, all of these costs vary with output. These operating or variable costs such as machinery, fuel, repairs and lubrication, seeds, fertilizers, materials and labor would not occur if the farmer produced nothing. The machinery costs such as taxes, insurance and interest are fixed and they remain if nothing is produced. Since machinery fixed cost does not vary with output, it may be allocated to more or less units of use and result in changed unit costs.

Three measures of estimated returns were given for each enterprise budget. They were: (1) returns to land, labor, risk and management;

TABLE XV

ESTIMATED PER ACRE REQUIREMENTS, COSTS AND RETURNS FOR SINGLE CROP MUNGBEAN ENTERPRISE, KINGFISHER AND LOGAN COUNTIES, OKLAHOMA

Item	Unit	Quantity	Price Dollars	Value Dollars
1. Production:				
Mungbean Grain	pound	364	.066	24.02
2. Inputs:				
Mungbean Seed	pound	20	.12	2.40
Inoculant	cwt. of seed	.20	.55	.11
Power and Machinery Operating Cost	acre	1	1.95	1.95
Power and Machinery Fixed Cost	acre	1	2.94	2.94
3. Total Specified Costs				7.40
4. Returns to Land, Labor, Risk and Management				16.62
5. Land Rent (1/3 of total sales)				8.01
6. Returns to Labor, Risk and Management				8.61
7. Labor	hour	2.18	1.00	2.18
8. Returns to Risk and Management				6.43

Source: See Tables IX, X, Appendix Tables I and VIII.

TABLE XVI

ESTIMATED PER ACRE REQUIREMENTS, COSTS AND RETURNS FOR SINGLE CROP WHEAT ENTERPRISE, KINGFISHER AND LOGAN COUNTIES, OKLAHOMA

Item	Unit	Quantity	Price Dollars	Value Dollars
1. Production:				
Wheat	bushel	14.8	1.60	23.68
2. Inputs:				
Seed Wheat	bushel	1	2.15	2.15
Fertilizer (16-48-0)	cwt.	.65	5.75	3.74
Power and Machinery Operating Cost	acre	1	2.15	2.15
Power and Machinery Fixed Cost	acre	1	2.92	2.92
3. Total Specified Costs				10.96
4. Returns to Land, Labor, Risk and Management				12.72
5. Land Rent (1/3 of total sale less 1/3 of fertilizer cost)				6.64
6. Returns to Labor, Risk and Management				6.08
7. Labor	hour	2.61	1.00	2.61
8. Returns to Risk and Management				3.47

Source: See Tables IX, X, Appendix Tables II and IX.

TABLE XVII

ESTIMATED PER ACRE REQUIREMENTS, COSTS AND RETURNS FOR WHEAT FOLLOWING MUNGBEANS IN A DOUBLE CROPPING SYSTEM, KINGFISHER AND LOGAN COUNTIES, OKLAHOMA

Item	Unit	Quantity	Price Dollars	Value Dollars
1. Production:				
Wheat	bushel	14.8	1.60	23.68
2. Inputs:				
Seed Wheat	bushel	1	2.15	2.15
Fertilizer (16-48-0)	cwt.	.65	5.75	3.74
Power and Machinery Operating Cost	acre	1	1.25	1.25
Power and Machinery Fixed Cost	acre	1	2.16	2.16
3. Total Specified Costs				9.30
4. Returns to Land, Labor, Risk and Management				14.38
5. Land Rent (1/3 of total sales less 1/3 of fertilizer cost)				6.64
6. Returns to Labor, Risk and Management				7.74
7. Labor	hour	1.44	1.00	1.44
8. Returns to Risk and Management				6.30

Source: See Tables IX, X, Appendix Tables III and X.

(2) returns to labor, risk and management; and (3) returns to risk and management. These returns are residual profit measures that show the estimated returns above the estimated costs as indicated in each budget table. The returns to labor, risk and management differ from the returns to land, labor, risk and management in that an estimated land rent has been deducted as the land cost. The returns to risk and management has had land and labor costs deducted from the returns to land, labor, risk and management.

The labor cost represents all labor whether family, operator or hired since there was no custom labor or work assumed in the budgets.

No capital costs were assumed for nonmachinery and nonland items. A return to these capital items was purposely omitted in order to simplify the structure of the budget tables.

