HIGHLIGHTS

of agricultural research

VOL. 17, NO. 3/FALL 1970

Agricultural Experiment Station
AUBURN UNIVERSITY

DIRECTOR'S COMMENTS

E. V. Smith

AS WE COME to the harvest season, the vast majority of Americans, who are non-farmers, have cause to be grateful to that small minority who are primary producers—the farmers. Because American farmers are so efficient, consumers are wont to take the abundant and varied supply of food and other basics for granted. Reading the recurring debate on payment limitations, they tend to picture farmers as burdens to taxpayers. Without considering all factors that go into the retail food prices, they subconsciously charge the "high cost of living" to the farmer.

Despite governmental efforts "to put a floor" under farm income and farmers' adoption of scientific practices, farming remains a most hazardous business. This fact is often painfully evident to the farmer at harvest time.

Although weather forecasting has been improved, unfavorable weather continues to be a major hazard. Any one of many possible examples will illustrate the problem.

Soybeans have become a major crop in Alabama. The yield is largely determined by the availability of water during the critical pod-filling stage of about a month's duration. At the Prattville Experiment Field, soybeans were 42 in. high, blooming profusely and had the prospect of a bumper yield when examined on August 7, 1969. The potential was not realized, however, since only 2 in. of rain fell between August 20 and September 20, and the yield was just 22 bu. per acre. Two years earlier the yield had been 48 bu. when 6.7 in. fell during the critical period.

"Nature" as well as the weather often contributes to the hazards of farming. A potentially critical example of this class of hazard has appeared this year.

A common leaf disease of corn that inflicts little damage is caused by a fungus with the awesome name, *Helminthosporium maydis*. In June plant pathologists began receiving reports of a serious disease of corn in Baldwin and other south Alabama counties. Upon investigation they discovered that the new disease is caused by *Helminthosporium maydis* and concluded that a new race of the fungus has developed. More recent reports indicate that the new disease is occurring in other parts of Alabama, in neighboring states, and as far north as the Corn Belt.

As surely as new hazards will appear, agricultural scientists will initiate research aimed at their removal. It is only through the constant vigilance of agricultural science and the application of scientific information by farmers that America maintains its well-fed status.

look for these articles

may we introduce . . .

Dr. Donald Y. Perkins, author of the story on page 11 that relates the history of the Horticulture Department, joined the Agricultural Experiment Station staff of Auburn University in 1966 as head of that department.

Perkins is a native of Ponchatoula, Louisiana. He did his undergraduate and early graduate study at Louisiana State University, where he received his B.S. Degree cum laude in 1950 and M.S. in 1951. His Ph.D. was awarded by Cornell University in 1954.

Before coming to Auburn, Dr. Perkins had served on the staffs of the University of California and Louisiana State University, and for 9 years had been Principal Horticulturist in the Cooperative State Research Service, U.S. Department of Agriculture. In the latter position he was responsible for coordinating all phases of horticultural research under jurisdiction of that agency.

He is a fellow of the American Association for the Advancement of Science, and holds membership in several honorary and professional societies.

HIGHLIGHTS of Agricultural Research

FALL 1970 VOL. 17, NO. 3

A quarterly report of research published by the Agricultural Experiment Station of Auburn University, Auburn, Alabama.

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COVER PHOTO. Dairy cows and swine can both use soybeans in rations, but they need different processing. See articles on pages 3 and 5.

In Dairy Rations - - -

Soybeans or Cottonseed Meal?

GEORGE E. HAWKINS and G. H. ROLLINS
Department of Dairy Science

L. A. SMITH and H. W. GRIMES
Black Belt Substation

SOYBEANS are an excellent feed for dairy cows and may be substituted for cottonseed meal or soybean meal when prices are competitive.

This was found to be true in an experiment carried out at Auburn University to compare raw and roasted soybeans with cottonseed meal as sources of nutrients for dairy cows fed blended all-in-one rations. Measurements made on the feeds included chemical composition of the blended rations, amounts of the rations eaten daily, milk production, fat content of the milk, and body weight.

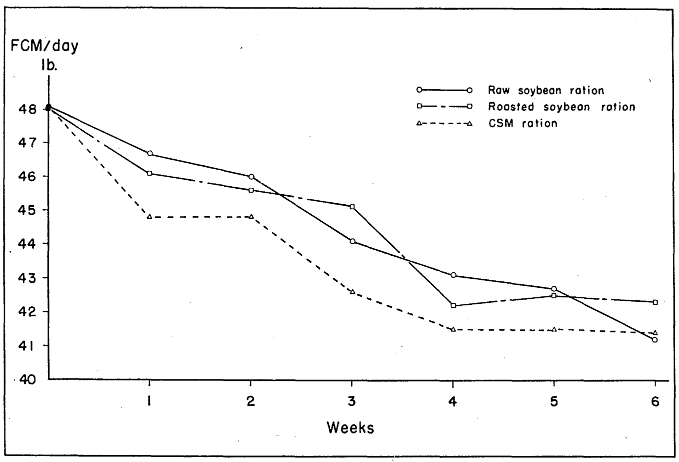
The experiment was started because the large soybean acreage in Alabama results in times when the market price of soybeans makes them an economical feed for dairy cattle. It was also undertaken because other experiments (page 5) have shown that roasted soybeans are superior to raw soybeans for pigs and other simple stomach animals, thus raising the question of whether dairy cows would respond to roasted beans.

Soybeans for the test were purchased in one lot on the open market. Concentrate mixes were prepared with 23 parts of raw or roasted soybeans or 21 parts of cottonseed meal as the principal source of protein plus 50 parts of ground yellow corn, 25 to 27 parts of crushed oats, 1 part of salt, and 1 part of mineral supplement. Prior to feeding, the ingredients were blended in the ratio of 274 lb. of a concentrate to 726 lb. of johnsongrass silage (21.1% dry matter).

A total of 18 cows, 6 per ration, were used in this 6-week test. During the last week of standardized feeding prior to the test, the cows produced 48.1 lb. of 4% fat-corrected milk (FCM). Throughout the 6-week test the cows were housed and fed in individual stalls. To ensure that quantity fed would not be a limiting factor the cows were fed more of the ration than they would eat.

Compositions of the blended rations containing raw and roasted soybeans were similar, Table 1. Both soybean rations, however, were higher in crude fat (EE) and gross energy than the cottonseed meal ration.

The average daily FCM production, Table 2, and the trends in daily FCM production, see Figure, by cows fed the raw and the roasted soybean rations were almost identical. Cows fed the soybean rations, however, averaged about a pound more FCM daily than cows fed the cottonseed meal ration. The chances are about 3 to 1 that the 1.1 to 1.2 lb. margin in FCM production by cows fed soybean rations was a true response to the rations. In 11 of the 12 comparisons cows on the soybean rations produced more milk than those fed the cottonseed meal. The exception was in the sixth week of the test when one cow on the raw soybean ration went "off feed" and her daily FCM production fell 14.8 lb. below that of the preceding week. The extra energy from the higher fat in the soybean rations compared to the cottonseed meal ration was enough to meet the energy needs for producing the extra milk. Protein levels of the soybean rations were lower than expected from average values used to formulate the rations. However, the protein intake was high enough to support milk production at the standardization level.



Trends in milk production of cows fed blended rations containing raw soybeans, roasted soybeans, or cottonseed meal as the energy source.

Milk fat per cent, body weights, and daily intakes of ration dry matter were not affected significantly by the rations.

Roasting adds to the cost of soybeans. In view of the lack of significant differences in responses of cows fed raw and roasted soybeans, roasting of soybeans for dairy cows is not warranted as a means of improving performance.

TABLE 1. COMPOSITION OF RATIONS, DRY MATTER BASIS*

Ration	CP	EE	CF	NFE	Ash	Energy
	Pct.	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*kcal/lb.*
Raw soybeans	12.4	6.5	15.8	61.2	4.1	1919
Roasted soybeans	12.5	6.9	16.3	60.2	4.1	1924
Cottonseed meal	14.0	3.7	17.0	61.1	4.2	1855

* Dry matter of johnsongrass silage averaged 21.1% and that of the blended rations averaged 39.4% as fed.

TABLE 2. RESPONSES OF COWS FED BLENDED RATIONS CONTAINING RAW OR ROASTED SOYBEANS OR COTTONSEED MEAL

Ration	Average responses*			Ration intake/day	
	FCM/ day	Milk fat	Body weight change/ day	Per cwt.	Total
	Lb.	*Pct.*	*Lb.*	*Lb.*	*Lb.*
Raw soybeans	43.9	4.43	−0.67	2.81	33.1
Roasted soybeans	44.0	4.24	+0.52	2.79	31.0
Cottonseed meal	42.8	4.33	−0.31	2.86	34.0

* The milk fat data were adjusted to take into account any initial differences between groups.

By mid-January, excellent growth of Nova vetch had occurred after reseeding in cotton (right foreground), soybeans (left foreground), and corn (left background).

NOVA VETCH—NEW VARIETY FOR ROW CROP ROTATIONS

C. C. KING, JR., *Department of Agronomy and Soils*
J. W. LANGFORD, *Plant Breeding Unit*

WITH NOVA RESEEDING VETCH, you may come close to eating your cake and having it too!

