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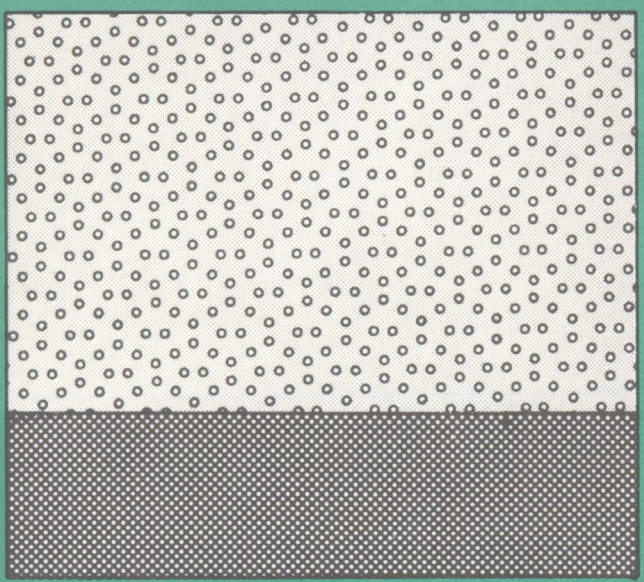
Suspension and Non-Suspension Fertilizer Use in the Tennessee Valley Area of Alabama



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Suspension and Non-Suspension Fertilizer Use in the Tennessee Valley Area of Alabama

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FERTILIZATION, LIMING, AND CROPPING practices in the Southeast have improved substantially over the years in response to economic signals reflecting market, educational, and technological developments. Innovation is continuing and practices are becoming more exact with each technological gain in the crop and soil sciences. Now, a relatively new innovation, suspension fertilizer, is being introduced in the Southeast by the Tennessee Valley Authority. Already a significant number of farmers have adopted the material in certain areas of Alabama and its use is growing.

Suspension fertilizers are opaque fluids containing undissolved nutrient crystals held in suspension by a clay gelling agent. This fertilizer type must be agitated to maintain consistency and thus requires specialized equipment for handling. Although there is no difference in crop response to nutrients from traditional fertilizer materials or from suspension fertilizers, suspensions are purported to offer other substantial benefits *(1)*. They have a relatively high analysis, about twice that of clear liquid fertilizers, and are easier to handle than granular or dry mixed fertilizers. Suspensions offer the opportunity for more uniform application than with granular fertilizer, in addition to being convenient carriers of pesticides and herbicides. Further, there are fewer problems with air and

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[2]Appreciation is expressed to Alabama Cooperative Extension Service personnel and retail fertilizer dealers who helped identify farmer participants for data collection purposes, and to the surveyed farmers for their support of this project. Appreciation also is extended to George L. Harrison for input into the survey and data summarization phases and to William D. Warren for input into the analysis phase of the study.

stream pollution from the manufacture of fluid fertilizers as opposed to granular or mixed fertilizers. Thus, this type fertilizer may have the potential for additional benefits to farmers.

Some farmers have accepted this product while others have continued with the traditional materials. There has been a lack of verifiable information as to why farmers have switched to suspension fertilizers and how use of this material has affected traditional cultural practices in introduction areas. Such information could assist farmers, researchers, extension workers, and agribusiness firms in improving the decision-making process and thereby contribute to increased efficiency of the resources used in the agricultural sector.

The rational economic reasons for shifting to suspension fertilizer may be related to its compatibility with existing cultural practices and the opportunity to combine operations which will reduce field travel. Knowledge to support this hypothesis may be enhanced by contrasting characteristics of traditional versus suspension fertilizer users, and by determining their respective reasons for use of these materials.

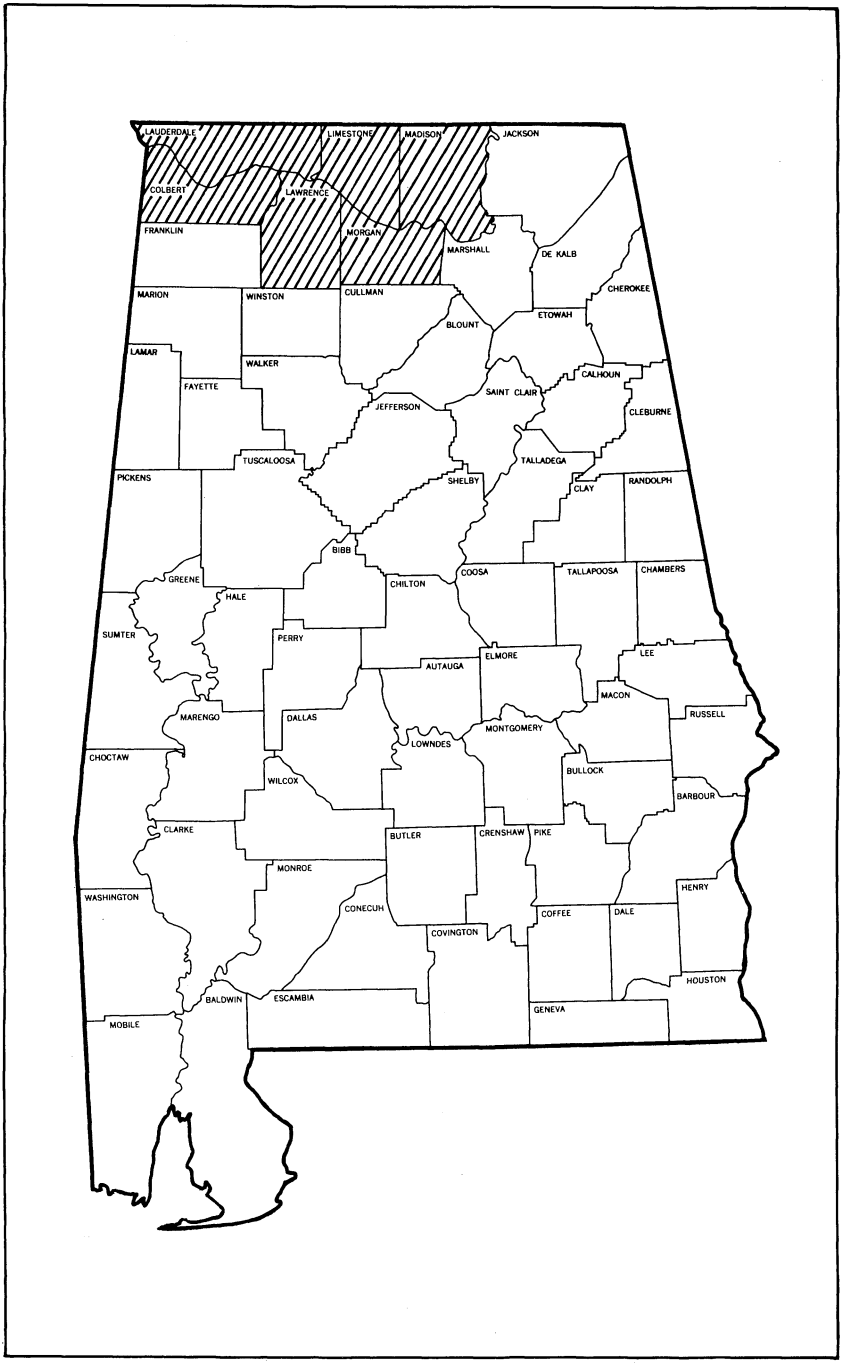
This study reports the results of research by the Alabama Agricultural Experiment Station in collaboration with the TVA to determine selected characteristics of farmers who have switched to suspension fertilizers and the reasons for their switching. In the process of collecting data to meet these objectives, sufficient information was accumulated to compare fertilizer equipment use and ownership patterns, production techniques, and production costs of suspension versus non-suspension fertilizer users on selected crops.