The estimated returns for a single-crop mungbeans (Table XV) were higher than they were for single-crop wheat (Table XVI). The estimated returns to land, labor, risk and management were $16.62 for single crop mungbeans and $12.72 for single crop wheat. Most of this $3.90 per acre return difference in favor of mungbeans was accounted for in the $3.74 per acre fertilizer cost for wheat. The estimated per acre return to land, labor, risk and management was $14.38 for wheat following mungbeans (Table XVII) which was $1.66 per acre more than for single crop wheat. All of the increased return for wheat following mungbeans resulted from lower machinery costs per acre for the wheat following mungbeans. The discussion and comparison of data in these tables has been to clarify the budget procedure. The principal objective of this chapter was to estimate and evaluate costs and returns from wheat grown as a single crop compared with mungbeans and wheat grown in a double cropping system.

The requirements, costs and returns for mungbeans in the double cropping system were assumed to be identical to the data for single crop mungbeans. The budgets were designed so that estimated requirements, costs and returns from wheat and mungbeans grown in a double cropping system could be obtained by combining data from Tables XV and XVII.

The gross sales, specified costs and returns data from Tables XV, XVI, and XVII were used in Table XVIII to present estimated costs and returns for the specified enterprises. The data for single crop mungbeans were combined with the data for wheat following mungbeans to provide data for wheat and mungbeans as a double crop. Table XVIII shows considerably higher returns for double crop wheat and mungbeans as compared to single crop wheat. One acre of double crop mungbeans represents the unit of input that was added to the one acre of single crop wheat. The margin or change resulting from this added input would be determined by subtracting the dollar figure for an item of single crop wheat from the dollar figure for the same item of double crop wheat and mungbeans in Table XVIII. Thus, the marginal revenue resulting from adding the one unit of mungbeans to the unit of wheat was $47.50 (gross sales for double crop wheat and mungbeans) less $23.68 (gross sales for single crop wheat). The results or marginal revenue would be $24.02. A marginal analysis of the data for the two enterprises showed that adding the summer crop of mungbeans to the single crop wheat enterprise resulted in a marginal revenue of $24.02 per acre and a marginal specified cost of $5.74 per acre. The added mungbeans resulted in an $18.28 per acre marginal return to land, labor, risk and management. The marginal return to land as a result of the change was $8.01 per acre. The resulting marginal return to labor, risk and mangement was $10.27 per acre. There was a $1.01 per acre increase in labor cost as a result of this change. The final measure of comparison indicated a $9.26 per acre marginal return to risk and management by adding the mungbeans. This analysis showed very favorable returns for double crop wheat and mungbeans as compared to single crop wheat.

TABLE XVIII

COMPARATIVE ESTIMATED PER ACRE COSTS AND RETURNS FROM MUNGBEANS, WHEAT, AND DOUBLE CROP MUNGBEANS AND WHEAT, KINGFISHER AND LOGAN COUNTIES, OKLAHOMA

Item	Single Crop Mungbeans	Single Crop Wheat	Wheat Following Mungbeans	Wheat and Mungbeans Double Crop
		Dollars		
Gross Sales	24.02	23.68	23.68	47.70
Total Specified Costs	7.40	10.96	9.30	16.70
Returns to Land, Labor, Risk and Management	16.62	12.72	14.38	31.00
Land Rent	8.01	6.64	6.64	14.65
Returns to Labor, Risk and Management	8.61	6.08	7.74	16.35
Labor	2.18	2.61	1.44	3.62
Returns to Risk and Management	6.43	3.47	6.30	12.73

Source: See Tables XV, XVI, and XVII.

Analysis made using 3 cents per pound as the assumed price for mungbeans showed higher returns to all factors for double crop wheat and mungbeans than for single crop wheat. With the price of mungbeans at 2 1/2 cents the same comparison showed higher returns to land, labor, risk and management for double crop wheat and mungbeans but \$.68 per acre lower return to risk and management. Assuming \$.04 mungbeans and a 2 bushel reduction in yield of the wheat following mungbeans, the double crop combination of wheat and mungbeans gave higher per acre returns to each combination of production factors than did single crop wheat.

CHAPTER VI

SUMMARY AND CONCLUSION

This study was designed specifically to evaluate the economics of mungbeans as a crop for the sandy soils of central Oklahoma. The major mungbean production area of the state which is centered in Logan and Kingfisher counties was used for the study. The primary purpose was to estimate costs and returns from wheat and mungbean production. In order to do this it was necessary to gather information about (1) farmers' resource situations, (2) cultural practices, (3) production requirements, (4) yields, and (5) price data. This information was obtained from farmers surveyed and secondary sources. Budgets were used to estimate costs and returns for the enterprises considered. Regression analysis was used for developing equations that might be useful in estimating mungbean planted acres, yield per harvested acre, and price.

