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

By
Jim Tomlinson and James S. Plaxico
Department of Agricultural Economics

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The mungbean, a summer legume, may be grown for its forage, seed, or soil-conserving qualities. Mungbean forage and seed are excellent livestock feeds, but the primary use of the seed is for producing bean sprouts used principally in oriental foods. It is estimated that the United States uses about 11 million pounds of mungbeans annually for commercial sprouting and that Oklahoma mungbean growers produce 90 percent of the sprouting beans grown in the United States. The acres, yield, production, price, and farm value of mungbeans in Oklahoma for the years 1943 through 1958 as estimated by Oklahoma Crop and Livestock Reporting Service (1) are given in Table 1.

This bulletin reports results of a study to evaluate the economic importance of mungbeans in the major mungbean producing area of Oklahoma.

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 from county agents, research scientists, farm equipment dealers, and other businessmen servicing mungbean growers. 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 production area of the state. Mungbeans are grown mostly in a double cropping system with wheat on sandy soils of the area. 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 predominantly used for small grain production.

Research reported herein was done under Oklahoma Agricultural Experiment Station Project Number 1066.

Table 1: Oklahoma Mungbean Production, 1943-1958

Year	Acreage		Yield Per Harvested Acre	Production	Season Average Price	Farm Value
	Planted	Harvested				
	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†	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††	9,334	7.6††	710

†Slightly more than one-half estimated to be of sprouting quality.
††Average yield and price are weighted by acres and production.
Source: "Annual Mungbean Production Report", Oklahoma Crop and Livestock Reporting Service, Oklahoma City, Oklahoma.

LAND RESOURCES AND CROPLAND USE

The land resources operated by the mungbean growers interviewed averaged 548 total acres of land per farm. The 548 acres consisted of 430 acres of cropland, 98 acres of pasture land and 20 acres of waste and other land.

Based on the survey data the typical farm with 430 acres of cropland would have 238 acres of wheat followed with 166 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 crop-land would be used for wheat and 29 percent would be used for other small grain production. Double crop mungbeans would be grown on 70 percent of the wheat acreage each year or on 38 percent of the total cropland.

Budget Analysis

Farm managers find it necessary periodically to re-evaluate their farm resource organization in light of changing technical and economic conditions. This budget analysis provides 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 is one of the basic decision making aids available to farmers as well as to professional agricultural workers.

The results of this study 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 was the basis for budget development. 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.

Input and Output Data

In calculating costs and returns for a farm enterprise, a level of equipment and a set of production practices must be assumed. The assumed production requirements and practices for this study were

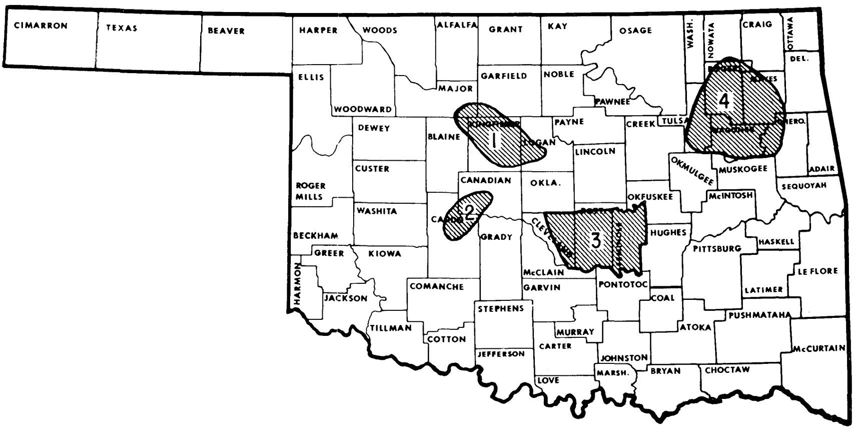

Figure 1. The principal mungbean producing areas of Oklahoma. This study was confined to Area 1.

based on practices followed by the farmers in Area I (Figure 1) and recommendations from the Oklahoma Agricultural Experiment Station. Crops in the area were produced primarily with 3-plow tractor power with appropriate equipment. Assumed labor and machinery requirements are specified in Appendix Table I.

Prices

Prices assumed for this study are presented in Table 2. These prices are estimates of long term projected prices. The USDA's (2) long term projected index of prices paid by farmers for production items was 248 compared to an index of 249 for 1956. Therefore the 1956 prevailing prices of the area were used as projected prices paid by farmers for this study. The USDA's (2) long term projected price of wheat for Oklahoma was assumed the price that farmers would receive for wheat.