OBJECTIVES

Objectives of the study were to: (1) determine the differences in characteristics between suspension and non-suspension fertilizer users in the Tennessee Valley area of Alabama, (2) identify differences in production practices for selected crops associated with suspension versus non-suspension fertilizer usage, and (3) determine the economic impact of any differences in crop production practices related to fertilizer usage, through the use of enterprise budgets.

METHOD OF SAMPLING

The study area encompasses six Alabama counties in the Tennessee Valley: Colbert, Lauderdale, Lawrence, Lime-



Counties in which study was conducted.

stone, Madison, and Morgan, see map. This area consists mainly of row-crop operations with some livestock enterprises. The most common row crops are cotton, soybeans, and corn.

During the summer of 1978, survey data on the 1977 crop year were collected. Two questionnaires were developed to profile suspension and non-suspension fertilizer users in the study area. Both questionnaires were administered by enumerators, but each was executed at a different time. The two-questionnaire approach was used to eliminate collection of unnecessary data and ensure adequate representation of all fertilizer user and crop subgroups.

The first questionnaire was used to solicit basic data on demographics, management decisions, fertilizer materials used, and general agronomic and economic characteristics. Dichotomous, multiple choice, and open-ended questions were asked, with each interview requiring 10 to 20 minutes. Survey responses are presented in the appendix and discussed in the next section.

The second questionnaire was applied to a subgroup of farmers chosen from those who responded to the first questionnaire. These farmers were selected with regard to the crop and number of acres they produced. Information on the sequence of field operations for cotton, corn, and soybeans was obtained. No farmer was asked to provide data for more than two crop enterprises. This questionnaire format was open ended, taking 20 to 40 minutes to administer.

The number of respondents sampled for this survey consisted of 43 suspension fertilizer users, 43 non-suspension fertilizer users, 14 who were using both types of fertilizer simultaneously, and 13 who used non-suspension fertilizer in 1977 and suspension fertilizer in 1978. The total sample number was 113 respondents. Survey data were subjected to analysis of variance by the simple F-test to determine relationships. A 5-percent level of significance indicates that a depicted relationship occurs by chance with only a 5-percent probability.

GENERAL DESCRIPTION OF FERTILIZER USERS

The average age of respondents was 47 years. By comparison, the 1974 Census of Agriculture revealed the average age

of farmers in the six-county area to be 51 years *(4)*. The formal education of survey respondents averaged 12 years, notably above the 1970 Census statistic of 9 years for the same age group in this geographical area *(5)*. Tenure in farming for this sample averaged 25 years, but ranged from 1 to 69 years. Eighty-one percent of the respondents did not work off the farm during the year. Seventy-seven percent were receiving all of their income from their farms and about 4 percent had some outside investment paying dividends. Those who did work off the farm usually did so during the winter months.

Farmers answering the first questionnaire were divided into four groups: non-suspension users, suspension users,

TABLE 1. AVERAGE FARM ACREAGES OF RESPONDENTS IN TENNESSEE VALLEY AREA OF ALABAMA, 1977

Respondents, by land classification and fertilizer type	Acreage in farms, by use of land				
	Total farm	Crop land	Improved pasture	Unimproved pasture	Other land
	Acres	*Acres*	*Acres*	*Acres*	*Acres*
Total operated					
Suspension	1,046	796	132	11	107
Non-suspension	1,021	688	201	22	109
Combination	1,204	835	236	10	123
Switched	1,287	965	288	0	34
Owned					
Suspension	276	186	62	0	28
Non-suspension	423	236	131	15	42
Combination	499	330	122	0	47
Switched	286	212	59	0	16
Cash rent					
Suspension	285	255	26	0	5
Non-suspension	282	187	59	7	29
Combination	196	118	66	7	5
Switched	522	320	194	0	8
Share rent					
Suspension	482	355	42	44	41
Non-suspension	299	253	25	0	20
Combination	490	372	48	0	70
Switched	471	433	35	0	3
Rent free					
Suspension	3	0	3	0	0
Non-suspension	0	0	0	0	0
Combination	0	0	0	0	0
Switched	0	0	0	0	0
Rented out					
Suspension	14	12	0	0	2
Non-suspension	18	1	0	0	17
Combination	0	0	0	0	0
Switched	0	0	0	0	0

[1]Sample size was: Suspension, 43; non-suspension, 43; combination, 14; and switched, 13.

combination users, and switchers.[3] The non-suspension users, comprising 38 percent of the sample, most commonly used dry granulated or bulk blended fertilizer, but a few were also using clear liquid fertilizers. Thirty-eight percent of the farmers used suspension fertilizers, while 12.4 percent used both suspension and non-suspension fertilizers. Another group, which comprised 11.5 percent of the farmers interviewed, used non-suspension fertilizer in 1977 and switched to suspension in 1978.

Non-suspension users owned a greater percentage of their total operated land than did suspension users, table 1. They also owned a larger percentage of cropland and improved pasture. Suspension users cash rented a larger percentage of cropland and share rented a larger portion of total farmland than did non-suspension users. There were noticeable similarities between suspension users and those who switched and also similarities between non-suspension fertilizer users and combination users.

Non-suspension Users

Non-suspension users averaged 47 years of age and had been engaged in farming approximately 26 years. Comparisons with all producers revealed these to be the more experienced farmers and slightly older. Seventy-seven percent of the non-suspension users were familiar with suspension fertilizers, but only 23 percent had used them. Of those who had used suspensions before but had switched back to non-suspension fertilizers, half reported problems related to dealer service as their reason for switching. Thirty percent had material-related problems and 20 percent gave no reason for switching back.

Satisfaction with the fertilizer material was the reason 30 percent of the non-suspension users gave for using their present fertilizer. Satisfaction with dealer service and ownership of non-suspension equipment was reported by 6 percent and 20 percent, respectively. The remainder either reported that "habit" or "tradition" was their reason or they gave no response when questioned.

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[3]For the purposes of this study the user groups were defined as: *non-suspension,* farmers who did not use suspension fertilizer as an N-P-K material in 1977 and 1978; *suspension,* farmers who only used suspensions as an N-P-K source in 1977 and 1978; *combination,* farmers using both suspension and non-suspension (dry bulk blended, granulated, or clear liquids) as N-P-K fertilizer sources in 1977 and 1978; and *switchers,* those who used a non-suspension N-P-K material in 1977 but switched to a suspension N-P-K fertilizer in 1978.