The sandy soils of the sample farms have a very low moisture storage capacity, readily give up stored moisture to growing crops, and have a rapid moisture intake rate. This results in a favorable moisture relationship for double cropping on these soils because less rainfall is required to refill their moisture storage capacity.

Wind erosión was a prevalent hazard in establishing a stand of wheat on the sandy soils. Farmers reported that the soil stabilizing effect of mungbean stubble helped in establishing a stand of wheat. This resulted in a higher longtime average yield for wheat following mungbeans in the double cropping system.

The farmers surveyed typically grew small grains on 84 percent of their cropland with over half of all cropland devoted to wheat production. Mungbeans were grown in a double cropping system with wheat on 70 percent of the wheat acreage or 38 percent of the cropland. The survey farmers were very consistent in mungbean production, and accounted for 18 percent of the planted mungbean acreage of the state. They reported considerably higher than state averages in percentage of planted acres harvested and yield per harvested acre of mungbeans. Mungbean production provided an additional source of income from wheat land without lowering the yield of wheat. And no equipment was required other than that commonly used for small grains. The extra labor and machine time required to produce one acre of double crop wheat and mungbeans compared with one acre of single crop wheat was very little more than that required to plant and harvest the mungbeans.

Budget analysis based on the inputs, yields and prices assumed for the study showed much higher returns from the wheat-mungbean double crop than from single crop wheat. The per acre return to land, labor, risk and management was $12.72 for single crop wheat and $31.00 for double crop wheat and mungbeans. The per acre return to labor, risk and management was $6.08 from single crop wheat and $16.35 from the double crop wheat and mungbeans. Return to risk and management was $3.47 per acre for single crop wheat compared to $12.73 per acre for double crop wheat and mungbeans. Mungbeans as a dairy feed would have a $.028 per pound value based on current grain sorghum and cottonseed meal prices. Budget analysis using $.028 as the price of mungbeans still showed a higher return to all combinations of factors for double crop wheat and mungbeans than single crop wheat.

Regression analysis of changes in planted acreage of mungbeans indicated (1) rainfall June 10 to July 10 and (2) price of mungbeans the previous year to be the important independent variables. The b value of the rainfall variable was significant at the .95 level of confidence. The b value of the mungbean price variable was significant at the .99 level of confidence. The analysis indicated that 70 percent of the variation in planted acres of mungbeans was explained by the two variables.

The mungbean yield per harvested acre analysis showed (1) rainfall July 10 to September 15 and (2) the price of mungbeans the current year to be the important independent variables affecting yield. The b value of the rainfall variable was significant at the .99 confidence level and the b value of the mungbean price variable was significant at the .95 level of confidence. Indications were that the two variables explained 73 percent of the variation in mungbean yields per harvested acre.

Regression analyses of change in price of mungbeans failed to indicate independent variables of significant importance.

One of the major limitations of this study was that the survey was confined to consistent mungbean growers which in turn limited the study to a rather small area and a particular soil type. More complete mungbean import and consumption data and adequate knowledge of the mungbean market structure would improve the study.

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APPENDIX

APPENDIX TABLE I

ESTIMATED PER ACRE LABOR AND MACHINERY REQUIREMENTS FOR MUNGBEANS GROWN AS A SINGLE CROP ON SANDY SOILS IN KINGFISHER AND LOGAN COUNTIES, OKLAHOMA, 1957

	Size of	Size of	Times	Acres Per	Time Per Acre Once Over		Total Time Per Acre	
Operation	Equipment	Crew	Over	10 Hrs.	Man Hrs.	Machine Hrs.	Man Hrs.	Machine Hrs.
Plow-Moldboard	3 x 14"	1	1	16.4	.73	.61	.73	.61
Harrow-Springtooth	12'	1	1.6	40	.30	.25	.48	.40
Planting-Drill	16 x 8"	1	1	40	.30	.25	.30	.25
Total preharvest per planted acre							1.51	1.26
Adjusted to per harvested acre (111 percent of planted acres)							1.68	1.40
Combine-Self Propelled	12'	1	1	34	.35	.29	.35	.29
Seed Hauling-Truck	1 1/2 ton	1	1	66	.15	.06	.15	.06
Total harvesting							.50	.35
Total							2.18	1.75

Source: Survey of 20 mungbean producers in Kingfisher and Logan counties, 1957.