This Auburn developed variety shows promise of being able to produce a crop for grazing or green manure for 2 or 3 years from a single seed crop. It has volunteered for 2 years after the original planting produced seed in a rotation experiment at the Plant Breeding Unit, Tallassee.

The originator of Nova, Dr. E. D. Donnelly, had already established that late planted summer crops like soybeans and sorghum could be grown after the vetch had matured seed. To plant cotton or corn on time, however, it was necessary to turn the vetch ahead of seed formation. Thus, for Nova to volunteer in cotton or corn, seed must remain viable in soil for 2 or more years.

The test was begun in the fall of 1967 when 10 lb. per acre of Nova seed were seeded in standing cotton stalks. (The stalks served as a support crop for seed production.) Hand-harvested samples in spring 1968 showed a seed yield of 1,440 lb. per acre, and hard seed percentage was 83%. This yield of seed was incorporated 6 to 8 in. deep into the soil, and five treatments were studied: A – vetch-grain sorghum; B – vetch-soybeans; C – 2-year rotation of vetch-soybeans-cotton; D – 2-year rotation of vetch-soybeans-corn; and E – 3-year rotation of vetch-soybeans-corn-cotton.

Summer crops were fertilized at planting with 26 lb. P and 50 lb. K per acre. In addition, 120 lb. N was applied to the grain sorghum, corn, and cotton. The vetch got no direct fertilization.

There has been no difficulty in preparing the land or getting a stand of the summer crops following vetch for green manure or seed. Grain sorghum yields were near normal in both 1968 and 1969, but extremely dry weather in 1968 reduced soybean yields. No cotton and corn crop was possible the first year because Nova seed does not mature until early June, too late for planting cotton and corn. Good yields of cotton and corn were obtained in 1969 following the volunteer vetch crop turned for green manure.

Stand counts taken in late fall both years showed that all treatments had satisfactory vetch stands. (The photo was made in mid-January when vetch was 6 to 8 in. tall.) However, there was considerable stand loss during February from a disease, *Sclerotinia trifoliorum*, which attacks many cool season legumes. The disease abated as the weather warmed and surviving plants recovered. By the first of April, when plots were turned for planting cotton and corn, there was 2½ tons of vetch green weight per acre.

Although the disease damaged all treatments both years, it was more severe in dense vetch stands. Limited grazing might be used to control growth of the vetch and reduce the disease incidence.

Vetch seed yields ranged from 150 to 880 lb. per acre, which is adequate for fall reseeding. All vetch seed produced was incorporated into the soil prior to planting grain sorghum and soybeans.

These results established that Nova vetch will reseed in clean cultivated summer crops if allowed to produce seed at least once every 2 years. Evaluations to be made in fall 1970 will determine if the seed will remain viable in the soil for 3 years.

A limited quantity of Nova seed will be available for planting in 1970. It is suggested that initial seedings of Nova vetch follow a clean cultivated crop. Cotton is preferred because it provides a better support for seed production than corn, grain sorghum, or soybeans.

NOVA SEED YIELDS AND ROW CROP YIELDS, VETCH-SUMMER CROP ROTATIONS, PLANT BREEDING UNIT, TALLASSEE, 1968-70

Cropping treatment	Yield per acre					
	Row crops			Vetch seed		
	1968	1969	Average	1969	1970	Average
A. vetch-grain sorghum	51 bu.	57 bu.	54 bu.	580 lb.	230 lb.	400 lb.
B. vetch-soybeans	16 bu.	37 bu.	27 bu.	460 lb.	190 lb.	320 lb.
C. vetch-soybeans	15 bu.	44 bu.	30 bu.	710 lb.	880 lb.	790 lb.
cotton[1]	[2]	2,230 lb.	----	----	----	----
D. vetch-soybeans	16 bu.	43 bu.	30 bu.	740 lb.	150 lb.	440 lb.
corn	[2]	72 bu.	----	----	----	----
E. vetch-soybeans	17 bu.	42 bu.	30 bu.	840 lb.	810 lb.	820 lb.
corn	[2]	70 bu.	----	----	----	----
cotton	[2]	2,350 lb.	----	----	----	----

[1] Seed cotton yields.
[2] Cotton and corn could not be planted until after vetch seed had matured. Thus, no planting was made in 1968. These crops were planted on time in 1969.

Soybeans in Swine Rations

B. G. RUFFIN, *Dept. of Animal Science*

V. L. BROWN, *Lower Coastal Plain Substation*

Soybean meal makes up approximately 21% of the growing-finishing rations for swine and up to 25% of a pig creep ration. In a conventional corn-soybean meal ration the meal accounts for up to 30% of the total cost of the ration.

The use of roasted soybeans in the ration has become important to swine producers because recent machinery developments have made it possible to grow and process more than 90% of the ration ingredients on the farm.

Feeding trials conducted a few years ago indicated that roasted soybeans were excellent sources of protein and energy for swine. Attempts to feed raw soybeans have been unsuccessful, however, because the raw or improperly roasted beans contain antigrowth factors. These harmful factors are destroyed by proper heat treatment.

A 16% corn-soybean meal ration contains approximately 3.5% fat, whereas a ration using full-fat soybeans (38% protein) as the protein supplement contains about 7.5% fat. While this difference is not great, the added unsaturated fat in the soybean tends to increase the deposition of unsaturated fat in swine.

If swine producers are to use full-fat soybeans as a source of protein and energy, the economics must be evaluated and the effect of the oil on carcass quality must be determined. To help resolve these questions trials were conducted in 1969-70 by the Agricultural Experiment Station. The trials, conducted at the Lower Coastal Plain Substation, involved a total of 215 weanling pigs divided into 5 similar groups.

Pigs in Group I received a 16% corn-soybean meal ration, those in Group II a 16% corn-heat treated full-fat soybean ration, and those in Group III a 16% corn-soybean meal ration with 3.5% added soybean oil. Group IV received the same ration as Group II but the soybeans were raw and the ration was pelleted. Group V received the same ration as Group I but in pelleted form.

The heat treated full-fat soybeans were prepared by heating to 235-245°F in a "Roast-A-Tron" unit. The roasted soybeans were then ground and mixed into the ration in the same way as the soybean meal.

To determine feed efficiency, consumption records were maintained for each lot. When the pigs in each lot approached 210 lb. they were removed and slaughtered. Samples of backfat from the area of the last rib and of leaf fat were collected from each animal, frozen, and iodine numbers were determined.

The summary of the data collected during the trials is shown in the table.

EFFECTS OF FEEDING HEAT TREATED FULL-FAT SOYBEANS TO PIGS AS A SOURCE OF PROTEIN AND ENERGY

	Group				
	I	II	III	IV	V
Pig performance					
Number of pigs	53	53	53	28	28
Initial wt., lb.	65.8	65.7	64.6	62.2	62.1
Final wt., lb.	211	209	212	190	209
Days fed	101	93	99	112	98
Average daily gain, lb.	1.47	1.54	1.51	1.21	1.59
Lb. feed/cwt. gain	371	335	336	393	346
Carcass data[1]					
Dressing percentage	69.1	70.7	69.5	----	----
Carcass length, in.	30.5	30.7	30.6	----	----
Loin eye area, sq. in.	4.35	4.40	4.50	----	----
Ham and loin, pct.	39.7	39.0	38.1	----	----
Lean cuts, pct.	57.2	56.5	56.1	----	----
Backfat thickness, in.	1.38	1.42	1.48	----	----
USDA Grade	1.94	2.06	2.27	----	----
Specific gravity	1.0464	1.0420	1.0395	----	----
Iodine number					
Backfat	58.42	71.59	72.88	----	----
Leaf fat	52.34	66.50	68.23	----	----

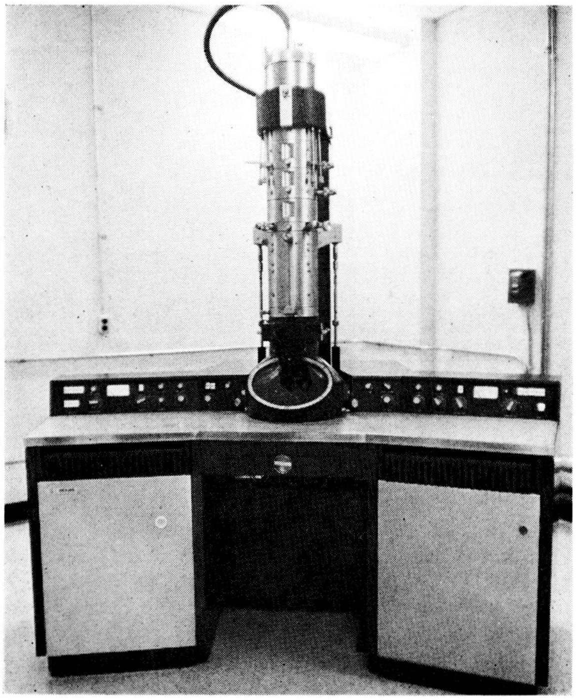
[1] Ten pigs from each treatment furnished carcass data.