Most (63 percent) non-suspension users were unsure of the agronomic value of suspension fertilizers when compared to the non-suspension fertilizers. Eight respondents (19 percent) said there was no yield difference, while six believed that non-suspension fertilizers produced better crop yields. One believed that suspension induced the better yields and another thought that the weather played a role in which of the two produced better.

Suspension Users

The suspension users tended to be younger and to have been in farming fewer years. Their average age was 46 years, with an average of 23 years of farming experience.

Of the 43 farmers using only suspension fertilizer, 74 percent had been doing so for less than 5 years. The greatest number of these (88 percent) had switched from granulated fertilizers to suspensions, as opposed to clear liquids. Fourteen percent of the suspension users were new farmers in their 20's who had used nothing but suspension fertilizers.

The big attractions of suspension fertilizer use were quality of product and flexibility of the practice. Characteristics of the material which attracted 56 percent of the users included uniform spreading, incorporating a combination of chemicals, and ability to get correct analysis. Closely related was the labor savings potential offered by suspensions, which attracted another 20 percent. The remainder were attracted by dealer services offered in conjunction with fertilizer purchases.

Eighty-four percent of the suspension fertilizer users were of the opinion that there is no yield difference between fertilizer types. Five percent said there was a yield advantage in favor of suspensions, 2 percent thought the advantage went to non-suspension fertilizer, and 5 percent did not express any opinion on yield advantage.

All of the suspension users were making various changes in their cultural practices as a result of their fertilizer switch. Of those who modified their cultural practices, 56 percent were mixing herbicides with fertilizer for use in a single application. Two-fifths of these farmers were mixing all their farm chemicals with fertilizer for a combined application approach. Cultural practices will be more closely examined further in this study.

Combination Users

Approximately 12 percent of the sample used a combination of suspension and non-suspension fertilizers. Though the limited number of observations of combination users limits inferences, combination users were the oldest and most experienced of the four groups of farmers. This group had an average age of 49 years and had been farming an average of 29 years. Many of the characteristics of this group resembled those in the group of non-suspension fertilizer users.

Though no single reason for this combination use dominated, the more popular explanatory statements were as follows:

"I own dry fertilizer application equipment, but have suspensions custom applied because of labor shortages."

"I use a combination because I cannot always get the material I want."

"I like suspensions, but also own stock in a co-op that sells dry fertilizers."

Switchers (Non-suspension 1977-Suspension 1978)

Farmers in this group, which comprised 12 percent of the sample, had used non-suspension fertilizer the previous year but changed to all suspension fertilizer for the current year. Characteristics of this group revealed they averaged 47 years of age, 54 percent had finished high school, 77 percent obtained all their income from farming, and 84 percent had been involved with farming for more than 15 years.

Farmers in this group said they had switched to suspension fertilizer because there was a cost advantage and they could incorporate chemicals and herbicides with suspension fertilizer for a single application. The farmers also cited labor savings and better quality of suspension fertilizer as reasons for changing.

Differences Among Users

Suspension users and non-suspension users were evenly divided and comprised 76 percent of the sample. Characteristics of combination users were similar to those of non-suspension fertilizer users, and those who switched from non-suspension to suspension paralleled characteristics of users of only suspension fertilizer.

TABLE 2. DIFFERENCES AMONG USERS, BY PERCENTAGES, TENNESSEE VALLEY AREA OF ALABAMA, 1977

Item	Result, by user group	
	Used only suspensions	Used only non-suspensions
	Pct.	*Pct.*
Years farmed		
1 to 15 years	33	26
16 to 30 years	42	35
More than 30 years	25	39
	F value = 1.523	
Age of operator		
23 to 30 years	14	14
31 to 50 years	49	49
51 years and older	37	37
	F value = 0.0	
Formal education, years		
11 years and less	39	26
High school graduate	39	35
Over 12 years	22	39
	F value = 3.705*	
Proportion of income from farming		
0 to 99 percent	21	28
100 percent	79	72
	F value = 0.558	
Ratio of total acres owned to total acres operated		
0 to 33 percent	61	35
34 to 66 percent	18	28
67 to 99 percent	14	9
100 percent	7	28
	F value = 6.946**	
How many months ago did you soil test?		
Within 18 months	63	74
More than 18 months	25	21
Never soil test	12	5
	F value = 0.501	
Are the test results followed?		
Always or usually	67	79
Sometimes or partially	14	9
Never soil test or follow results	19	12
	F value = 1.353	
Number of available fertilizer dealers		
One	7	5
Two	7	9
Three or more	86	86
	F value= 0.041	
Distance from present dealer		
Own dealership	7	0
1 to 6 miles	56	35
7 or more miles	37	65
	F value = 5.467**	
Number of years with present dealer		
1 to 6 years	51	33
7 to 16 years	33	28
17 or more years	16	39
	F value = 5.801**	
Is your current dealer your closest?		
No	26	37
Yes	74	63
	F value = 1.339	
Method of fertilizer purchase		
Cash, bank credit, other	14	26
Dealer credit within 30 days	51	67
Dealer credit more than 30 days	35	7
	F value = 8.925***	

*level of significance ≥ 90%.
**level of significance ≥ 95%.
***level of significance ≥ 99%.

More suspension users had been involved in farming less than 15 years, whereas more non-suspension users had operated a farm for more than 30 years, table 2. There was no percentage difference in the age of the operators when divided into three groups: 23 years to 30 years = 14 percent, 31 years to 50 years = 49 percent, and older than 50 years = 37 percent. When comparing the operators by formal education, it was found that 39 percent of those who used only suspension fertilizer had less than 11 years of schooling, compared with 26 percent of non-suspension users. Also, 17 percent more non-suspension users furthered their education beyond high school (39 percent vs. 22 percent). Seventy-nine percent of the suspension users and 72 percent of non-suspension users obtained all their income from farming. When the users were compared by the ratio of total acreage owned to total acreage operated, 61 percent of suspension users owned only one-third of their land versus 35 percent of non-suspension users. Twenty-eight percent of the non-suspension users owned all the land they operate, as compared with 7 percent for the suspension users.

There were also managerial differences among the users in this study. When the respondents were questioned as to how long since their last soil test, more of the non-suspension users (74 percent vs. 63 percent) had tested their soil within the last 18 months. Also, 12 percent of the suspension users never used a soil test, as compared with 5 percent of the non-suspension users. Of those who soil tested, more of the non-suspension users followed closely the recommendations of the test results.

Eighty-six percent of the users in both groups had access to three or more fertilizer dealers, and 7 percent of the suspension users owned a suspension dealership. Fifty-six percent of the suspension users were within 6 miles of their dealer, whereas 65 percent of the non-suspension users were serviced by a more distant dealer. Non-suspension users were almost evenly divided with respect to the number of years they had transacted business with their present dealer (1 to 6 years, 7 to 16 years, and 17 or more), whereas 51 percent of the suspension users had used their current supplier for less than 7 years. More of the suspension users were supplied by their closest dealer than were the non-suspension users.