The 1946-57 twelve year weighted average price received for mungbeans by Oklahoma farmers was used as the assumed projected price for the study. This price was based on the seasonal average price by years as reported by the Oklahoma Crop and Livestock Reporting Service (Table 1).

Table 2: Assumed Prices For The Study.

Item	Unit	Price
Prices Paid by Farmers†		
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 filter 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††	bushel	1.60
Mungbeans†††	pound	.066
Wheat pasture	animal unit month	5.00

Source of data:
†Twenty farmers surveyed and farm supply agencies, 1957.
††(2).
†††Weighted average price for 12 years 1946-57 (Table 1).

Costs

The estimated hourly costs of repairs and lubrication for the specified machinery were calculated in Appendix Table II. The estimated fuel and oil consumption and costs per hour for the specified power units were calculated and shown in Appendix Tables III and IV. The estimated per hour fixed costs for the specified machinery as calculated are listed in Appendix Table V.

The estimated hourly machinery costs reported in Appendix Tables II, III, IV, and V were used with the estimated machinery time requirements per acre (Appendix Table I) to calculate the estimated per acre machinery costs shown in Appendix Tables VI, VII, and VIII. 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 thereby obtaining 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 VI, VII, and VIII.

The per acre nonmachinery costs are specified in the individual enterprise cost and return budget Tables 3, 4, and 5. 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.

Table 3: Estimated Per Acre Requirements, Costs and Returns for Single Crop Mungbean Enterprise.

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 Table 2 and Appendix Tables I and VI.

ENTERPRISE BUDGETS

In the calculations presented in the enterprise cost and return budgets, the costs were divided into four major categories: (1) non-machinery operating expenses, (2) 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 made no attempt to produce a crop. 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; (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 have had land and labor costs deducted from the returns to land, labor, risk and management.

Table 4: Estimated Per Acre Requirements, Costs and Returns for Single Crop Wheat Enterprise.

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 (⅓ of total sales less ⅓ 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 Table 2 and Appendix Tables I and VII.

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 non-machinery and non-land items. A return to these capital items was purposely omitted in order to simplify the structure of the budget tables.

RESULTS

The estimated returns for single-crop mungbeans (Table 3) were higher than they were for single-crop wheat (Table 4). 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 5) which was $1.66 per acre more than for single crop wheat. This increased return for wheat following mungbeans resulted from lower machinery costs per acre for the wheat following mungbeans.

The principal objective of the enterprise budgets 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 gross sales, specified costs and returns data from Tables 3, 4, and 5 were used in Table 6 to present estimated costs and

Table 5: Estimated Per Acre Requirements, Costs and Returns for Wheat Following Mungbeans in a Double Cropping System.

	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 (⅓ of total sales less ⅓ 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 Table 2 and Appendix Tables I and VIII.

return 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 6 shows much higher returns for double crop wheat and mungbeans as compared to single crop wheat. The per acre returns to land, labor, risk and management were $31.00 for double crop wheat and mungbeans and $12.72 for single crop wheat. The analysis shows very favorable returns to all factors for double crop wheat and mungbeans as compared to single crop wheat.

Mungbeans as a dairy feed would have a $.028 per pound value based on current grain sorghum and cottonseed meal prices according to Morrison (3). Analysis made using $.028 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 $.025 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.

Statistical Analysis of Mungbean Supply And Demand Data

The major objectives of these analyses were: (1) to determine if there was a relationship between three dependent variables and unit changes in ten independent variables, (2) to obtain a measure of the relationship, and (3) to provide a basis for making predictions of the

Table 6: Comparative Estimated Per Acre Costs and Returns From Mungbeans, Wheat, and Double Crop Mungbeans and Wheat

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

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 7).

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

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 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 the Previous Year.—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. Farmers interviewed ranked mungbean price for the previous year 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 7).

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 farmers surveyed 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 7).

Deflated Price of Cowpeas in the Previous Year.—Cowpea production is an alternative use for mungbean resources. Cowpeas and mungbeans are competitive enterprises as 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 and the price of mungbeans. 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 the Previous Year.—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 7).

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

Table 7: Simple Correlations Between Selected Factors, Mungbean Data, 1943-1948.

	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*	.583*	.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	.474	-.019	-.071
X_7													1.	-.254	-.220	-.441	-.421	-.137	-.131	-.614*	-.683**	.360	.247
X_8														1.	.969	.028	-.033	-.232	-.144	.784**	.741**	.372	.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	-.070
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

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:

$$Y_1 = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_{10}$$

where

Y_1 = estimated planted acres of mungbeans

X_1 = deflated price of mungbeans the previous year

X_2 = rainfall from June 10 to July 10

X_3 = deflated price of cowpeas the previous year

X_4 = percentage of wheat abandoned in Kingfisher County in the current year

X_{10} = yield of mungbeans per harvested acre the previous year

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 8. 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 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.