Pigs fed the heat treated soybean ration did not gain appreciably faster than pigs that received the basal corn-soybean meal ration. The addition of soybean oil to the ration fed Group III made the diet equivalent in calories to the heat treated full-fat soybean ration fed Group II. This did not significantly improve the average daily gain for Group III pigs above those in either Group I or Group II. The pigs receiving the raw soybeans, Group IV, had a growth rate significantly below those in the other groups. Average daily gain for Group IV was only 1.21 lb., which was 27% lower than the 1.54 lb. of Group II, the high group.

Pigs receiving the ration containing the roasted soybeans and the ration with added soybean oil showed reduced feed requirements of 12% and 10%, respectively, when compared with those receiving the basal ration. The improved feed efficiency exhibited by these two groups was apparently the result of the oil in the heat treated full-fat soybeans and the added soybean oil.

Little or no difference in carcass length or dressing per cent was found among treatments. Backfat thickness was slightly higher in Groups II and III than in the group receiving the basal ration. The USDA Grade was higher for Group III than for Groups I or II. The lower specific gravity in Groups II and III demonstrated that the carcasses were fatter than those in Group I. The two lots (II and III) receiving the higher soybean oil diets also produced backfat and leaf fat with higher iodine numbers, indicating a more unsaturated fat and a less firm carcass.

Results of these trials indicate some of the differences in performance and carcass quality a producer might expect if he decides to use heat treated full-fat soybeans or added soybean oil. The choice of whether to use these energy sources or soybean meal depends not only on these differences but also on the cost of the raw soybeans plus processing compared with the price of the extracted meal.



The electron microscope is an invaluable tool in agricultural research.

ELECTRON MICROSCOPY in AGRICULTURE

E. C. MORA and G. G. BRADLEY
Department of Poultry Science

THE ELECTRON MICROSCOPE is no longer considered an exotic laboratory item. It is firmly established as a necessary standard piece of equipment in most academic and industrial laboratories.

The number of people using electron microscopes has increased markedly during the last decade and there has been a corresponding increase in the types of work projects requiring electron microscopy.

The use of electron microscopy in research has reached a stage in which this instrument is providing one of the most powerful means of investigating biological organization at the molecular and supramolecular levels. The recently refined techniques of ultrathin sectioning, negative staining, and preparation of ultrathin films have escalated the use of the electron microscope.

The electron microscope is found in most agricultural research laboratories. Within the past year, agricultural scientists saw for the first time the viruses which cause Marek's disease of chickens, an infectious and costly malignant disease. Recognition of the virus responsible for this neoplasm enabled the scientists to work on the development of an anti-chicken neoplasm vaccine. Most techniques developed in this research can be applied to the study of human cancers.

Animal scientists use the electron microscope to diagnose diseases, identify the causative agents and to determine disease processes almost at the level of molecules. The results have been most rewarding. For instance, diseases once thought to be organic in nature, such as some respiratory diseases, were found to be caused by organisms smaller than bacteria but bigger than viruses. This information, originating in agricultural laboratories, was effectively used in the diagnoses of human diseases.

Plant scientists have made increasing use of the electron microscopical techniques in the study of plant structures and physiology and in the diagnoses of plant disease processes. For many years plant viruses were used as the specimens of choice in the study of virus morphology.

Recent innovations in electron microscope designs have made the electron microscope almost a necessity in agricultural laboratories. The new scanning electron microscope has done away with some of the more tedious specimen preparation procedures and at the same time large specimens may be visualized. The standard transmission electron microscope requires a specimen about 1/50 in. square and 1/150,000 to 1/300,000 in. thick. The preparation of such a specimen requires several days for processing. However, a specimen the size of an ordinary fly can be studied in the new scanning electron microscope. The scanning instrument provides a new needed tool for agricultural scientists in all areas of research. Soil scientists, parasitologists, ecologists, botanists, and food technologists are making much use of the scanning electron microscope throughout the United States.

Electron microscopy is not a simple extension of light microscopy. Electron microscopy proceeds at a slower pace than light microscopy. This sluggish pace is intrinsic to electron microscopy. It takes several years' work to analyze and photograph with the electron microscope the same area that could be photographed in less than an hour with the light microscope. The limit of effective magnification with the light microscope is under 2,000 x. A magnification of up to 500,000 x can be obtained with the electron microscope. These differences show why the area visualized with the electron microscope is only a minuscule part of the area seen with the light microscope.

Most new textbooks dealing with biology include electron micrographs of one type or another. Hence, some understanding of electron microscopy is necessary for teaching purposes. Auburn University has established an electron microscopy laboratory complex including a Phillips EM 300 transmission electron microscope and necessary accessories in the School of Agriculture and Agricultural Experiment Station. The laboratory is situated in the Animal Science building and the physical and training facilities are available to any researcher and for demonstration purposes. A scanning electron microscope is not yet available at Auburn University.

Wintering Brood Cows on Limited Hay and Supplement

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V. L. BROWN, *Lower Coastal Plain Substation*
W. B. ANTHONY, *Department of Animal Science*

MATURE BROOD COWS can be wintered on hay alone. But there are two conditions that must be met: (1) they must be in good flesh at beginning of winter, and (2) they must be provided good quality spring grazing immediately following so that body weight losses can be recovered.

It's a different story with young cows, however, as learned several years ago in a 9-year wintering test at the Lower Coastal Plain Substation, Camden. Such animals require special winter treatment, including additional protein and energy feed. (See Agricultural Experiment Station Bulletin 393, October 1969.)

In the long-term test, cows confined to a bermudagrass sod lot and full-fed medium quality grass hays lost an average of 110 lb. during winter (November 1-April 1). This was not excessive loss and did not lower performance of mature cows. These cows were fed 24.7 lb. of hay daily – 1,072 lb. per winter season more than cows that got protein supplement and hay.

These results suggested that a protein supplement might permit an appreciable savings in hay for wintered beef cows. This idea was supported by results of later Substation trials.

Three wintering rations were evaluated with beef cows during a 3-year test: Group 1 – Coastal bermudagrass (CB) hay full-fed with 1 lb. of 65% protein-mineral supplement per cow daily; Group 2 – CB hay limited to about 15 lb. daily plus 1 lb. of protein-mineral supplement; and Group 3 – CB hay full-fed with no protein supplement.

Fifteen cows were assigned to each feeding plan during November 1-April 1. All 45 cows were pastured together on Coastal bermuda pasture during the remainder of the year. The study began November 1, 1965, with 2-year-old pregnant heifers as test animals.

Calves were usually born during January or February and were creep-fed grain until April 1. The calf creep consisted of shelled corn, CB hay, cottonseed meal, cane molasses, and minerals, self-fed as a blended mixture. Cows were weighed at beginning and end of the winter feeding period. Calves were weaned at 250 days of age and evaluated on the basis of both slaughter and stocker/feeder grade.

Cows full-fed hay with protein supplement (Group 1) received an average of 22.2 lb. of hay daily, or 3,268 lb. each winter during the 3 years. Group 2 had an average hay ration of 16.4 lb., or 2,404 lb. for the period. Cows getting full-fed hay only (Group 3) averaged consuming 21.8 lb. daily, or 3,207 lb. total. Hay fed in the study averaged 5.94% crude protein.

All cows that got protein supplement were fed 1 lb. daily, or about 150 lb. total of the urea-containing mixture (Auburn-65). It consists of 59% cottonseed meal, 15% urea, 13% ground snapped corn, 13% dicalcium phosphate, and Vitamin A. This mixture was not relished by cows and was eaten rather slowly when fed in a trough under a hay rack. However, results from other tests show that it is readily consumed by cattle if mixed into a complete feed or fed with silage.

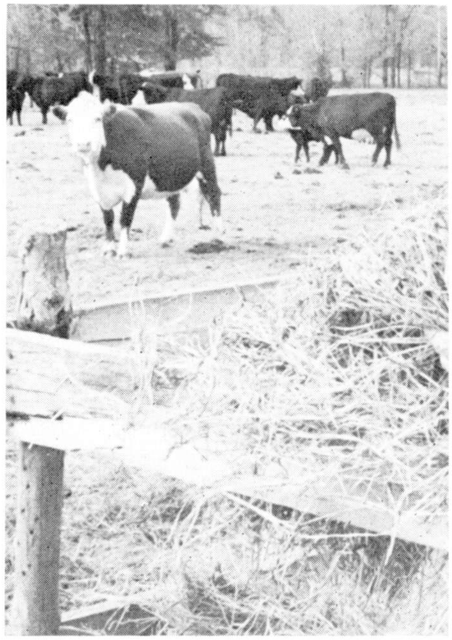
The total creep feed consumed by each calf averaged 110, 141, and 133 lb. for Groups 1, 2, and 3, respectively.

Cows given limited hay and protein supplement weaned calves weighing only 21 lb. less than those from cows full-fed hay with protein (470 vs. 491 lb.). Since these cows consumed the same amounts of supplement, the only difference in feed was the additional 864 lb. of hay consumed by the full-fed group. With hay at $25 per ton, the feed for the extra 21 lb. of calf gain cost $10.80, or 51¢ per lb.