Dealer credit for more than 30 days was used by 35 percent of suspension users but by only 7 percent of non-suspension

users. However, dealer credit for less than 30 days was the primary mode of purchase of both groups of users.

ENTERPRISE BUDGET ANALYSIS

Previously reported data were from the initial questionnaire administered to all respondents. A subset of suspension and non-suspension users was selected from the first sample and interviewed concerning production practices used for soybeans, cotton, and corn. Data collected for corn were not sufficient to analyze.

Results of the second questionnaire indicated that individual decision makers cannot expect significant differences in yield or input costs for seed, lime, and insecticides because of change of fertilizer type. Therefore, budgets reflect a pattern of difference only in cultural practices and herbicide and fertilizer costs as determined by the survey. Budgets of production costs for soybeans and cotton are presented for suspension users and non-suspension users.

Soybeans

Budgets for suspension users and non-suspension users were calculated to show the differences in soybean production costs, tables 3 and 4. The receipts section of the two budgets reflects no statistical yield difference between the two types of fertilizers. Differences in variable costs appear between the two types of fertilizer users. Non-suspension users applied less total nutrients than suspension fertilizer users. Even though the suspension fertilizer was $10 per ton lower in cost, per acre fertilizer costs of non-suspension users were $7.75 lower. Also, interest on operating capital was less for the non-suspension budget because of the lower fertilizer cost. There were small savings per acre in the use of tractors and machinery by suspension users due to fewer trips across the field. Likewise, the fixed costs of tractors and machinery for suspension users were less. The non-suspension fertilizer budget included cost of a non-suspension fertilizer spreader and separate trips over the field for herbicide application. Summing the costs for the two budgets indicated a budgeted savings of $5.36 per acre by using non-suspension fertilizers. However, if suspension fertilizer application rates could be reduced without reducing yield, the cost advantage would shift in favor of suspension fertilizer.

TABLE 3. SOYBEANS, SUSPENSION FERTILIZER USERS: ESTIMATED COSTS AND RETURNS PER ACRE USING 4-ROW EQUIPMENT, TENNESSEE VALLEY REGION OF ALABAMA, 1979

Item	Unit	Price or cost/unit	Quantity	Value or cost
1. Gross receipts				
Soybeans	Bu.	6.00	30.00	180.00
Total				180.00
2. Variable costs				
Preharvest				
Seed	Lb.	.20	60.00	12.00
Suspension fertilizer	Ton	125.00	.17	21.25
Lime	Ton	12.00	.25	3.00
Herbicide	Acre	15.35	1.00	15.35
Insecticide	Acre	6.75	1.00	6.75
Machinery	Acre	2.84	1.00	2.84
Tractors	Acre	11.67	1.00	11.67
Interest on operating capital	Dol.	.10	32.91	3.29
Subtotal, pre-harvest				76.15
Harvest costs				
Hauling	Bu.	.03	30.00	.90
Machinery	Acre	1.20	1.00	1.20
Subtotal, harvest				2.10
Total variable cost				78.25
3. Income above variable costs				101.75
4. Fixed costs				
Machinery	Acre	16.76	1.00	16.76
Tractors	Acre	11.02	1.00	11.02
Overhead	Acre	6.50	1.00	6.50
Total fixed costs				34.28
5. Labor cost				
Preharvest labor (tractor & machinery)	Hour	3.00	2.21	6.62
Harvest labor (tractor & machinery)	Hour	3.00	.34	1.01
Total labor costs				7.63
6. Total costs				120.16
7. Net returns to land and management				59.84

Operation	Date	Times over	Labor hours	Machine hours	Fuel, oil, lubricant, repairs per acre	Fixed costs per acre
Moldboard plow	Dec.	1.00	0.574	0.475	3.22	4.15
Heavy disk	Mar.	1.00	.179	.148	1.08	2.03
Fertilizer custom applied, herbicide included	Apr.					
Do-All	Apr.	1.00	.188	.155	2.28	1.63
Planter	May	1.00	.248	.205	1.84	2.60
Row cultivator	June	1.00	.288	.238	1.69	2.35
Sprayer	Aug.	2.00	.730	.603	4.39	5.75
Self-propelled combine-grain	Oct.	1.00	.336	.280	1.20	9.28
Totals			2.543	2.104	15.71	27.78

TABLE 4. SOYBEANS, NON-SUSPENSION FERTILIZER USERS: ESTIMATED COSTS AND RETURNS PER ACRE USING 4-ROW EQUIPMENT, TENNESSEE VALLEY REGION OF ALABAMA, 1979

Item	Unit	Price or cost/unit	Quantity	Value or cost
1. Gross receipts				
Soybeans	Bu.	6.00	30.00	180.00
Total				180.00
2. Variable costs				
Preharvest				
Seed	Lb.	.20	60.00	12.00
Dry fertilizer	Ton	135.00	.10	13.50
Lime	Ton	12.00	.25	3.00
Herbicide	Acre	15.35	1.00	15.35
Insecticide	Acre	6.75	1.00	6.75
Machinery	Acre	3.05	1.00	3.05
Tractors	Acre	12.26	1.00	12.26
Interest on operating capital	Dol.	.10	29.80	2.98
Subtotal, pre-harvest				68.89
Harvest costs				
Hauling	Bu.	.03	30.00	.90
Machinery	Acre	1.20	1.00	1.20
Subtotal, harvest				2.10
Total variable cost				70.99
3. Income above variable costs				109.01
4. Fixed costs				
Machinery	Acre	17.77	1.00	17.77
Tractors	Acre	11.58	1.00	11.58
Overhead	Acre	6.50	1.00	6.50
Total fixed costs				35.85
5. Labor costs				
Preharvest labor (tractor & machinery)	Hour	3.00	2.32	6.96
Harvest labor (tractor & machinery)	Hour	3.00	.34	1.01
Total labor costs				7.97
6. Total costs				114.80
7. Net returns to land and management				65.20

Operation	Date	Times over	Labor hours	Machine hours	Fuel, oil, lubricant, repairs per acre	Fixed costs per acre
Moldboard plow	Dec.	1.00	0.574	0.475	3.22	4.15
Heavy disk	Mar.	1.00	.179	.148	1.08	2.03
Dry fertilizer spread	Apr.	1.00	.112	.093	.73	1.28
Do-All	Apr.	1.00	.188	.155	2.28	1.63
Planter	May	1.00	.248	.205	1.84	2.60
Herbicide application	May	1.00	.0	.286	.07	.29
Row cultivator	June	1.00	.288	.238	1.69	2.35
Sprayer	July	2.00	.730	.603	4.39	5.75
Self-propelled combine-grain	Aug.	1.00	.336	.280	1.20	4.28
Totals			2.655	2.483	16.51	29.35

Cotton

Budgets for cotton production indicate a clear cost advantage—both variable and fixed costs—for using suspension fertilizer, tables 5 and 6. Equivalent tonnages of both types of fertilizer were applied per acre with the suspension having a $2.50 per acre cost advantage. Suspension users in