APPENDIX TABLE II

ESTIMATED PER ACRE LABOR AND MACHINERY REQUIREMENTS FOR WINTER WHEAT GROWN AS A SINGLE CROP ON SANDY SOILS IN KINGFISHER AND LOGAN COUNTIES, OKLAHOMA, 1957

Operation	Size of Equipment	Size of Crew	Times Over	Acres Per 10 Hrs.	Time Per Acre Once Over		Total Time Per Acre	
					Man Hrs.	Machine Hrs.	Man Hrs.	Machine Hrs.
Plow-Moldboard	3 x 14"	1	1	16.4	.73	.61	.73	.61
Harrow-Springtooth	12'	1	2.6	40	.30	.25	.78	.65
Planting-Drill	16 x 8"	1	1	40	.30	.25	.30	.25
Total preharvest per planted acre							1.81	1.51
Adjusted to per harvested acre (111 percent of planted acres)							2.01	1.68
Combine, Self Propelled	12'	1	1	40	.30	.25	.30	.25
Grain Hauling, Truck	1 1/2 ton	1	1	40	.30	.25	.30	.10
Total harvesting							.60	.35
Total							2.61	2.03

Source: Survey of 20 mungbean producers in Kingfisher and Logan counties, 1957.

APPENDIX TABLE III

ESTIMATED PER ACRE LABOR AND MACHINERY REQUIREMENTS FOR WINTER WHEAT GROWN AFTER MUNGBEANS IN A DOUBLE CROPPING SYSTEM ON SANDY SOILS IN KINGFISHER AND LOGAN COUNTIES, OKLAHOMA, 1957

Operation	Size of Equipment	Size of Crew	Times Over	Acres Per 10 Hrs.	Time Per Acre Once Over		Total Time Per Acre	
					Man Hrs.	Machine Hrs.	Man Hrs.	Machine Hrs.
Disk, Tandem	8'	1	1	26	.46	.38	.46	.38
Plant, Drill	16 x 8"	1	1	40	.30	.25	.30	.25
Total preharvest per planted acre							.76	.63
Adjusted to per harvested acre (111 percent of planted acres)							.84	.70
Combine, Self Propelled	12'	1	1	40	.30	.25	.30	.25
Grain Hauling, Truck	1 1/2 ton	1	1	40	.30	.25	.30	.10
Total harvesting							.60	.35
Total							1.44	1.05

Source: Survey of 20 mungbean producers in Kingfisher and Logan counties, 1957.

APPENDIX TABLE IV

ESTIMATED COSTS OF REPAIRS AND LUBRICATION PER HOUR OF OPERATION FOR SPECIFIED MACHINERY ON A TYPICAL 430 ACRE CROPLAND FARM IN THE MUNGBEAN PRODUCTION AREA OF KINGFISHER AND LOGAN COUNTIES, OKLAHOMA, 1957

Machine (Typical)	Size	New Price[a]	Repairs: Percent of New Price[b]	Repairs: Cost Per Year	Repairs: Hours Operated Per Year[c]	Repairs: Cost Per Hour	Lubrication: Percent of New Price[b]	Lubrication: Cost Per Year	Lubrication: Hours Operated Per Year[c]	Lubrication: Cost Per Hour	Total Cost Per Hr.
		Dollars	Percent	Dollars		Dollars	Percent	Dollars		Dollars	Dollars
Tractor	3-plow	3,400	3.5	119.00	780	.150	0.7	23.80	780	.030	.18
Plow Moldboard	3 x 14"	410	7.0	28.70	165	.174	0.6	2.46	165	.015	.19
Harrow Springtooth	12'	180	2.0	3.60	140	.026	0.1	.18	140	.001	.03
Disk Tandem	8'	312	3.0	9.36	140	.067	0.5	1.56	140	.011	.08
Drill Grain	16 x 8"	710	3.0	21.30	150	.142	1.0	7.10	150	.047	.19
Combine, Self Propelled	12'	6,300	3.0	189.00	150	1.26	0.3	18.90	150	.126	1.39
Truck	1 1/2 T.	2,950	5.0	147.50	1,040	.142	0.7	20.65	1,040	.019	.16

[a]New machinery prices were based on information obtained from machinery dealers in Kingfisher and Logan counties relative to prices paid by farmers in 1957.