Cows full-fed hay ate about the same amount regardless of whether protein supplement was fed (slightly over 3,200 lb.). However, those receiving 1 lb. of protein supplement daily weaned calves 44 lb. heavier (491 vs. 447 lb.). This supports the earlier finding that young cows should be fed protein supplement when wintered on grass hay.

Group 1, 2, and 3 cows lost an average of 145, 172, and 179 lb. each during the winter. Although this is a significant loss for a 900-lb. cow, it includes calving loss, so actual tissue loss was considerably less. The cows fed no protein supplement lost the most weight their first winter (2 years old). As they became older they were better able to tolerate the protein deficiency, and weight losses became progressively smaller during following winters.

Mature body size was apparently not affected by winter feeding treatment.



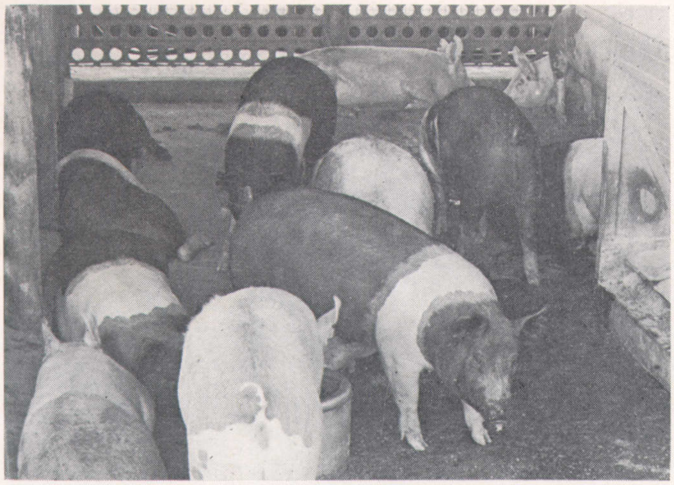
Average 5-year live weights were 1,090, 1,072, and 1,048 lb., respectively, for Groups 1, 2, and 3.

Rates of calving were similar – 93, 90, and 89% for Groups 1, 2, and 3, respectively. Calf crop weaned averaged 86, 83, and 84%. The study was too short to establish definite effects of nutritional treatment on reproduction. The effects noted were probably not related to feeding.

Calves from all treatments averaged middle Good slaughter grade and low Choice stocker/feeder grade at weaning. Feed cost per pound of calf weaned was 13¢, 11¢, and 12¢, respectively, for Groups 1, 2, and 3.

Wintering on limited hay-protein supplement appeared to be practical, since there was little difference in calf weaning weight when cows got all the hay they would eat. In fact, the 864 extra lb. of hay consumed resulted in only 21 lb. more gain for calves, but cost 51¢ per pound gain.

Protein supplement was found to be necessary during winter for young cows to grow and reproduce normally on low protein grass hay. Providing this supplement with full feeds of hay resulted in calves weaning 44 lb. heavier (491 vs. 447 lb.) than those from cows getting hay only.



Costs and Returns of Market Hog Production

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Department of Agricultural Economics and Rural Sociology

MARKET HOGS have been raised on Alabama farms as a secondary source of farm income for many years. In recent years, however, increased mechanization and improved production practices have increased specialization to the point where the hog enterprise is now a primary source of income for many farmers.

This increased specialization has enlarged the demand for more information on costs and returns of market hog production. To help satisfy this need, a study was done by Auburn University Agricultural Experiment Station to determine costs, returns, and investment required for confinement farrow-to-finish hog production. Additional objectives were to illustrate the effects of size and level of management on costs of producing market hogs.

Cost data reported are based on personal interviews with 22 producers designated as "Swine Expansion Demonstrators" by the Cooperative Extension Service. These producers were raising crossbred pigs using permanent farrowing-nursery facilities of various types, and then finishing these pigs in confinement.

Fifteen producers finished their hogs in concrete floored parlors and eight used drylots. Average costs and returns per hundredweight sold during 1967 are given in the table for producers according to size of enterprise and for all producers.

These producers sold an average of 1,252 cwt. of hogs, with gross return averaging $20.24 per cwt. Average cost of production (excluding labor) was $17.05, giving a net return to labor and management of $3.19 per cwt. sold. When the 2.2 hours of labor per cwt. was charged at $1.50 per hour, average return to management was minus 13¢ per cwt. sold. There was an average initial investment of $13.74 per cwt. sold.

Economies of size were indicated in the production of market hogs for enterprises selling up to 3,170 cwt. annually. Average cost of production decreased from $19.07 per cwt. for the small producer group to $16.72 for the large group.

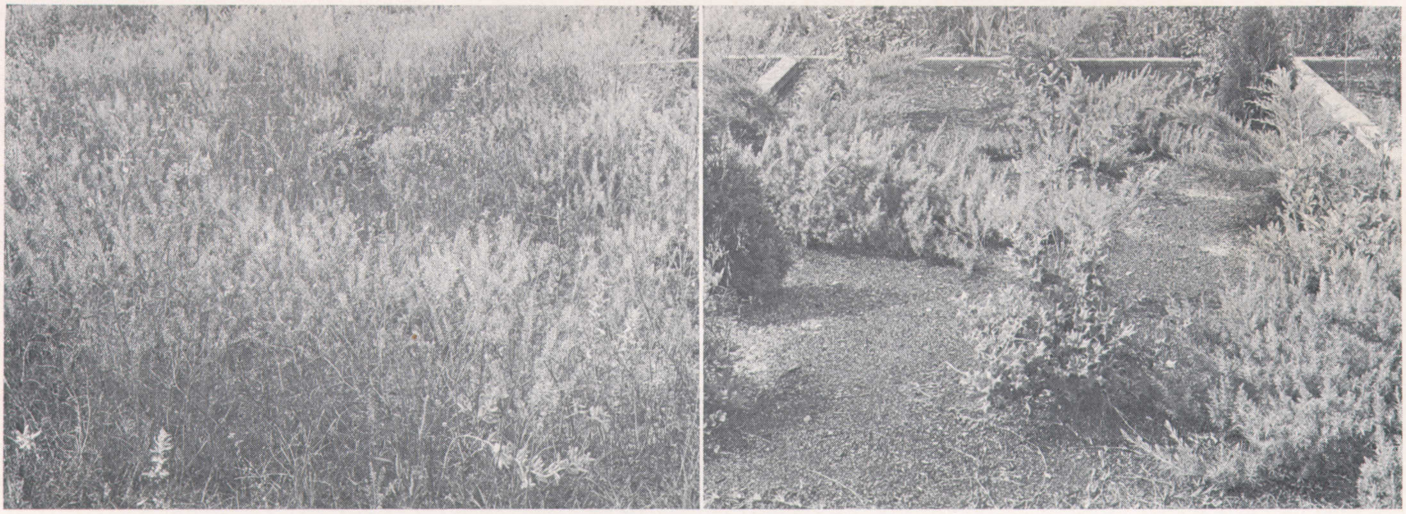
Producers with the larger enterprises had better feed efficiency than the other two groups, and thus had a lower corn cost. The large producer group was able to reduce its fixed cost per unit of production by using fixed facilities more fully because of larger herds. Labor required to produce 100 lb. of hogs decreased significantly as size of enterprise increased.

Producers were grouped according to their cost of production into low, middle, and high cost groups to determine why some producers were more efficient. The low cost producers were more efficient than the other two groups because they (1) utilized their fixed facilities more, thereby reducing fixed costs, (2) obtained a better feed efficiency, and (3) had significantly better labor efficiency.

Cost of production was $16.60 per cwt. for producers finishing hogs on concrete, compared with $18.79 on drylot. This saving was primarily because of lower feed costs. Producers finishing hogs on concrete had significantly higher initial investments, which resulted in greater fixed costs. However, their lower costs of feed because of better feed efficiency on concrete floors more than offset the increased fixed costs and resulted in lower total production costs.

AVERAGE COSTS AND RETURNS PER HUNDREDWEIGHT OF HOGS SOLD FOR FARROW-TO-FINISH ENTERPRISES

Item	Producer group			
	All	Small	Medium	Large
No. of producers	22	7	9	6
Average pork sold, cwt.	1252	474	960	2598
Gross sales	$19.71	$19.45	$19.23	$20.03
Change in inventory	.53	2.09	1.19	—.17
Gross returns	$20.24	$21.54	$20.42	$19.86
Feed costs				
Corn	8.22	9.51	8.58	7.74
Protein supplement	3.92	4.11	3.76	3.97
Feed additives	.58	.54	.24	.77
Creep & starter	1.16	1.14	1.02	1.24
Other	.04	.13	.11	----
Non-feed variable costs				
Pasture	.20	.23	.20	.20
Replacement stock	.24	.35	.14	.29
Vaccination and veterinary	.20	.23	.20	.19
Trucking	.18	.18	.17	.18
Electricity	.16	.18	.15	.15
Repairs	.12	.12	.14	.10
Other cash expenses	.23	.13	.27	.24
Interest on operating capital	.61	.67	.60	.60
Total variable costs	$15.86	$17.52	$15.58	$15.67
Fixed costs				
Capital depreciation	.56	.74	.62	.49
Interest, taxes, insurance	.63	.81	.74	.56
Total fixed costs	$ 1.19	$ 1.55	$ 1.36	$ 1.05
TOTAL COSTS	$17.05	$19.07	$16.94	$16.72
Return to labor & mgt./cwt. sold	3.19	2.47	3.48	3.14
Charge for labor @ $1.50/hr.	3.32	4.59	3.78	2.79
Return to mgt./cwt. sold	$—.13	$—2.12	$—.30	$ .35



Good weed control from 2-in. mulch of sawdust with 57 g. dichlobenil incorporated per cu. ft., right, is contrasted to the heavy weed infestation of untreated plot, left.