TABLE 5. COTTON, SUSPENSION FERTILIZER USERS: ESTIMATED COSTS AND RETURNS PER ACRE USING 4-ROW EQUIPMENT, TENNESSEE VALLEY REGION OF ALABAMA, 1979

Item	Unit	Price or cost/unit	Quantity	Value or cost
1. Gross receipts				
Cotton lint	Lb.	0.60	600.00	360.00
Cotton seed	Ton	100.00	.50	50.00
Total				410.00
2. Variable costs				
Preharvest				
Seed	Lb.	.45	17.00	7.65
Suspension fertilizer	Ton	130.00	.13	16.25
Ammonium nitrate	Cwt.	6.75	2.10	14.17
Lime	Ton	12.00	.33	3.96
Herbicide	Acre	7.68	1.00	7.68
Fungicide	Acre	6.75	1.00	6.75
Insecticide	Acre	25.75	1.00	25.75
Cotton scouting	Acre	2.00	1.00	2.00
Custom spraying	Acre	1.50	4.00	6.00
Machinery	Acre	5.82	1.00	5.82
Tractors	Acre	15.59	1.00	15.59
Interest on operating capital	Dol.	.10	53.90	5.39
Subtotal, pre-harvest				117.02
Harvest costs				
Defoliant	Acre	4.00	1.00	4.00
Ginning	Lb.	.06	600.00	36.00
Hauling	Lb.	.01	600.00	6.00
Machinery	Acre	8.94	1.00	8.94
Subtotal, harvest				54.94
Total variable cost				171.96
3. Income above variable costs				238.04
4. Fixed costs				
Machinery	Acre	42.03	1.00	42.03
Tractors	Acre	14.72	1.00	14.72
Overhead	Acre	12.00	1.00	12.00
Total fixed costs				68.74
5. Labor costs				
Preharvest labor (tractor & machinery)	Hour	3.00	3.36	10.08
Harvest labor (tractor & machinery)	Hour	3.00	.87	2.62
Total labor costs				12.70
6. Total costs				253.40
7. Net returns to land and management				156.60

Continued

TABLE 5 (Continued). COTTON, SUSPENSION FERTILIZER USERS: ESTIMATED COSTS AND RETURNS PER ACRE USING 4-ROW EQUIPMENT, TENNESSEE VALLEY REGION OF ALABAMA, 1979

Operation	Date	Times over	Labor hours	Machine hours	Fuel, oil, lubricant, repairs per acre	Fixed costs per acre
Offset disk	Mar.	1.00	0.179	0.148	1.08	2.03
Fertilizer custom applied, herbicide included	Apr.					
Do-All	Apr.	1.00	.188	.155	2.28	1.63
Planter	Apr.	1.00	.248	.205	1.84	2.60
Row cultivator	May	1.00	.288	.238	1.69	2.35
Row cultivator	June	1.00	.288	.238	1.69	2.35
Row cultivator	July	1.00	.288	.238	1.69	2.35
Hiboy sprayer	July	2.00	.205	.171	1.27	5.02
Row cultivator	Aug.	1.00	.288	.238	1.69	2.35
Hiboy sprayer	Aug.	2.00	.205	.171	1.27	5.02
Cotton picker	Nov.	1.00	.873	.728	8.94	20.80
Rotary mower	Nov.	1.00	.428	.354	2.60	4.08
Moldboard plow	Nov.	1.00	.574	.475	3.22	4.15
Offset disk	Nov.	1.00	.179	.148	1.08	2.03
Totals			4.232	3.506	30.36	56.74

TABLE 6. COTTON, NON-SUSPENSION FERTILIZER USERS: ESTIMATED COSTS AND RETURNS PER ACRE USING 4-ROW EQUIPMENT, TENNESSEE VALLEY REGION OF ALABAMA, 1979

Item	Unit	Price or cost/unit	Quantity	Value or cost
1. Gross receipts				
Cotton lint	Lb.	0.60	600.00	360.00
Cotton seed	Ton	100.00	.50	50.00
Total				410.00
2. Variable costs				
Preharvest				
Seed	Lb.	.45	17.00	7.65
Dry fertilizer	Ton	150.00	.13	18.75
Ammonium nitrate	Cwt.	6.75	2.10	14.17
Lime	Ton	12.00	.33	3.96
Herbicide	Acre	9.50	1.00	9.50
Fungicide	Acre	6.75	1.00	6.75
Insecticide	Acre	25.75	1.00	25.75
Cotton scouting	Acre	2.00	1.00	2.00
Custom spraying	Acre	1.50	4.00	6.00
Machinery	Acre	6.03	1.00	6.03
Tractors	Acre	16.18	1.00	16.18
Interest on operating capital	Dol.	.10	56.89	5.69
Subtotal, pre-harvest				122.44
Harvest costs				
Defoliant	Acre	4.00	1.00	4.00
Ginning	Lb.	.06	600.00	36.00
Hauling	Lb.	.01	600.00	6.00
Machinery	Acre	8.94	1.00	8.94
Subtotal, harvest				54.94
Total variable cost				177.38

Continued

TABLE 6 (Continued). COTTON, NON-SUSPENSION FERTILIZER USERS: ESTIMATED COSTS AND RETURNS PER ACRE USING 4-ROW EQUIPMENT, TENNESSEE VALLEY REGION OF ALABAMA, 1979

3. Income above variable costs ..				232.62
4. Fixed costs				
Machinery	Acre	43.04	1.00	43.04
Tractors	Acre	15.28	1.00	15.28
Overhead	Acre	12.00	1.00	12.00
Total fixed costs				70.31
5. Labor costs				
Preharvest labor (tractor & machinery)	Hour	3.00	3.47	10.41
Harvest labor (tractor & machinery)	Hour	3.00	.87	2.62
Total labor costs				13.03
6. Total costs				260.73
7. Net returns to land and management				149.27

Operation	Date	Times over	Labor hours	Machine hours	Fuel, oil, lubricant, repairs per acre	Fixed costs per acre
Offset disk	Mar.	1.00	0.179	0.148	1.08	2.03
Dry fertilizer spread	Apr.	1.00	.112	.093	.73	1.28
Do-All	Apr.	1.00	.188	.155	2.28	1.63
Planter	Apr.	1.00	.248	.205	1.84	2.60
Herbicide application ..	Apr.	1.00	.0	.286	.07	.29
Row cultivator	May	1.00	.288	.238	1.69	2.35
Row cultivator	June	1.00	.288	.238	1.69	2.35
Row cultivator	July	1.00	.288	.238	1.69	2.35
Hiboy sprayer	July	2.00	.205	.171	1.27	5.02
Row cultivator	Aug.	1.00	.288	.238	1.69	2.35
Hiboy sprayer	Aug.	2.00	.205	.171	1.27	5.02
Cotton picker	Nov.	1.00	.873	.728	8.94	20.80
Rotary mower	Nov.	1.00	.428	.354	2.60	4.08
Moldboard plow	Nov.	1.00	.574	.475	3.22	4.15
Offset disk	Nov.	1.00	.179	.148	1.08	2.03
Totals			4.344	3.886	31.16	58.31

the sample also had lower herbicide costs per acre ($1.82 less) due to use of less herbicide materials. Machinery and tractor costs per acre were less because of fewer trips over the field. Likewise, interest on operating capital was 30¢ lower per acre. The differences in variable costs summed to a $5.42 advantage per acre for suspension fertilizer. Fixed costs were $1.57 per acre lower for suspension fertilizer users because of less equipment being required. Total costs of using suspension fertilizer were $7.33 per acre less than the total for using non-suspension fertilizer. The $7.33 represented an increase in net return per acre to land and management from using the suspension fertilizer.