[b]Repair and lubrication costs were based on F. C. Fenton and G. E. Fairbanks, The Cost of Using Farm Machinery; Engineering Experiment Station Bulletin 74, Kansas State College, Manhattan, Kansas, September, 1954.

[c]Hours used per year for machinery were based on estimated machinery use by operations for crops grown on the typical 430 cropland acre farm of the 20 mungbean growers interviewed in Kingfisher and Logan counties in 1957.

APPENDIX TABLE V

ESTIMATED GAS AND OIL CONSUMPTION AND PER HOUR COST FOR OPERATING A THREE-PLOW TRACTOR OR A 12' SELF-PROPELLED COMBINE IN THE MUNGBEAN PRODUCING AREA OF KINGFISHER AND LOGAN COUNTIES, OKLAHOMA, 1957

Item	Units	Quantity Per Hour	Price	Cost Per Hour
			Dollars	Dollars
Gasoline	gallon	2.6	.185	.481
Oil	quart	.2	.25	.050
Oil Filter	cartridge	.0125	1.20	.015
Total				.546

Oil consumption was based upon the following:

Add 1 quart oil per 10 hours = 8 quarts for 80 hours.
Oil bath services 40 hours = 1 quart = 2 quarts for 80 hours.
Oil change 6 quarts = 6 quarts for 80 hours.

Total oil 16 quarts for 80 hours.

16 ÷ 80 = .2 quarts per hour
Oil filter changed every 80 hours of use
1 hour ÷ 80 = .0125 cartridges used per hour

Source: Gasoline and oil consumption was based on F. C. Fenton and G. E. Fairbanks, The Cost of Using Farm Machinery; Engineering Experiment Station, Bulletin 74, Kansas State College, Manhattan, Kansas, September, 1954; and information from farmers and farm machinery dealers in Kingfisher and Logan counties. Gasoline and oil prices were based on bulk delivery to farm prices, 1957.

APPENDIX TABLE VI

ESTIMATED FUEL AND OIL CONSUMPTION AND COST PER HOUR FOR OPERATING A 1 1/2 TON TRUCK FOR HAULING WHEAT OR MUNGBEANS FROM COMBINE TO MARKET IN THE MUNGBEAN PRODUCTION AREA OF LOGAN AND KINGFISHER COUNTIES, OKLAHOMA, 1957

Item	Units	Quantity Per Hour	Price	Cost Per Hour
			Dollars	Dollars
Gasoline	gallon	4.0	.26	1.04
Oil	quart	.11	.25	.0275
Oil Filter	cartridge	.013	1.90	.025
Total				1.09

Fuel and oil consumption was based upon the following:

Gasoline: 20 miles driven per trip for road, field, and other driving. Truck will average 5 miles per gallon of gasoline for this driving and use 4 gallons of gasoline per trip. The time required per trip or load is one hour of actual truck driving. 20 miles per hour at 5 miles per gallon = 4 gallons per hour.

Oil used:	Oil added in 1500 miles	1 quart
	Oil changed "	6 quarts
	Oil bath serviced "	1 quart
	Total	8 quarts.

8 ÷ 1500 = .0053 quarts of oil per mile driven
20 miles per hour x .0053 = .11 quart of oil used per hour
Oil filter is changed every 1500 miles of driving
20 miles per hour ÷ 1500 miles = .013 filter cartridge used per hour

Source: Gasoline and oil consumption was based on information from farmers, truck operators and truck dealers. Gasoline and oil prices were based on discounted filling station rates for trucks.

APPENDIX TABLE VII

ESTIMATED PER HOUR FIXED COST FOR SPECIFIED MACHINERY IN KINGFISHER AND LOGAN COUNTIES, OKLAHOMA, 1957

Machine	Size	New Price[a]	Total Fixed Cost as Percent of New Price[b]	Cost Per Year	Hours Operated Per Year[c]	Cost Per Hour	Cost Per Hour Including Tractor
		Dollars	Percent	Dollars		Dollars	Dollars
Tractor	3 plow	3,400	14.0	476.00	780	.61	.61
Plow Moldboard	3 x 14"	410	10.6	43.46	165	.26	.87
Harrow Springtooth	12'	180	9.5	17.10	140	.12	.73
Disk Tandem	8'	312	10.6	33.07	140	.24	.85
Drill Grain	16 x 8"	710	10.0	71.00	150	.47	1.08
Combine, Self Propelled	12'	6,300	14.0	882.00	150	5.88	5.88
Truck	1 1/2 T.	2,950	14.0	413.00	1,040	.40	.40

[a]New machinery prices were based on information obtained from machinery dealers in Kingfisher and Logan counties relative to prices paid by farmers in 1957.