HERBICIDE MULCHES KEEP DOWN WEEDS IN ORNAMENTALS

KENNETH C. SANDERSON, *Dept. of Horticulture*

KEEPING DOWN WEEDS in ornamental plantings is a time-consuming and never-ending job for grower, landscaper, and home gardener. But it is a necessary chore if value of the planting is to be maintained.

Herbicide mulches offer a new approach to this weed control problem, and a method that eliminates back-breaking, hand weeding. These mulches are produced by incorporating a small amount of herbicide into mulch material. Mulching with this mixture gives all the advantages of mulching, along with efficient weed control, and with less mulch and herbicide than if used alone. Herbicide mulches will control weeds at half the depth of ordinary mulch. Getting the job done with a small amount of herbicide is desired, both for economy and to reduce chances of chemical pollution.

Herbicides such as dichlobenil, diphenamid, and trifluralin can be used. Applied at a constant depth, these herbicide mulches deliver a known rate of herbicide. Thus, no further calibration is needed in applying for effective control.

The herbicide mulch method is especially suited to use on irregular shaped plantings that are common to ornamentals. The mulch is simply spread to a constant depth and the application rate is correct. Application can be done at any time of year, but putting on in cold weather generally gives best results.

Research with the method at Auburn has involved incorporation of dichlobenil into two mulch materials, sawdust and processed garbage. Incorporation rates were 114 g. and 57 g. per cu. ft. when applied as a 1-in. and 2-in. mulch, respectively. Mixing was done in a cement mixer before application. Also included were mulches without herbicide and use of the same herbicide without mulch.

Potted liners of Harland box, Kurume azalea, Chinese juniper, Burkwood viburnum, Chinese holly, Shore juniper, and Pyramidal arborvitae were mulched immediately after planting in July 1968. Herbicide treatments were reapplied a year later by raking in broadcast dichlobenil.

Herbicide mulches proved more effective in weed control than the other treatments. Combinations of 2 in. of sawdust and dichlobenil gave the best weed control, as shown by weed coverage figures in November 1968 and October 1969 below:

Treatment	*Per cent weed coverage*		
	1968	*1969*	*Mean*
No mulch or herbicide	100	100	100
Dichlobenil, 114 g./125 sq. ft.	94	58	76
Sawdust, 1 in.	23	69	46
Sawdust, 2 in.	2	45	24
Sawdust, 1 in., 114 g. dichlobenil	30	40	35
Sawdust, 2 in., 57 g. dichlobenil	1	16	9
Garbage, 1 in.	17	81	49
Garbage, 2 in.	11	94	53
Garbage, 1 in., 114 g. dichlobenil	3	85	44
Garbage, 2 in., 57 g. dichlobenil	0	41	21

Sizeable differences in plant growth and death losses were noted among treatments. Herbicide mulch plots averaged 19% death loss after 4 months, as compared with 13% for mulch without herbicides. However, least loss from any treatment was the 2.9% from the 1-in. sawdust with dichlobenil.

Non-herbicide mulch plants averaged 33 in. tall and those getting herbicide mulch were 32 in. Plant spread averaged 37 in. with the herbicide mulch and 35 in. for the plants mulched without herbicide.

Greatest plant height and plant spread occurred with the 2-in. sawdust-dichlobenil mulch, as shown below:

Treatment	*Plant height 1970, in.*	*Plant spread 1970, in.*	*Pct. dead after 4 months*
No mulch or herbicide	29.6	26.1	5.7
Dichlobenil, 114 g./125 sq. ft.	29.7	31.8	10.5
Sawdust, 1 in.	33.7	35.4	3.8
Sawdust, 2 in.	37.9	41.5	5.0
Sawdust, 1 in., 114 g. dichlobenil	33.6	38.7	2.9
Sawdust, 2 in., 57 g. dichlobenil	38.1	43.5	5.7
Garbage, 1 in.	30.8	31.2	20.0
Garbage, 2 in.	29.5	32.7	26.6
Garbage, 1 in., 114 g. dichlobenil	28.0	32.8	24.8
Garbage, 2 in., 54 g. dichlobenil	26.7	33.0	42.0

CHANGES in LEVEL-of-LIVING of RURAL ALABAMA FAMILIES

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CONSIDERABLE CHANGES occurred between 1960-1966 in the level-of-living of families residing in low-income, rural areas of Alabama. Families were quite optimistic about their prospects for the immediate future.

Information supporting these conclusions is provided by a study of the Southern Region, concerned with the development and mobility of people in low-income, rural areas, including Alabama. The Alabama part of the survey was conducted by the Department of Agricultural Economics and Rural Sociology.

A sample of 136 families responded in both 1960 and 1966 to questions relating to the family's material level-of-living. The homemaker's perception of the family's level-of-living past, present, and future was obtained as a part of the 1966 resurvey.

Level-of-living is a measure of the material well being of people – in this case, a family or household unit. This measure is highly indicative of the social and economic status of the people. Studies have shown that a family's socioeconomic status as measured by level-of-living is related to the adjustment, satisfaction, and general well being of family members. Thus, one goal of development, especially in rural areas, is increasing the level-of-living of families.

A family's level-of-living is measured by determining the possession of certain material items, such as an automobile, piped water, and television. The table shows the percentage of households, surveyed in 1960 and 1966, which possessed selected items. More items than the 14 contained here were utilized in 1960, but analysis indicated that these were most important in measuring level-of-living for these rural families.

Items most often owned were mechanical refrigerator, radio, gas or electric range, and television. For example, more than 96% of the families owned a mechanical refrigerator. Approximately 85% had ranges, radios, and televisions. A majority of the households had items most directly influencing their physical well being – piped water, mechanical refrigerator, kitchen sink, range, and bath or shower. Two other items possessed by more than half of the families were automobile and telephone.

Between 1960 and 1966, there was an increase in the possession of all items except one. The largest increases occurred for bath or shower, telephone, automobile, television, and piped water. Thus, two items thought to be very important in a family's well being – bath or shower and piped water – were among those with the largest percentage increases. This is an encouraging indicator of improved housing and improved living conditions in these rural areas. There was a small decrease in possession of daily newspapers, and only a slight increase in farm or trade magazines. The latter is not surprising in that a number of the families had left farming for nonfarm jobs or retirement.

Even though considerable improvement in the levels-of-living characterizing these rural Alabama families has occurred, a need still exists for further improvements to close the gap with urban residents. One area of need is that of reading matter available in the households. Only a minority of the families reported receiving any kind of magazines or newspapers. This lack of reading materials may be partially compensated for by possession of radios and televisions. Another need is shown by the fact that approximately 41% of the homes still did not have a bath or shower, and 29% had no kitchen sink, in spite of the improvement noted. In fact, about one-third of the families possessed 7 or less of the 14 items. Thus, for many rural Alabama families, level-of-living is still low, even though it is improving.

In order to determine how families viewed their past, present, and future well being, each homemaker was shown a picture of a 10-rung ladder and asked to place her family on the rung that best represented its situation. This was done for the present when the survey was made (1966), 5 years ago, and 5 years from now. Analysis of these data indicates that homemakers were quite optimistic about their families' future and rated them higher at present than they thought they were 5 years ago. Only 40% rated their family on one of the top 3 rungs 5 years ago, compared to 57% in 1966, and 66% who thought they would be on the top rungs 5 years in the future. Conversely, only 6% felt their family would be on one of the lowest 3 rungs 5 years from now, compared to 12% who rated their present condition at that level. Actually, only 3 families felt they would be worse off in the future than they were at present. This optimism is very important in that how one feels about his or her family status may be as important, if not more so, than the actual status.

Several conclusions from these data are possible. Rural people in Alabama are characterized by relatively low, but rapidly improving levels-of-living. Moreover, they are not pessimistic about their future. At the same time, a significant number of these rural families still have very low levels-of-living, which indicates the need for further improvement.