Equation 8.1 provided the maximum R^2 and equation 8.6 had the lowest R^2 of the six equations (Table 8). 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 the previous year resulted in more planted acres of mungbeans in the current year and a lower price of mungbeans in the previous year 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 the previous year 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 8.1 and 8.3.

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 the previous year and planted acres of mungbeans the current year. 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.

Table 8: Selected Statistics Related To Alternative Equations For Predicting Planted Acres of Mungbeans

		Equations††					
Values†		8.1	8.2	8.3	8.4	8.5	8.6
R^2		.77	.70	.71	.70	.75	.67
b_0		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	4.3934xx	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	.1016x				.0878x	.0873x
	S_b	.0602				.0562	.0581

†(t) indicates current year and (t-1) indicates previous year.
††x Significant at .80 level
xxSignificant at .90 level
* Significant at .95 level.
**Significant at .99 level.

Conclusions

Of the six regression equations, two would be acceptable and four would be unacceptable. Equations 8.1 and 8.3 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 and planted acres of mungbeans. 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 8.1, 8.4, and 8.6 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 8.2 and 8.5 seem to fit the data and are logically consistent with expectations with respect to the parameters of each of the independent variables.

In equation 8.2 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 the previous year was associated with a change of 5,195 acres planted to mungbeans the current year. The b value of the X_2 variable indicates that a one inch change in the June 10-July 10 rainfall the current year was associated with a 5,465 acre change in the planted acreage of mungbeans that year.

In equation 8.5 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 was associated with a change of 6,958 acres in planted acres of mungbeans the following year. The b value of the X_2 variable indicates that a one inch change in June 10-July 10 rainfall was associated with a 4,928 acre change in the planted acreage of mungbeans. The b value of the X_{10} variable indicates that a one pound change in mungbean yield per harvested acre was associated with an 88 acre change in planted acres of mungbeans the following year, or a 50 pound change in yield would be associated with a 440 acre change in planted acres.

It seems that either equation 8.2 or 8.5 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, and (3) planted acres of mungbeans.

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 7).

Deflated Price of Mungbeans.—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 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.—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.

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:

$$Y_2 = b_0 + b_1X_5 + b_2X_9 + b_3Y_1$$

where

Y_2 = yield of mungbeans per harvested acre

X_5 = rainfall July 10-September 15

X_9 = deflated price of mungbeans, current year

Y_1 = planted acres of mungbeans, current year

The regression results are shown in Table 9.

Equations 9.1 and 9.2 were fitted to the actual data. The logs of the actual data were used in equations 9.3 and 9.4. 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 9.1 and 9.2. 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 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 9: Selected Statistics Related To Alternative Equations For Predicting Mungbean Yields Per Harvested Acre

Values†		Equations†† 9.1	9.2	9.3†††	9.4†††
R^2		.75	.73	.79	.68
b_0		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	

†(t) denotes current year.
††* Significant at .95 level.
**Significant at .99 level.
†††All variables are expressed in logs in equations 9.3 and 9.4.

Conclusion

Equations 9.1 and 9.3 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 9.2 and 9.4 seem to fit the data and could be used for predicting the yield of mungbeans per harvested acre. Equation 9.2 seems to fit the data better than equation 9.4 in that it produces an R^2 of .73 as compared to an R^2 of .68 for equation 9.4. Equation 9.2 indicates that 73 percent of the variation in yield of mungbeans per harvested acre was explained by the price of mungbeans and the rainfall July 10-September 15.

PRICE OF MUNGBEANS

The correlation results failed to indicate any 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 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.

Summary

This bulletin reports results of a study to determine the profitability of growing mungbeans on sandy soils in central Oklahoma. Economic data were developed to show estimated costs and returns from mungbeans when grown in a double cropping system with wheat. These cost and return estimates were compared with similar estimates for wheat grown as a single crop.

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.

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 indicated that 70 percent of the yearly variation in planted acreage of mungbeans was explained by the June 10 to July 10 rainfall and the price of mungbeans the previous year.

The analysis indicated that rainfall from July 10 to September 15 and the price of mungbeans the current year accounted for 73 percent of the annual variation in yields of mungbeans per harvested acre.

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

More complete mungbean import and consumption data and adequate knowledge of the mungbean market structure could improve the study.