[b]F. C. Fenton and G. E. Fairbanks, The Cost of Using Farm Machinery; Engineering Experiment Station Bulletin 74, Kansas State College, Manhattan, Kansas, September, 1954.

[c]Hours used per year for machinery were based on estimated machinery use by operations for crops grown on the typical 430 cropland acre farm of the 20 mungbean growers interviewed in Kingfisher and Logan counties in 1957.

APPENDIX TABLE VIII

ESTIMATED PER ACRE MACHINERY COST FOR MUNGBEANS AS A SINGLE CROP ON SANDY SOILS IN KINGFISHER AND LOGAN COUNTIES, OKLAHOMA, 1957

Operation	Size of Equipment	Operating Cost Per Hour: Repair and Lubrication[a]	Operating Cost Per Hour: Fuel and Oil[b]	Operating Cost Per Hour: Tractor Operating Cost Per Hour	Total Operating Cost Per Hour Including Tractor	Fixed Cost Per Hour[c]	Machine Operating Time Per Acre[d]	Operating Cost Per Acre	Fixed Cost Per Acre	Total Cost Per Acre
		Dollars			Dollars		Hours	Dollars		
Tractor	3-plow	.18	.55	(110x.73=.80)[e]	.80	.61				
Plow Moldboard	3 x 14"	.19		.80	.99	.87	.61	.60	.53	1.13
Harrow Spring-tooth	12'	.03		.80	.83	.73	.40	.33	.29	.62
Plant Drill	16 x 8"	.19		.80	.99	1.08	.25	.25	.27	.52
Total preharvest per planted acre							1.26	1.18	1.09	2.27
Adjusted to per harvested acre (111 percent of planted acres)							1.40	1.31	1.21	2.52
Combine, Self Propelled	12'	1.39	.55		1.94	5.88	.29	.56	1.71	2.27
Grain Hauling Truck	1 1/2 T.	.16	1.09		1.25	.40	.06	.08	.02	.10
Total harvesting and hauling							.35	.64	1.73	2.37
Total for producing one acre of mungbeans							1.75	1.95	2.94	4.89

[a] See Appendix Table IV.

[b] See Appendix Table V and VI.

[c] See Appendix Table VII.

[d] See Appendix Table I.

[e] Tractor operating cost was increased to allow for idling time and to and from field driving.

APPENDIX TABLE IX

ESTIMATED PER ACRE MACHINERY COST FOR WHEAT AS A SINGLE CROP ON SANDY SOILS IN KINGFISHER AND LOGAN COUNTIES, OKLAHOMA, 1957

Operation	Size of Equipment	Operating Cost Per Hour: Repair and Lubrication[a]	Operating Cost Per Hour: Fuel and Oil[b]	Operating Cost Per Hour: Tractor Operating Cost Per Hour	Operating Cost Per Hour: Total Operating Cost Per Hour Including Tractor	Fixed Cost Per Hour[c]	Machine Operating Time Per Acre[d]	Operating Cost Per Acre	Fixed Cost Per Acre	Total Cost Per Acre
		Dollars			Dollars		Hours	Dollars		
Tractor	3-plow	.18	.55	(110x.73=.80)[e]	.80					
Plow Moldboard	3 x 14"	.19		.80	.99	.87	.61	.60	.53	1.13
Harrow Spring-tooth	12'	.03		.80	.83	.73	.65	.54	.47	1.01
Plant Drill	16 x 8"	.19		.80	.99	1.08	.25	.25	.27	.52
Total preharvest per planted acre							1.51	1.39	1.27	2.66
Adjusted to cost per harvested acre (111 percent of planted acres)							1.68	1.54	1.41	2.95
Combine, Self Propelled	12'	1.39	.55		1.94	5.88	.25	.49	1.47	1.96
Grain Hauling Truck	1 1/2 T.	.16	1.09		1.25	.40	.10	.12	.04	.16
Total harvesting and hauling seed							.35	.61	1.51	2.12
Total for producing one acre of wheat							2.03	2.15	2.92	5.07

[a] See Appendix Table IV.