CHANGES IN POSSESSION OF LEVEL OF LIVING ITEMS

Item	1960	1966	Change
	Per cent	*Per cent*	*Per cent*
Automobile	59.0	76.1	+17.1
Gas or electric range	75.4	87.7	+12.3
Piped water	56.7	72.9	+16.2
Telephone	35.8	54.2	+18.4
Radio	79.8	87.7	+ 7.9
Television	68.6	85.2	+16.6
Mechanical refrigerator	89.6	96.1	+ 6.5
Bath or shower	38.8	58.7	+19.9
Kitchen sink	63.4	71.0	+ 7.6
Vacuum cleaner	27.6	41.9	+14.3
Daily newspaper	44.0	41.3	– 2.7
Farm or trade magazine	48.5	49.0	+ 0.5
Magazine for women	26.1	34.2	+ 8.1
Other magazine	37.3	47.1	+ 9.8

A History of Horticulture at Auburn University

DONALD Y. PERKINS, *Department of Horticulture*

TEACHING OF HORTICULTURE dates from the early days of the founding of Auburn University (then the Agricultural and Mechanical College of Alabama). Although a degree of autonomy was achieved in the formation of the Department of Biology and Horticulture in 1896, it was not until 1903 that Horticulture was recognized as a separate and distinct department. In that year R. S. Mackintosh was named Professor of Horticulture and Horticulturist and H. O. Sargent became Assistant in Horticulture.

Professor Mackintosh served as first Head of the Department until 1910 when he was succeeded by P. F. Williams. It was during Mackintosh's tenure in 1907 that courses in horticulture were first formally described and numbered. Research in these early years emphasized variety testing and cultural experiments.

Williams was head of the department for only 2 years before his death in 1912. By this time the department had grown to three members. Serving with Williams were J. C. C. Price, as Assistant in Horticulture, and H. M. Conally who was Field Agent. E. P. Sandsten replaced Williams in 1912 but left after 1 year, going to Colorado where in later years he served as Director of the Agricultural Experiment Station. Under Sandsten, the first course in food technology was added to the Horticulture Curriculum.

Sandsten was succeeded in 1913 by Ernest Walker, but again the Department was destined to lose its department head quickly. Walker died in 1916 and was followed by G. C. Starcher who remained until 1922. When Starcher assumed leadership of the department, the staff had grown to four. Mr. Price was then Associate Professor of Horticulture, C. L. Isbell was hired in 1916 as Laboratory Assistant, and P. O. Davis was hired the same year as Field Agent.

During the decade 1910-1920, which saw four different heads of the department, it was Professor Price who provided the stabilizing influence in both teaching and research. Some of Price's students were to become distinguished in Alabama and other states. Among these were P. O. Davis, C. L. Isbell, Otto Brown, Lyle Brown, L. M. Ware, and W. D. Kimbrough.

A graduate program leading to a Master of Science Degree in Horticulture was initiated. Early graduate students of the Department were Otto Brown and C. L. Isbell, who received their M.S. degrees in 1916 and 1918, respectively. Price left the department in 1920 to become head of the Department of Horticulture at Mississippi State College.

In 1922, Dr. Isbell became Acting Head of the Department and Head in 1928, a position he held until 1930. While there were no major changes in courses during this time, J. A. Myers was employed in 1922 primarily to teach landscape gardening. This reflected a growing interest in the area of ornamentals. Interest was also increasing in forestry, and in 1928 the name of the department was changed to that of the Department of Horticulture and Forestry. During this period Dr. Isbell distinguished himself in his research on the vegetative and reproductive growth habits of pecans.

L. M. Ware became Acting Head of the Department in 1930 and Head of the Department in 1931, a position which he was to retain until his retirement in 1966. About this same time the Gulf Coast Substation was established at Fairhope in Baldwin County, and experiments in horticulture were initiated at that location.

During the 1930's and 1940's emphasis in horticultural research was on maximizing yields on small intensively cultivated acreages. With this objective in mind, Ware conceived the idea of field bins for field research in horticulture to allow simultaneous research on nutrition, culture, and irrigation of horticultural crops on several important soil types transported to the Auburn location. Interest in ornamental research was also developing, and in 1936 the first formal research project involving ornamentals was initiated. The early 1940's saw increased emphasis given to food processing research.

In 1935, D. J. Weddell joined the staff as the first trained forester of the Alabama Station. Interest in forestry continued to develop, and in 1946 forestry and horticulture were separated. At that time the name of the department again became Department of Horticulture.

Funds were provided in 1947 to establish the North Alabama and Chilton Area Horticulture substations. These two substations permitted extension of horticultural research into the central and northern portions of the State. That same year funds were made available for expanded research and teaching facilities in ornamental horticulture.

In 1961 the department moved into its present location in Funchess Hall. The new facility provided analytical, microbiological, and food processing laboratories, as well as plant growth chambers for precise research under controlled conditions to supplement field research. Emphasis in production research shifted from intensive field management systems requiring high labor use to production and management practices designed to increase labor efficiency in production.

Professor Ware retired in 1966 and was succeeded that year by Dr. Donald Y. Perkins, who is the current Department Head.

There are now 16 professional employees in the department engaged in its two curricula, General Horticulture and Ornamental Horticulture, and its 18 research projects covering the fields of fruits, nuts, vegetables, ornamentals, and food science. Staff of the department also participate in the new Food Science Curriculum, which was organized in 1967.

SLUDGE ACCUMULATION in ALABAMA SWINE LAGOONS

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Department of Agricultural Engineering

ANAEROBIC SWINE WASTE LAGOONS have been in use a relatively short time in Alabama but swine producers have apparently accepted their use.

However, it is felt that the long term operational characteristics of this method of waste disposal should be evaluated more extensively since the rate of accumulation of sludge in the lagoon has a direct effect on the lagoon life and the required frequency of sludge removal. The rate of sludge accumulation in five lagoons located on three Alabama Agricultural Experiment Station Substations was investigated during the summer and fall of 1969.

Two of the lagoons (UCP1 and UCP2) are located at the Upper Coastal Plain Substation at Winfield. These lagoons are constructed in series, with effluent from UCP1 emptying into UCP2. The water line dimensions of the lagoons are 102 x 50 ft. with 4.5 ft. depth and 105 x 50 ft. with 3.5 ft. depth for UCP1 and UCP2, respectively. The lagoons were constructed in 1962 to dispose of waste from a swine finishing house designed to accomodate 90 animals.

A third lagoon (SM1) located at the Sand Mountain Substation at Crossville was constructed in 1964 to accomodate the waste from a 100-head finishing unit on solid floors. Dimensions of the lagoon are 120 x 75 ft. with average depth of 3.5 ft.

Two lagoons (LCP1 and LCP2) are located at the Lower Coastal Plain Substation at Camden. LCP1, a non-overflow type lagoon, was constructed in 1959 to handle waste from a 100-head farrowing-finishing unit on a solid floor. Original dimensions of the lagoon were 110 x 70 ft. with 3.5 ft. depth. LCP2 was constructed in 1965 to handle waste from 320-head finishing unit on a solid floor. A farrowing house was added in 1967 with an average load of 12 sows with pigs. This lagoon functions as an overflow type for most of the year. Original size was 130 x 43 ft. with 4.0 ft. depth.

Based on the opinions of the superintendents, all lagoons surveyed were operating in a satisfactory manner. Water temperature during the survey ranged from 70°F to 90°F with an average of 80°F for the five lagoons. Past performance indicated no major odor problems. Occasional odor problems occurred after long periods of cold weather followed by warmer weather. Color of the lagoons changed from time to time with green and red hue being predominant.

Lagoons were evaluated on the basis of their volumetric allowance which is the cubic feet of lagoon volume per 200 lb. of hog weight. Although the lagoons with low volumetric allowances were not as aesthetically pleasing as the ones with larger volumetric allowances, they were apparently functioning satisfactorily.

Total volume and sludge volume of each lagoon were determined by probing. Sludge accumulation was found to be directly proportional to the number of animals served by the lagoon. The sludge accumulation also varied with the volume of lagoon allowed per animal. Other investigators have reported a definite correlation between sludge accumulation and the lagoon volumetric allowance. The lagoons with low volumetric allowance generally had higher sludge accumulation.

Results of this survey agree closely with studies in South Carolina and Louisiana. LCP1 and SM1, with volume allowances of 340 and 220 cu. ft., respectively, were found to have sludge accumulations of 12.0 and 19.0 cu. ft. per year per 200 lb. of animal weight, see table. LCP2 was found to have a sludge accumulation of only 7.4 cu. ft. per year per head, with a volume allowance of only 70 cu. ft. per head. Observations of this lagoon however revealed very active gas production and suspended solids of a very thick consistency. The bulk of the expected sludge appeared to be suspended in the liquid portion of the lagoon. UCP1 and UCP2 were constructed in series with a volume allowance of 190 and 150 cu. ft. per year per head. The lagoons are of the overflow type with an average overflow from UCP2 of approximately 0.5 gal./min. Sludge accumulation in UCP1 was found to be 8.4 cu. ft. per year per head. That in the lower lagoon, UCP2, was only 0.1 cu. ft. per year per head. This is because most of the solid material settled in the upper lagoon.

Although the shallow lagoons surveyed in this report were performing satisfactorily the loss of volume by sludge accumulation will necessitate the emptying and removal of the accumulated sludge for prolonged use. Based on current findings, allowances for sludge accumulation on the order of 12-18 cu. ft. per year per finish weight hog should be included in the design volume of all new lagoons. The current recommended volumetric allowances of 300 cu. ft. of lagoon per finish weight hog should provide for an expected lagoon life of about 10 years. Periodic removal of sludge with liquid manure equipment will extend the lagoon life indefinitely.