SUMMARY

Suspension and non-suspension fertilizer users in the Tennessee Valley area of Alabama had distinguishing characteristics. More of the farmers using suspension fertilizer had finished high school, but a lower percentage continued their education past high school than was true for non-suspension users.

A particularly significant difference between the two groups of users was the ratio of land owned to land farmed. Twice as many suspension users owned less than one-third of the land they operated compared to non-suspension users. Also, 28 percent of the non-suspension users, four times more than suspension users, owned 100 percent of the land they farmed.

Suspension fertilizer users tended to purchase their fertilizer materials from dealers located closer to their farming operations than did non-suspension users. Fifty-six percent of the suspension users bought from dealers within 6 miles of their operations; in contrast, 65 percent of the non-suspension users purchased from dealers located 7 miles or more from their farms. As expected with an innovation such as suspension fertilizer, adopters had shorter histories with their dealers—half of suspension users had used their dealers 6 or fewer years as compared to one-third of the non-suspension users. Dealer loyalty appeared to be of more importance to non-suspension users than to suspension users.

Twice as many non-suspension users, 26 percent, paid cash or used bank credit to purchase fertilizer. However, the greatest contrast was the 5-to-1 difference, 35 percent to 7 percent, of suspension users purchasing fertilizer by dealer credit for more than 30 days.

Budget comparisons for the two types of fertilizers were tabulated for soybeans and cotton. Suspension fertilizer showed a cost advantage for tractors and machinery expenses due to fewer trips over the field and lower equipment requirements. Soybean growers who used suspension fertilizer applied more nutrients than non-suspension users without experiencing a yield increase. This would seem to indicate that equivalent amounts of suspension and non-suspension fertilizer could be used in soybean production as was found in cotton production. Fewer trips over the field, lower herbicide cost, and lower fertilizer cost resulted in a cost advantage to the user of suspension fertilizer in cotton production.

Implications

The results of this study indicate that suspension and non-suspension fertilizer users in the Tennessee Valley area of Alabama are similar, but with some significant differences. These differences are interrelated. From the suspension user's perspective, the common denominator of these differences appeared to be the use of suspension fertilizer and the attendant package of services (custom application of herbicide, micronutrient, and fertilizer in one operation) to relieve labor and investment capital constraints. In total, the results tended to indicate that the adoption of suspension fertilizer is not a marketing phenomenon—i.e., there are rational economic reasons for this fertilizer innovation's adoption and use by farmers.

The results suggest the decision criteria in the type of fertilizer choice goes beyond acquisition cost per unit of nutrient *per se* and is related to farm organization, operation, and financial management. The study revealed that suspension fertilizer users (including "switchers") were younger, had been in farming fewer years, were more tenant-oriented, and supplemented farm income with off-farm employment. These features tended to characterize suspension fertilizer users in the Tennessee Valley area of Alabama as relatively new entrants in farming or part-time and full-time owner-renters who were confronted with different problems of resource access and acquisition than those faced by the established owner-operator.

An interpretation that suspension users were utilizing suspension fertilizers and the attendant package of services to relieve critical labor constraints and ration limited investment capital is consistent with observations by others. Drache *(2)* observed that farmers who do not own sufficient land to capture the economics of commercial row crop agriculture cannot look to cashflow via technology and units of operation. Thus, custom hiring of specific jobs (e.g., fertilizer, herbicide, and micronutrient application) is an important alternative for obtaining the services of qualified labor and specialized equipment for timeliness of operation and farm firm expansion without sacrifice of off-farm income. From the investment capital perspective, the observation by Irwin *(3, p. 19)* that "an alternative approach is to avoid capital investment by buying only current use-rights to the assets, and thus substituting a

payment out of operating expenses for an investment" is appropriate.

1. Implications for Farm Management Research and Extension

Acceptance of these hypotheses implies that the basic tool of farm management research and extension, the enterprise budget, needs to be revisited. Traditional budget development, synthetic or survey in origin, generally assumes perfect substitution over wide ranges of purchased inputs, equipment, and custom services. This assumption is questionable. There is no reason to expect the production function for, say, soybeans or cotton to be constant across all farming systems or organizational structure. The appropriate technology in one instance may not be least-cost and/or most profitable for another. Likewise, an incomplete application of budgeting as the criterion for choice of fertilizer decisions could lead to reduced profits.

It follows that research and extension programs to develop firm growth strategies for beginning farmers and limited resource farmers should give increased attention to identifying alternative input service packages. Innovative use of such packages can impact equipment investment strategies, enterprise combinations, technology choice, and farm organization and operation. There appear to be a high potential payoffs in this area.

2. Implications for Input Marketing Firms

The results and implications delineated suggest a stronger "farming systems" approach to input marketing than is presently evident. This will require some analysis of farming systems, production competence, equipment and material alternatives, and operating strategies to develop a product/service package mix for the market area. Retailers should be cognizant of the problems and conflicts that can arise from the individual application of partial budgeting to each component of the product and service package. The optimum product/service package mix for one farmer may be incompatible with another's operation—i. e., there is no one "program."

3. *Fertilizer Research and Development*

The immediate implication is that fertilizer research and development programs—from conceptual design of the product to market introduction—should be broader than the technical features of the product. The potential of a market, either alone or as a joint factor of production, to alter farm organization and operation necessitates a comprehensive approach to development and evaluation. It implies that field testing and introduction efforts be broadened to encompass farming systems where appropriate rather than relying solely on plot response work. Likewise, it suggests a tailoring of the material for a target consumer group as well as the crop. Each of these will require early-on feedback into the development process.

This is not to imply that end-use considerations alone should dominate fertilizer technology development considerations. But there is sufficient evidence to suggest a broader perspective is needed when the technology has the potential to induce or facilitate significant changes in production practices and/or farming systems.