[b] See Appendix Table V and VI.

[c] See Appendix Table VII.

[d] See Appendix Table II.

[e] Tractor operating cost was increased to allow for idling time and to and from field driving.

APPENDIX TABLE X

ESTIMATED PER ACRE MACHINERY COST FOR WHEAT FOLLOWING MUNGBEANS IN A DOUBLE CROPPING SYSTEM ON SANDY SOILS IN KINGFISHER AND LOGAN COUNTIES, OKLAHOMA, 1957

Operation	Size of Equipment	Operating Cost Per Hour: Repair and Lubrication[a]	Operating Cost Per Hour: Fuel and Oil[b]	Operating Cost Per Hour: Tractor Operating Cost Per Hour	Operating Cost Per Hour: Total Operating Cost Per Hour Including Tractor	Fixed Cost Per Hour[c]	Machine Operating Time Per Acre[d]	Operating Cost Per Acre	Fixed Cost Per Acre	Total Cost Per Acre
		Dollars			Dollars		Hours	Dollars		
Tractor	3-plow	.18	.55	(110x.73=.80)[e]	.80					
Disk Tandem	8'	.08		.80	.88	.85	.38	.33	.32	.65
Plant Drill	16 x 8"	.19		.80	.99	1.08	.25	.25	.27	.52
Total preharvest per planted acre							.63	.58	.59	1.17
Adjusted to cost per harvesting acre (111 percent of planted acres)							.70	.64	.65	1.29
Combine, Self Propelled	12'	1.39	.55		1.94	5.88	.25	.49	1.47	1.96
Grain Hauling Truck	1 1/2 T.	.16	1.09[d]		1.25	.40	.10	.12	.04	.16
Total harvesting and hauling wheat							.35	.61	1.51	2.12
Total for producing one acre of wheat following mungbeans							1.05	1.25	2.16	3.41

[a]See Appendix Table IV.

[b]See Appendix Tables V and VI.

[c]See Appendix Table VII.

[d]See Appendix Table III.

[e]Tractor operating cost was increased to allow for idling time and to and from field driving.

APPENDIX TABLE XI

DATA USED IN STATISTICAL ANALYSIS, 1942-1959

Year	Deflated Price of Mungbeans[a] in (t) cents per lb. X_9; X_1; Y_3[b]	Log Deflated Price of Mungbeans in (t) X_9'; X_1'; Y_3'[b]	Rainfall[c] June 10 to July 10 inches X_2	Log Rainfall June 10 to July 10 inches X_2'	Deflated Price of Cowpeas[a] in (t-1) cents per lb. X_3	Log Deflated Price of Cowpeas in (t-1) X_3'
1942	6.76	0.82995				
1943	11.49	1.06032	.96	-1.98227	3.47	0.54033
1944	20.68	1.31555	3.89	0.58995	5.06	0.70415
1945	14.01	1.14644	9.61	0.98272	4.79	0.68034
1946	9.79	0.99078	4.64	0.66652	3.12	0.49415
1947	8.00	0.90309	3.27	0.51455	4.25	0.62839
1948	4.99	0.69810	10.58	1.02449	4.26	0.62941
1949	3.88	0.58883	4.65	0.66745	3.05	0.48430
1950	3.74	0.57287	4.59	0.66181	2.76	0.44091
1951	5.03	0.70157	4.74	0.67578	2.98	0.47422
1952	15.54	1.19145	.83	-1.91908	3.15	0.49831
1953	7.44	0.87157	1.54	0.18752	3.71	0.56937
1954	10.48	1.02036	.99	-1.99564	3.72	0.57054
1955	6.09	0.78462	2.43	0.38561	3.93	0.59439
1956	11.80	1.07188	2.21	0.34439	2.74	0.43775
1957	5.33	0.72673	5.07	0.70501	3.25	0.51188
1958	3.63	0.55991	7.55	0.87795	2.70	0.43136
1959	2.83	0.45179	4.33	0.63649	2.50	0.39794

(Continued)

APPENDIX TABLE XI (Continued)