LAGOON AGE, VOLUMETRIC ALLOWANCE, LOADING AND SLUDGE ACCUMULATION

Lagoon	Age (years)	Volume allowance (ft.^{3}/200 lb. live weight)	Loading (200-lb. hogs)	Sludge volume (ft.^{3} per year per 200-lb. hog)
UCP1	8	190	95	8.4
UCP2*	8	150	95	0.1
SM1	5	220	100	19.0
LCP1	10	340	50	12.0
LCP2	4	70	270	7.4

* This lagoon is in series with UCP1.

KUDZU CONTROL: WHEN TO SPRAY?

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WHEN IS THE BEST TIME to spray kudzu for control?

Research results over the past 20 years indicate that most brush species were more susceptible to hormone type herbicides such as 2,4,5-T or 2,4-D in the late spring when reserves of stored food in the root are low. However, in sections of Alabama where cotton and other sensitive crops are grown, crop injury is caused by this type herbicide sprayed to control kudzu and other weed species. Recent research may provide a solution to this problem.

Preliminary studies in 1967 indicated excellent initial top kill of kudzu was obtained from picloram applied on August 4. Observations of plots in the spring of 1968 revealed that kudzu was completely eliminated on some of these areas. The objective of these experiments was to determine how late in the growing season kudzu can be sprayed with picloram and other herbicides and still obtain acceptable control.

An experiment was established in 1968 by the Auburn University Agricultural Experiment Station on U.S. Highway 84 right-of-way east of Evergreen. Plots were 800 sq. ft. on a uniform stand of kudzu. Various formulations, rates, and combinations of picloram, 2,4,5-T, dicamba, TBA, and silvex were applied by hand sprayers to individual plots on either May 22, July 9, or August 20, 1968. Counts of the number of living kudzu crowns on each plot were made April 24, 1969. Results showed that late August application was superior to the earlier applications when all the herbicides and rates were considered, Table 1. Picloram and 2,4,5-T were among the more effective herbicides. Control of kudzu was obtained at 0.25 lb. of picloram[1] per acre when applied August 20.

More extensive replicated experiments were established in 1969 on Station property north of Auburn to determine the lowest effective dosage rate for picloram and to determine the effect of date of application on kudzu control.

Picloram at rates from 0.10-0.50 lb. per acre was compared with 2,4,5-T and the combination of picloram plus 2,4-D. Plots were sprayed either on June 6, July 24, September 18, or October 28, 1969. Ratings of initial top kill were made approximately 30 days after each application date except the October 28 application. Frosts on November 3, 4, and 5 caused complete top kill of all kudzu vegetation at that time.

[1] Not available for homeowner use. Liquid formulation for use by commercial operators only. Pellet forms are available for homeowner use.

On April 22, 1970 the number of living kudzu crowns was determined by counting the emerging plants on each 400 sq. ft. plot. Picloram applied at rates less than 0.3 lb. per acre at all dates of application gave poor control of kudzu, Table 2. The addition of 2,4-D to picloram was not beneficial in the control of kudzu.

TABLE 2. INFLUENCE OF DATES OF APPLICATION ON KUDZU CONTROL, AUBURN, ALABAMA

Herbicide	Rate/A.	Live crowns/100 sq. ft.[1] in 1970			
		Dates of application in 1969			
		June 6	July 24	September 18	October 28
	Lb.	*No.*	*No.*	*No.*	*No.*
Picloram	0.1	40	22	18	31
Picloram	0.15	22	14	15	16
Picloram	0.3	2	5	9	9
Picloram	0.5	1	1	4	3
Picloram +	0.25				
2,4-D	1	5	8	9	3
2,4,5-T	4	7	6	17	44
Check	----	57	58	45	53

[1] Counts were made April 22, 1970 following herbicide applications in 1969.

The phenoxy type herbicide 2,4,5-T was less effective when applied on October 28 than when applied earlier in the year; whereas, picloram at 0.3 lb. per acre and above was effective regardless of when it was applied. The lower rates of picloram appeared to be more effective when applied in late summer or early fall. The apparent reason for the difference in reaction between picloram and 2,4,5-T is their differing resistance to degradation and movement in soils. Picloram is readily mobile in the soil and highly resistant to degradation; whereas, 2,4,5-T is decomposed faster by soil microorganisms.

Results of these studies indicate that kudzu can be controlled by spray application of picloram applied any time between June 1 and 1 week before the first killing frost. On the other hand, 2,4,5-T appears to be more effective when applied in early to mid summer. By using picloram, one can delay spraying kudzu until after cotton, tomatoes, and other sensitive crops have matured and thus avoid damage from herbicide drift.

TABLE 1. EFFECT OF HERBICIDES AND DATE OF APPLICATION ON KUDZU CONTROL EVERGREEN, ALABAMA 1968-69

Herbicide	Rate/A.	Live crowns/800 sq. ft. in 1969[1]			
		Dates of application in 1968			
		May 22	July 9	August[2] 20	Average
	Lb.	*No.*	*No.*	*No.*	*No.*
Picloram + 2,4-D	0.25 + 0.5	13	42	0	18
	0.5 + 1	6	33	0	13
	1 + 2	4	1	0	2
2,4,5-T Amine	2	6	65	22	31
	4	52	55	7	38
Dicamba	2	60	70	5	45
	4	48	44	0	31
Picloram	0.25	13	6	0	6
	0.5	7	5	0	4
	1	1	2	0	1
TBA	5	50	55	2	36
	10	3	5	0	3
2,4,5-T Ester	2	26	14	8	16
Silvex	2	18	39	8	22
Check	--	170	156	160	162

[1] Counts made April 24, 1969.
[2] Plants on these plots were much reduced in size and vigor compared to other dates of treatment.

FERTILIZATION of TURNIP GREENS

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Department of Horticulture

PRODUCTION OF TURNIP GREENS for mechanical harvest has gradually increased over the past several years, especially in the areas of the processing industry. Turnip greens can be grown as a second crop and can be produced over a short period of time as compared to other crops.

Due to the lack of current published information on the fertilization of turnip greens, this article is presented as a progress report of 1 year's work with turnips grown on a coarse textured soil in which N and K are subject to leaching during periods of excessive rainfall. Because of leaching, high rates of fertilizer were used in the study. The purpose of the study was to evaluate the effects of different levels of N, P, and K on production of quality greens, to determine the N, P, K, Ca, and Mg content in the greens, and the amounts of N, P, and K removed by the crop at the various levels applied on this type of soil.

Fertilizer was applied broadcast and incorporated with a rotary tiller. The crop was planted in multiple rows, four rows each, 10 in. apart, on a 60-in. low, flat bed. The crop was planted in September and harvested 5 weeks later. The crop was irrigated with ½ in. of water immediately after planting to ensure seed germination. Irrigation was also used during the growing period whenever rainfall was insufficient.

EFFECT OF DIFFERENT RATES OF N, P, AND K ON YIELDS OF TURNIP GREENS AND ON LEVELS OF UPTAKE OF NUTRIENTS

Fertilizer[1] N P K	Yields of greens	Uptake N	Uptake P	Uptake K	Uptake Mg	Uptake Ca
Lb./A.	*Lb./A.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*
120-70-133	17,354	.54	.06	.35	.38	.09
160-70-133	17,552	.57	.06	.39	.41	.10
200-70-133	19,562	.59	.07	.40	.39	.11
240-70-133	19,354	.61	.07	.37	.39	.10
200-35-133	16,506	.58	.06	.40	.43	.11
200-53-133	18,038	.58	.06	.44	.41	.12
200-70-133	19,562	.59	.07	.40	.39	.11
200-88-133	17,219	.59	.06	.44	.39	.11
200-70- 66	16,858	.58	.07	.31	.49	.13
200-70-100	16,400	.58	.07	.39	.45	.13
200-70-133	19,562	.59	.07	.40	.39	.11
200-70-166	18,506	.58	.06	.47	.38	.10

[1] One-half N and all of P and K was applied before planting and ½ of N applied 3 weeks after planting.

Soil before planting had a pH of 6.7, P content of 230, K 64, Ca 600, and Mg content of 96 lb. per acre.

The fertilizer treatments together with yields of greens and per cent content of N, P, K, Ca, and Mg are given in the table. Because of the preliminary nature of the data, the results are not conclusive but do indicate yield responses to some of the levels of added N, P, and K. There was a trend to higher yields with added N up to 200 lb. per acre. Increasing P from 35 to 53 to 70 lb. per acre resulted in a yield response, with 70 lb. of P giving the greatest increase in greens over the 35-lb. rate. There was a considerable yield response to 133 lb. of applied K over that of 66 lb. per acre, but further increase in the level of applied K did not result in greater response.

The N content of the greens harvested was increased as the rate of N applied was increased. Increasing the rates of P or K did not affect the N content of the greens. The greens harvested removed 95 lb. of N from the treatment receiving 120 lb. of N as compared to 128 lb. removed when the treatment received 240 lb. of applied N. There was very little increase in P content of greens as rates of applied P were increased.