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APPENDIX
Survey Responses

I. DEMOGRAPHICS

A. Number of years in farming

Years	Response, by fertilizer used in 1977-78			
	Suspension	Non-suspension	Combination	Non-suspension 1977, suspension 1978
1-5	6	7	0	0
6-10	6	1	3	1
11-15	2	3	2	1
16-20	6	7	2	4
21-25	2	5	1	1
26-30	10	3	3	0
31-35	4	4	1	5
36-40	3	6	1	0
40+	4	7	1	1
Total	43	43	14	13

B. Age

Years	Response, by fertilizer used in 1977-78			
	Suspension	Non-suspension	Combination	Non-suspension 1977, suspension 1978
25	1	5	0	1
26-30	5	1	3	0
31-35	3	0	1	1
36-40	4	7	2	2
41-45	6	4	2	1
46-50	8	10	0	0
51-55	7	3	3	5
56-60	6	5	2	2
61-65	2	4	0	1
66-70	1	4	0	0
71+	0	0	1	0
Total	43	43	14	13

C. Years of education

Years	Response, by fertilizer used in 1977-78			
	Suspension	Non-suspension	Combination	Non-suspension 1977, suspension 1978
1-6	4	2	0	1
7-9	6	8	3	2
10-12	24	16	7	8
13-16	8	17	4	2
16+	1	0	0	0
Total	43	43	14	13

II. MANAGEMENT DECISIONS

A. Do you soil test?

Soil test	Response, by fertilizer used in 1977-78			
	Suspension	Non-suspension	Combination	Non-suspension 1977, suspension 1978
Yes	38	41	12	12
No	5	2	2	1
Total	43	43	14	13

B. Months since soil tested, as of July 1, 1978

Since soil tested	Response, by fertilizer used in 1977-78			
	Suspension	Non-suspension	Combination	Non-suspension 1977, suspension 1978
Never	5	2	2	1
6 months and less	18	13	5	3
7-12 months .	10	15	2	4
13-18 months .	4	4	4	1
19-24 months .	3	6	1	1
25-30 months .	3	1	0	0
31-36 months .	2	0	0	3
More than 36 months	3	2	0	0
Total	43	43	14	13

C. How often do you regularly soil test?

Regularity	Response, by fertilizer used in 1977-78			
	Suspension	Non-suspension	Combination	Non-suspension 1977, suspension 1978
Never soil test	5	2	2	1
Twice/year .	2	2	1	2
Once/year .	12	16	5	1
Every 2 or 3 years ..	17	11	4	7
More than 3 years ..	3	9	1	1
Whenever it needs it .	4	3	1	1
Total	43	43	14	13

D. Who performed the soil test?

Where tested	Response, by fertilizer used in 1977-78			
	Suspension	Non-suspension	Combination	Non-suspension 1977, suspension 1978
Does not soil test	5	2	2	1
Private soil test lab ..	10	2	5	3
Auburn University soil test lab	26	38	7	9
Private individual other than a soil test lab	1	0	0	0
Other	1	1	0	0
Total	43	43	14	13

E. Do you lime and fertilize according to soil test results?

Follow soil test	Response, by fertilizer used in 1977-78			
	Suspension	Non-suspension	Combination	Non-suspension 1977, suspension 1978
Always	16	20	3	6
Most of the time	13	14	5	3
Sometimes	4	1	1	0
Never	3	3	0	2
Lime yes; fertilizer no	2	3	3	1
Lime no; fertilizer yes	0	0	0	0
Do not soil test	5	2	2	1
Total	43	43	14	13

F. Where (else) do you get fertilizer and lime recommendations?

Source	Response, by fertilizer used in 1977-78			
	Suspension	Non-suspension	Combination	Non-suspension 1977, suspension 1978
Nowhere	35	34	11	10
Fertilizer dealer or sales representative	1	2	1	1
Farm supply store or co-ops	2	4	0	1
Neighbors and other farmers	0	0	0	0
County extension chairman or agent	0	0	1	1
Experiment station scientist	0	1	0	0
Extension specialist	3	0	0	0
Farm magazines	0	0	0	0
Soil test labs	0	0	0	0
Local experiment stations	0	0	0	0
Other	0	0	0	0
Experience	2	2	1	0
Total	43	43	14	13

G. How many dealers are handy to you for fertilizer purchases?

Number of dealers	Response, by fertilizer used in 1977-78			
	Suspension	Non-suspension	Combination	Non-suspension 1977, suspension 1978
1	3	2	0	0
2	3	4	0	4
3	9	12	5	3
4	9	10	4	0
5	7	3	3	2
6	9	10	1	2
7	1	2	0	0
8	2	0	1	1
9	0	0	0	0
10	0	0	0	0
11	0	0	0	0
12	0	0	0	1
Total	43	43	14	13

How many dealers are handy to you for lime purchases?

Number of dealers	Response, by fertilizer used in 1977-78			
	Suspension	Non-suspension	Combination	Non-suspension 1977, suspension 1978
1	4	12	3	0
2	8	5	2	4
3	13	12	7	5
4	8	6	1	0
5	4	4	1	1
6	5	4	0	2
7	1	0	0	1
Total	43	43	14	13

H. How far from your farm, one way, is your fertilizer dealer?

Distance	Response, by fertilizer used in 1977-78			
	Suspension	Non-suspension	Combination	Non-suspension 1977, suspension 1978
Own dealership	3	0	0	1
1-5 miles	20	12	5	8
6-10 miles	13	13	6	2
11-15 miles	4	11	2	2
16-20 miles	2	5	0	1
More than 20 miles	1	2	1	0
Total	43	43	14	13

I. How long have you been trading with your present fertilizer dealer?

Years	Response, by fertilizer used in 1977-78			
	Suspension	Non-suspension	Combination	Non-suspension 1977, suspension 1978
1-5	19	11	3	4
6-10	11	12	4	1
11-15	6	3	3	2
16-20	2	8	1	3
21-25	1	0	0	1
26-30	3	5	3	1
More than 30	1	4	0	1
Total	43	43	14	13

J. Is this the closest dealer to your farm? (If no, how many are closer?)

Closest	Response, by fertilizer used in 1977-78			
	Suspension	Non-suspension	Combination	Non-suspension 1977, suspension 1978
Yes	32	27	10	11
No	11	16	4	2
Total	43	43	14	13
Number of dealers closer				
0	32	27	10	11
1	8	8	3	2
2	1	4	1	0
3	2	3	0	0
4	0	0	0	0
5	0	0	0	0
6	0	1	0	0
Total	43	43	14	13

K. When making most of your fertilizer purchases, do you?

Financing	Response, by fertilizer used in 1977-78			
	Suspension	Non-suspension	Combination	Non-suspension 1977, suspension 1978
Pay cash	4	6	2	2
Dealer credit due within 30 days	22	29	10	8
Dealer credit due after 30 days	15	3	1	3
Bank credit	0	1	1	0
Other	2	4	0	0
Total	43	43	14	13

L. What services does your current dealer offer that you consider important?

Service	Response, by fertilizer used in 1977-78			
	Suspension	Non-suspension	Combination	Non-suspension 1977, suspension 1978
Nothing	0	0	0	1
Soil testing	13	1	2	1
Availability of chemicals or materials	6	3	1	1
Mixing to suit soil test	0	0	1	0
Custom application	8	13	3	1
Lowest cost for materials or application	0	4	0	0
Delivery	0	2	1	0
Location	0	1	1	2
Dependability	0	2	0	1
Have stock in company	0	4	0	0
Handles specific brands or products	0	4	2	0
Analysis available	3	0	0	1
Gives advice	2	2	0	0
Other	8	1	1	0
Available credit	3	2	0	0
Good service	0	2	1	0
Fast service	0	1	0	0
Furnishes equipment	0	0	1	0
Agronomic information	0	1	0	0
Total	43	43	14	13

Second most important service dealer offers.