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APPENDIX TABLE I: Estimated Per Acre Labor and Machinery Requirements for Wheat and Mungbean Production

Operation	Size of Equipment	Size of Crew	Times Over			Acres Per 10 Hrs.			Time Per Acre Once Over: Man Hrs.			Time Per Acre Once Over: Machine Hrs.			Total Time Per Acre: Man Hrs.			Total Time Per Acre: Machine Hrs.		
			A†	B††	C†††	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
Plow-Moldboard	3 x 14″	1	1	1	-	16.4	16.4	--	.73	.73	--	.61	.61	--	.73	.73	--	.61	.61	--
Harrow-Springtooth	12′	1	1.6	2.6	_	40	40	--	.30	.30	--	.25	.25	--	.48	.78	--	.40	.65	--
Planting-Drill	16 x 8″	1	1	1	1	40	40	.40	.30	.30	.30	.25	.25	.25	.30	.30	.30	.25	.25	.25
Disk, Tandem	8′	1	_	_	1	_	_	.26	--	--	.46	--	--	.38	--	--	.46	--	--	.38
Total preharvest per planted acre															1.51	1.81	.76	1.26	1.51	.63
Adjusted to per harvested acre (111 percent of planted acres)															1.68	2.01	.84	1.40	1.68	.70
Combine-Self Propelled	12′	1	1	1	1	34	40	40	.35	.30	.30	.29	.25	.25	.35	.30	.30	.29	.25	.25
Seed Hauling-Truck	1½ ton	1	1	1	1	66	40	40	.15	.30	.30	.06	.25	.25	.15	.30	.30	.06	.10	.10
Total Harvesting															.50	.60	.60	.35	.35	.35
Total															2.18	2.61	1.44	1.75	2.03	1.05

Source: Survey of 20 mungbean producers in Kingfisher and Logan counties, 1957.
† A refers to mungbeans grown as a single crop.
†† B refers to winter wheat grown as a single crop.
††† C refers to winter wheat grown after mungbeans in a double cropping system.

APPENDIX TABLE II Estimated Costs of Repairs and Lubrication Per Hour of Operation for Specified Machinery on a Typical 430 Acre Cropland Farm.

Machine (Typical)	Size	New Price†	Repairs: Percent of New Price††	Repairs: Cost Per Year	Repairs: Hours Operated Per Year†††	Repairs: Cost Per Hour	Lubrication: Percent of New Price††	Lubrication: Cost Per Year	Lubrication: Hours Operated Per Year†††	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	1½ T.	2,950	5.0	147.50	1,040	.142	0.7	20.65	1,040	.019	.16

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

††Repair and lubrication costs were based on F. C. Fenton and G. E. Fairbanks (4), *The Cost of Using Farm Machinery*; Engineering Experiment Station Bulletin 74, Kansas State College, Manhattan, Kansas, September, 1954.

†††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 III. Estimated Fuel and Oil Consumption and Per Hour Cost for Operating a Three-Plow Tractor or a 12′ Self-Propelled Combine.

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, (4) *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 IV. Estimated Fuel and Oil Consumption and Cost Per Hour for Operating a 1½ Ton Truck for Hauling Wheat or Mungbeans from Combine to Market.

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 pre 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 V. Estimated Per Hour Fixed Cost For Specified Machinery.

Machine	Size	New Price†	Total Fixed Cost as Percent of New Price††	Cost Per Year	Hours Operated Per Year†††	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	1½ T.	2,950	14.0	413.00	1,040	.40	.40

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

††F. C. Fenton and G. E. Fairbanks, (4) *The Cost of Using Farm Machinery*; Engineering Experiment Station Bulletin 74, Kansas State College, Manhattan, Kansas, September, 1954.

†††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 VI. Estimated Per Acre Machinery Cost For Mungbeans As A Single Crop.

Operation	Size of Equipment	Operating Cost Per Hour: Repair and Lubrication†	Operating Cost Per Hour: Fuel and Oil††	Operating Cost Per Hour: Tractor Operating Cost Per Hour	Operating Cost Per Hour: Total Operating Cost Per Hour Including Tractor	Fixed Cost Per Hour†††	Machine Operating Time Per Acre§	Operating Cost Per Acre	Fixed Cost Per Acre	Total Cost Per Acre
		Dollars				*Dollars*	*Hours*	*Dollars*		
Tractor	3-plow	.18	.55 (110x. 73=.80)§§		.80	.61				
Plow Moldboard	3 x 14″	.19		.80	.99	.87	.61	.60	.53	1.13
Harrow Springtooth	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	1½ 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

†See Appendix Table II.
††See Appendix Table III and IV.
†††See Appendix Table V.
§See Appendix Table I.
§§Tractor operating cost was increased to allow for idling time and to and from field driving.

APPENDIX TABLE VII. Estimated Per Acre Machinery Cost For Wheat As A Single Crop.