Year	% of Wheat Abandoned in Kingfisher County in (t) X_4	Log % of Wheat Abandoned in Kingfisher County in (t) X_4'	Rainfall[c] July 10 to Sept. 15 inches X_5	Log Rainfall July 10 to Sept. 15 inches X_5'	Mungbean Production in (t-1) (1000 lbs.) X_6	Log Mungbean Production in (t-1) (1000 lbs.) X_6'
1942						
1943	30.7	1.48714	2.73	0.43616	5,600	3.73239
1944	7.1	0.85126	5.67	0.75358	6,300	3.79934
1945	5.2	0.71600	4.38	0.64147	11,000	4.04139
1946	9.8	0.99123	4.64	0.66652	24,200	4.38382
1947	7.2	0.85733	2.28	0.35793	14,700	4.16732
1948	5.1	0.70757	4.68	0.67025	10,080	4.00346
1949	4.9	0.69020	6.04	0.78104	16,000	4.20412
1950	21.0	1.32222	13.55	1.13194	9,000	3.95424
1951	36.4	1.56110	7.01	0.84572	13,950	4.14457
1952	9.7	0.98677	3.84	0.58433	4,000	3.60206
1953	15.6	1.19312	8.76	0.94250	1,200	3.07918
1954	10.2	1.00860	3.01	0.47857	6,500	3.81291
1955	51.1	1.70842	3.26	0.51322	840	2.92428
1956	4.4	0.64345	3.76	0.57519	7,000	3.84510
1957	20.1	1.30320	6.47	0.81091	2,400	3.38021
1958	4.7	0.67210	10.32	1.01368	7,600	3.88081
1959	4.4	0.60206	7.01	0.84572	14,850	4.17173

(Continued)

APPENDIX TABLE XI (Continued)

Year	Time in Years 1943=1 X_7	Mungbean Production Plus Imports in (t) (1000 lbs.) X_8; X_{11}[d]	Log Mungbean Production Plus Imports in (t) (1000 lbs.) X_8'; X_{11}'[d]	Acres of Mungbeans Planted in (t) (1000 acres) Y_1	Log Acres of Mungbeans Planted in (t) (1000 acres) Y_1'	Yield of Mungbeans/ Harvested Acre in (t) (pounds) Y_2; X_{10}[e]	Log Yield Mungbeans/ Harvested Acre in (t) (pounds) Y_2'; X_{10}'[e]
1942		5400	3.73239			540	2.73239
1943	1	6300	3.79934	45	1.65321	180	2.25527
1944	2	11000	4.04139	75	1.87506	200	2.30103
1945	3	24200	4.38382	169	2.22789	220	2.34242
1946	4	14800	4.17026	110	2.04139	210	2.32222
1947	5	10380	4.01620	62	1.79239	250	2.39794
1948	6	16400	4.21484	64	1.80618	320	2.50515
1949	7	9500	3.97772	31	1.49136	400	2.60206
1950	8	14050	4.14768	40	1.60206	450	2.65321
1951	9	5500	3.74036	30	1.47712	250	2.39794
1952	10	9900	3.99564	20	1.30103	120	2.07918
1953	11	8700	3.93952	28	1.44716	325	2.51188
1954	12	5040	3.70243	18	1.25527	100	2.00000
1955	13	9000	3.95424	38	1.57978	280	2.44716
1956	14	7835	3.89404	32	1.50515	200	2.30103
1957	15	9522	3.97873	28	1.44716	380	2.57978
1958	16	16568	4.21927	35	1.54407	550	2.74036
1959	17	(4167)		25	1.39794	290	2.42240

[a] Mungbean and cowpea prices were deflated by using the index of wholesale price of the United States, with 1946-1950 as the base period.

[b] The deflated price of mungbeans in (t) was indicated as X_9 when used as an independent variable in Table XIII and as Y_3 when used as a dependent variable in Table XIV. A lag of one year in this data resulted in data for (X_1 variable) the deflated price of mungbeans in (t-1).

(Continued)

Appendix Table XI (Continued)

[c]The precipitation data for Crescent, Fort Cobb, Seminole, and Wagoner were weighted by the estimated percentage of the state mungbean crop produced by the area represented to obtain the rainfall data.

[d]The figures reported are data for the (X_8 variable) mungbean production plus imports in (t). A lag of one year in the data resulted in data for (X_{11} variable) mungbean production plus imports in (t-1).

[e]The data given are for (Y_2 variable) yield of mungbean per harvested acre in (t). A lag of one year in the data gave (X_{10} variable) yield of mungbeans per harvested acre in (t-1).

Source: (1), (21), (22), (23), (24), and (25).

VITA

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