Service	Response, by fertilizer used in 1977-78			
	Suspension	Non-suspension	Combination	Non-suspension 1977, suspension 1978
Nothing	13	20	6	7
Soil testing	12	1	2	0
Availability of chemicals or materials	1	3	0	0
Mixing to suit soil test	12	0	1	1
Custom application	4	2	2	0
Lowest cost for materials or application	0	4	2	0
Delivery	0	1	0	0
Location	0	2	0	0
Dependability	0	0	0	2
Have stock in company	0	0	1	1
Handles specific brands or products	0	2	0	0
Analysis available	0	1	0	0
Gives advice	0	0	0	1
Other	1	1	0	0
Available credit	0	2	0	0
Good service	0	2	0	0
Fast service	0	2	0	1
Furnishes equipment	0	0	0	0
Agronomic information	0	0	0	0
Total	43	43	14	13

M. Where do you get information on pesticides and herbicides?

Source	Response, by fertilizer used in 1977-78			
	Suspension	Non-suspension	Combination	Non-suspension 1977, suspension 1978
Nowhere	0	0	0	0
Chemical dealer or sales representative	16	9	7	6
Farm supply store or co-op	3	5	0	3
Neighbors and other farmers	0	2	0	2
County extension chairman or agent	8	10	2	0
Experiment station scientist	0	0	0	0
Extension specialist	8	9	4	2
Farm magazines	2	1	1	0
Local experiment stations	0	0	0	0
Experiment station publications	2	3	0	0
Experience	3	2	0	0
Other	0	0	0	0
Scouts	1	2	0	0
Labels	0	0	0	0
Books	0	0	0	0
Total	43	43	14	13

Second source of information on pesticides and herbicides?

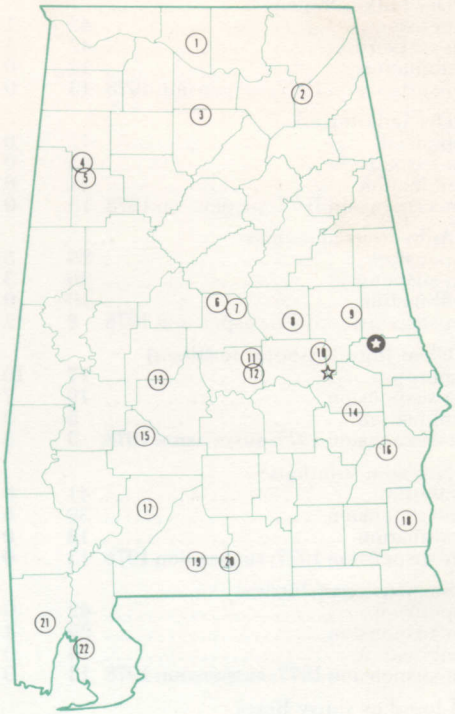
Source	Response, by fertilizer used in 1977-78			
	Suspension	Non-suspension	Combination	Non-suspension 1977, suspension 1978
Nowhere	18	11	6	2
Chemical dealer or sales representative	10	8	2	4
Farm supply store or co-op	3	5	2	0
Neighbors and other farmers	2	5	2	1
County extension chairman or agent	0	1	0	1
Experiment station scientist	0	1	0	1
Extension specialist	1	3	0	1
Farm magazines	5	6	2	3
Local experiment stations	0	0	0	0
Experiment station publications	0	3	0	0
Experience	0	0	0	1
Other	0	0	0	0
Scouts	2	0	0	0
Labels	1	0	0	0
Books	1	0	0	0
Total	43	43	14	13

N. Are any of these materials available in your area?

Material	Available			Custom application		
	Yes	No	Don't know	Yes	No	Don't know
(1) Dry bulk nitrogen						
Suspension	42	1	0	40	2	1
Non-suspension	42	1	0	42	1	0
Combination	14	0	0	11	3	0
Non-suspension 1977; suspension 1978	13	0	0	12	0	1
(2) Dry bulk mixed						
Suspension	42	0	1	41	1	1
Non-suspension	43	0	0	43	0	0
Combination	14	0	0	13	1	0
Non-suspension 1977; suspension 1978	13	0	0	13	0	0
(3) Anhydrous ammonia						
Suspension	29	5	9	20	12	11
Non-suspension	26	3	14	20	6	17
Combination	10	0	4	5	4	5
Non-suspension 1977; suspension 1978	8	2	3	6	3	4
(4) Clear liquids (starter fertilizer)						
Suspension	17	10	16	16	10	17
Non-suspension	19	7	17	16	7	20
Combination	5	3	6	1	6	7
Non-suspension 1977; suspension 1978	3	3	7	3	2	8
(5) Nitrogen solutions						
Suspension	41	0	2	40	0	3
Non-suspension	39	0	4	39	0	4
Combination	13	0	1	10	2	2
Non-suspension 1977; suspension 1978	13	0	0	12	0	1
(6) Suspensions (slurries)						
Suspension	42	0	1	42	0	1
Non-suspension	29	4	10	29	5	9
Combination	14	0	0	14	0	0
Non-suspension 1977; suspension 1978	13	0	0	13	0	0
(7) Liquid or slurry limes						
Suspension	11	16	16	10	16	17
Non-suspension	4	16	23	3	17	23
Combination	1	7	6	1	7	6
Non-suspension 1977; suspension 1978	0	8	5	0	8	5

Alabama's Agricultural Experiment Station System
AUBURN UNIVERSITY

With an agricultural research unit in every major soil area, Auburn University serves the needs of field crop, livestock, forestry, and horticultural producers in each region in Alabama. Every citizen of the State has a stake in this research program, since any advantage from new and more economical ways of producing and handling farm products directly benefits the consuming public.



Research Unit Identification

★ Main Agricultural Experiment Station, Auburn.
☆ E. V. Smith Research Center, Shorter.

1. Tennessee Valley Substation, Belle Mina.
2. Sand Mountain Substation, Crossville.
3. North Alabama Horticulture Substation, Cullman.
4. Upper Coastal Plain Substation, Winfield.
5. Forestry Unit, Fayette County.
6. Foundation Seed Stocks Farm, Thorsby.
7. Chilton Area Horticulture Substation, Clanton.
8. Forestry Unit, Coosa County.
9. Piedmont Substation, Camp Hill.
10. Plant Breeding Unit, Tallassee.
11. Forestry Unit, Autauga County.
12. Prattville Experiment Field, Prattville.
13. Black Belt Substation, Marion Junction.
14. The Turnipseed-Ikenberry Place, Union Springs.
15. Lower Coastal Plain Substation, Camden.
16. Forestry Unit, Barbour County.
17. Monroeville Experiment Field, Monroeville.
18. Wiregrass Substation, Headland.
19. Brewton Experiment Field, Brewton.
20. Solon Dixon Forestry Education Center, Covington and Escambia counties.
21. Ornamental Horticulture Field Station, Spring Hill.
22. Gulf Coast Substation, Fairhope.