Harvested greens removed 12 and 14 lb. of P, respectively, from treatments receiving 35 and 70 lb. of applied P. The per cent K content of the greens increased as the rates of K applied were increased. Also, the per cent of K increased as rates of N were increased from 120 to 200 lb. per acre. The greens removed 53 and 87 lb. of K, respectively, from treatments receiving 66 and 166 lb. of applied K.

The per cent of Mg in the greens was decreased as rates of P applied were increased up to 70 lb. of P per acre. Both the per cent of Ca and Mg were decreased as the rates of K applied were increased.

Mineral Deficiency Symptoms in Loblolly Pine Seedlings

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HAVE YOU NOTICED that loblolly pine trees are not always of a uniform dark green color? If you have noticed, did you wonder what caused the unusual color?

These color changes are always of interest to the practicing forester. He usually sets about to determine as quickly as possible if the discoloration is a result of disease, insect injury, extreme climatic conditions, toxic elements, or mineral deficiency. It is usually not too difficult to determine disease or insect injury, and extreme climatic conditions are obvious. The effects of toxic elements are more difficult to determine, but fortunately they do not occur often enough to be of major concern to the timber grower. This leaves mineral deficiency as the most troublesome cause of discoloration in loblolly pine. Of course, the discoloration itself is not important. The growth loss that usually accompanies the discoloration is important to any landowner, so research has been conducted at Auburn University to determine the extent and type of mineral deficiencies found in Alabama pine trees.

The obvious solution to a mineral deficiency is fertilization, and this is practically always justified when dealing with agronomic crops. However, fertilization must be used with caution when dealing with tree crops. Will the growth increase caused by fertilization pay for the fertilizer and labor, and will the timber be cut soon enough to prevent excessive interest accumulations on the money invested? These questions have plagued foresters and landowners for many years. Within the last few years some large landowners, notably wood pulp companies, have begun to fertilize many of their lands in the belief that it will be profitable. These companies do not wait for extreme deficiency symptoms, such as needle discoloration, to appear. They are fertilizing to increase wood production just as the grower of agronomic crops fertilizes to increase crop production. While small landowners probably cannot justify fertilization in the mere hope that wood production will be increased, they probably would be justified in adding small amounts of fertilizer where extreme deficiency symptoms such as needle discoloration appear.

The symptoms as described in this article are intended as a tool for making preliminary diagnoses of deficiencies. To verify a particular deficiency, it would be necessary to use foliar fertilization, foliar analysis, soil fertilization, soil analysis, or some combination of these methods.

Now comes the problem of deciding what the different needle discolorations and other symptoms mean when they appear on loblolly pine seedlings in Alabama. The most common discoloration is a yellowing of the pine needles. Recent research work at Auburn has shown that this usually denotes nitrogen, magnesium, sulfur, or iron deficiency. Of this group, the most likely culprit is nitrogen in any part of Alabama except the Black Belt. When the trees are growing on an alkaline soil of the Black Belt, the most likely culprit is iron. Nitrogen deficiency usually occurs on bare soils that have been eroded or where the topsoil has been removed. As soon as the trees generate a small amount of litter to cover the bare soil, the yellow color disappears. However, this process sometimes takes many years, and a small amount of nitrogen fertilizer would probably speed the process. No practical method has been discovered for relieving iron deficiency of loblolly pine growing on an alkaline soil. Pines do not occur naturally on these soils and it is best not to plant them on such soils.

Magnesium deficiency is believed to occur frequently during the growing season, but it does not persist throughout the entire season and probably does not cause as much growth loss as nitrogen and iron deficiencies. Yellow coloration due to sulfur deficiency is unknown in Alabama except for one instance in a seedling nursery.

Calcium and boron deficiency both produce a characteristic symptom in which the buds seem to break down and pine gum oozes from the tissues. In the case of calcium deficiency, the needles will also exude gum when extreme deficiency occurs. This does not seem to be true for boron deficiency. Boron deficient needles usually have a darker green color than normal colored needles. If the needles are dark green and shorter, thicker, and more twisted than normal, then the deficiency is probably zinc. There is no oozing of gum from buds or needles in zinc deficiencies.

The symptom for phosphorus deficiency is a reddish-purple coloration of the needles. This is the same color that has been reported for phosphorus deficiency in many agronomic crops. This symptom is seldom seen in forest stands but has been noted in nurseries and corrected by the addition of a phosphorus fertilizer to the soil. Potassium deficiency also produces reddish colored needles, but they do not have a purple cast. Also, potassium deficient needles tend to form a spiral arrangement around the buds.

Seedlings that are deficient in manganese do not develop normal bundles of three needles each. Most of the needles will be single needles. Copper deficient seedlings produce normal shaped needles but the needles seem to be made up of bands of greenish-yellow and tan. This is the only deficiency symptom that appears in distinct bands rather than a gradual shading from one color to another.

Molybdenum was the only element that did not produce a characteristic symptom when withheld from loblolly pine seedlings.

Podworms Cut Soybean Yields

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Soybean insects are usually divided into 3 groups: seedling, foliage, and pod feeders. It is generally agreed that pod feeders are the most serious insect pests of soybeans, primarily because they are directly destructive to the marketable product. In the Southeast the podworm, *Heliothis zea* L., is the most destructive of this group.

Control programs for any insect should be based on the economic injury threshold of the pest on the crop in question. This threshold is defined as the population level of the pest species required to cause damage enough to justify control measures. The economic injury threshold of the podworm on soybeans has not been determined exactly, and because of this control recommendations in the Southeast have varied considerably from state to state.

Several experiments have been conducted in Alabama recently in an attempt to determine the economic injury threshold of podworms on soybeans. Infestations of varying numbers of podworms were established on caged soybeans to determine the number of podworms per foot of row necessary to produce economic damage. One experiment was conducted in 1968 and 1969 on the Auburn University Agricultural Experiment Station's Plant Breeding Unit at Tallassee. Related tests with similar results were conducted in insectaries at Auburn and the Gulf Coast Substation, Fairhope. Data from the experiment conducted in 1969 at Tallassee are presented in Table 1. All artificially introduced podworm infestation levels resulted in reduced yields. Based on the cost of insecticidal control applications, an introduced population level of three podworms per foot of row would justify control measures. When equal numbers of larvae were introduced into cages twice (2 weeks between introductions), population levels of one larva per foot of row produced economic losses. Under the conditions of this test, the economic damage level would fall between one and three podworms per foot of row. This would vary considerably depending on the plants' capacity to compensate for pod loss, which would be influenced by state of maturity, moisture conditions, and previous damage by pod and foliage feeders. Before harvest the number of damaged or destroyed pods inside each cage were counted. Each larva had consumed at least six partial pods.

In another test, soybean pod loss due to insects was simulated by removing varying percentages of the soybean pods at various stages of maturity. This experiment was conducted in three locations within the State (northern, central, and coastal areas) with similar results at each location. Until the pods began to fill, 80% pod loss was required to reduce yields. As the pods matured, removal of smaller percentages of pods reduced yields. After the second week in September, at which time the pods were almost filled in all locations, as little as 10% pod removal reduced yields. Therefore, any loss of pods after they were filled produced a direct reduction in yield. The results from this test at one location are presented in Table 2.

Much of the capacity of the soybean plant to compensate for this pod loss was due to increasing seed weight which was influenced by soil moisture. Adequate moisture during the critical period of pod filling appeared to be the most important factor in the plant's ability to compensate for pod loss. Other factors which influenced the soybean plant's capacity to compensate for pod loss were time of season, plant maturity, and previous damage from foliage and pod feeders.

TABLE 1. YIELD FROM CAGED SOYBEANS[1] ARTIFICIALLY INFESTED WITH VARIOUS LEVELS OF PODWORMS

Larvae added	Yield	Yield reduction
	Bu./A.	*Bu./A.*
One Infestation		
Check	46.7	....
1/row foot	46.0	0.7
3/row foot	44.6	2.1
5/row foot	43.3	3.4
Two Infestations		
Check	43.9	....
1/row foot	42.8	1.1
3/row foot	40.9	3.0
5/row foot	38.8	5.1

[1] Each cage contained 13 row feet of soybeans.

TABLE 2. SOYBEAN YIELDS AFTER SIMULATED PODWORM DAMAGE AT FAIRHOPE, ALABAMA[1]

Treatment (pod removal)	Date on which pods were removed			
	Aug. 26	Sept. 3	Sept. 9	Sept. 16
Pct.	*Bu./A.*	*Bu./A.*	*Bu./A.*	*Bu./A.*
Check	40.1a[2]	39.9a	38.9a	39.1a
10	38.8a	39.1a	31.1b	31.0b
20	38.8a	39.5a	28.1bc	28.8c
30	38.6a	38.5a	26.7cd	....
40	38.4a	33.1b	24.1d	....
80	35.6a	27.1b	18.9e	....

[1] Yield data are averages of all replications for given dates of treatment.

[2] Means which share a common letter within a column are not significantly different at P = .05.

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PUBLICATION—Highlights of Agricultural Research 9/70 10M

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