Operation	Size of Equip-ment	Operating Cost Per Hour: Repair and Lub-rica-tion†	Operating Cost Per Hour: Fuel and Oil††	Operating Cost Per Hour: Tractor Operating Cost Per Hour	Operating Cost Per Hour: Total Operating Cost Per Hour Including Tractor	Fixed Cost Per Hour†††	Machine Operating Time Per Acre§	Operating Cost Per Acre	Fixed Cost Per Acre	Total Cost Per Acre
			Dollars			*Dollars*	*Hours*		*Dollars*	
Tractor	3-plow	.18	.55 (110x. 73=.80)§§		.80					
Plow Moldboard	3 x 14″	.19		.80	.99	.87	.61	.60	.53	1.13
Harrow Springtooth	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	1½ 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

†See Appendix Table II.
††See Appendix Table III and IV.
†††See Appendix Table V.
§See Appendix Table I.
§§Tractor operating cost was increased to allow for idling time and to and from field driving.

APPENDIX TABLE VIII. Estimated Per Acre Machinery Cost For Wheat Following Mungbeans in a Double Cropping System.

		Operating Cost Per Hour								
Operation	Size of Equipment	Repair and Lubrication†	Fuel and Oil††	Tractor Operating Cost Per Hour	Total Operating Cost Per Hour Including Tractor	Fixed Cost Per Hour†††	Machine Operating Time Per Acre§	Operating Cost Per Acre	Fixed Cost Per Acre	Total Cost Per Acre
		Dollars				*Dollars*	*Hours*	*Dollars*		
Tractor	3-plow	.18	.55 (110x. 73=.80)§§		.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 harvested 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	1½ T.	.16	1.09§		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

†See Appendix Table II.
††See Appendix Table III and IV.
†††See Appendix Table V.
§See Appendix Table I.
§§Tractor operating cost was increased to allow for idling time and to and from field driving.

APPENDIX TABLE IX. Data Used in Statistical Analysis, 1942-1959.

Year	Deflated Price of Mungbeans† in (t) cents/lb. $X_9; X_1; Y_3$††	Rainfall††† June 10 to July 10 inches X_2	Deflated Price of Cowpeas† in (t-1) cents/lb. X_3	% of Wheat Abandoned in Kingfisher County in (t) X_4	Rainfall††† July 10 to Sept. 15 inches X_5	Mungbean Production in (t-1) (1000 lbs.) X_6	Mungbean Production Plus Imports in (t) (1000 lbs.) $X_8; X_{11}$§	Acres of Mungbeans Planted in (t) (1000 acres) Y_1	Yield of Mungbeans/ Harvested Acre in (t) (pounds) $Y_2; X_{10}$§§
1942	6.76						5,400		540
1943	11.49	.96	3.47	30.7	2.73	5,600	6,300	45	180
1944	20.68	3.89	5.06	7.1	5.67	6,300	11,000	75	200
1945	14.01	9.61	4.79	5.2	4.38	11,000	24,200	169	220
1946	9.79	4.64	3.12	9.8	4.64	24,200	14,800	110	210
1947	8.00	3.27	4.25	7.2	2.28	14,700	10,380	62	250
1948	4.99	10 58	4.26	5.1	4.68	10,080	16,400	64	320
1949	3.88	4.65	3.05	4.9	6.04	16,000	9,500	31	400
1950	3.74	4.59	2.76	21.0	13.55	9,000	14 050	40	450
1951	5.03	4.74	2.98	36.4	7.01	13,950	5,500	30	250
1952	15.54	.83	3.15	9.7	3.84	4,000	9,900	20	120
1953	7.44	1.54	3.71	15.6	8.76	1,200	8,700	28	325
1954	10.48	.99	3.72	10.2	3.01	6,500	5,040	18	100
1955	6.09	2.43	3.93	51.1	3.26	840	9,000	38	280
1956	11.80	2.21	2.74	4.4	3.76	7,000	7,835	32	200
1957	5.33	5.07	3.25	20.1	6.47	2,400	9,522	28	380
1958	3.63	7.55	2.70	4.7	10.32	7,600	16,568	35	550
1959	2.83	4.33	2.50	4.4	7.01	14,850	(4167)	25	290

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

††The deflated price of mungbeans in the current year was indicated as X_9 when used as an independent variable in Table 9 and as Y_3 when used as a dependent variable in price analysis. A lag of one year in this data resulted in data for (X_1 variable) the deflated price of mungbeans in (t-1).

†††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.

§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).

§§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).

(t) indicates current year and (t-1) indicates previous year.

Source: (1), (5), (6), (7), (8), and (9).