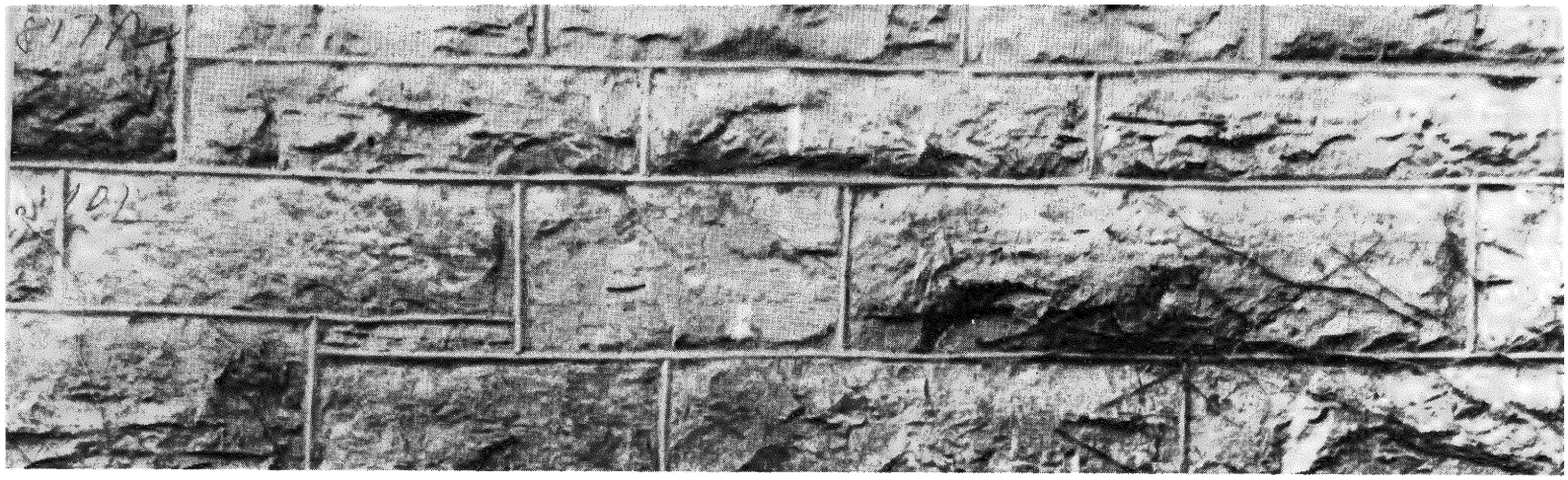

Agricultural Progress

Virginia Agricultural Experiment Station—Research Report 102

Contents

THE PICTURE ON THE COVER . . .

. . . is an aerial view of part of the Beef Cattle Research Station near Front Royal. These hills and buildings lie north of the highway that runs along the bottom of the picture. Another large area lies south of the highway, and still more acres lie east of those pictured here. The establishment was an Army Remount Station before tanks and jeeps replaced horses.

Agricultural Progress

Virginia Agricultural Experiment Station

RESEARCH REPORT 102, DECEMBER, 1965

Foreword

Agricultural research benefits all people. Economic growth and development in Virginia depends on a sound and prosperous industry of agriculture. Research provides the information which makes a sound and prosperous agricultural industry possible.

Today's industry of agriculture includes all farmers, all firms that provide goods or services used by farmers, and all firms engaged in processing and marketing the food and fiber produced by farmers.

The VPI Agricultural Experiment Station serves all segments of this industry by conducting research on problems related to: (1) the production, harvesting, processing and marketing of high quality food, feed, and fiber, free from contaminants or toxic residues; (2) the control or eradication of diseases of farm animals; (3) elimination of nutritional deficiencies in the diets of people and animals; (4) conservation and protection of soil, water, forests, and wildlife; and (5) the socio-economic problems having their origin in rural communities.

The farmer uses research information to reduce his production costs and to improve the quality of the products he sells. Lower production costs lead to lower prices to consumers. Today the average American family spends less than 20% of its disposable income for food. Even more important, the quality of the food available is at an all-time high.

Research on soils, water, forests and wildlife provide a basis for wise use of these resources by the present generation and for conserving and developing them for future generations.

Research on the care of lawns, ornamental shrubs, and turf contributes to the beauty of home grounds and highway rights-of-way.

Industrial development is aided and promoted by research on processing and marketing of fruits, vegetables, meat, poultry, and dairy products.

Most agricultural research is aimed at solving problems but a significant portion of the effort is devoted to basic research, which contributes to the pool of human knowledge.

Coyt T. Wilson, Director

This report covers the results of research on agricultural and home economics problems conducted by the Virginia Agricultural Experiment Station from July 1, 1963 to June 30, 1965.

Only the principal highlights of the Station's research results are presented here. More complete information is given in other publications. A list of print-

ed reports issued by the Station in this two-year period, and a list of articles written by members of the staff and published in scientific journals and elsewhere, are given in later pages of this publication. Also given is a list of all research projects active during this period.

Contributions by the United States Department of Agriculture and other divisions of government are a part of the research reported in this publication. In many instances, business and industrial organizations, as well as private individuals, have contributed funds or other material aid. Many farmers have provided land on which experiments have been conducted. Separate acknowledgments related to each piece of research would make a lengthy document; therefore, the Experiment Station here takes grateful recognition of the aid received from these various sources.

R. D. Michael, Editor

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The Virginia Agricultural Experiment Station was established by Act of the Virginia General Assembly in 1886. *It has served agriculture and the people of the State continuously ever since.*

Soil, Land, and Water

Soil Survey Aids Urban Development

Following Fairfax County's experience of saving millions of dollars of public funds by the proper use of soil information, a similar program has been established in a number of other counties where urban development is rapid. Soil scientists are now active in Prince William, Loudoun, Henrico, and Chesterfield Counties in addition to Fairfax.

Their job, of course, is interpreting soil survey information and advising the county agencies on the proper use of soils. These men are financed jointly by the counties involved, VPI, and the Soil Conservation Service.

At present, soil surveys are in progress in Stafford, Spotsylvania, Henrico, Chesterfield, Augusta, Charlotte, and Campbell Counties. These surveys are in cooperation with the Soil Conservation Service and the respective counties. Various officials in the counties want soil information on which to base approval of subdivision developments and location of schools, absorption fields for sewage disposal, public buildings, high rise apartments, roads, and utility lines.

Physical Properties

The suitability of a soil for both agricultural and urban uses depends to a large extent on the physical properties of the soil. The shrink-swell properties of soils are directly related to the stability, porosity, water movement, and drainage characteristics of soils. Soils containing swelling clays which exhibit large volume changes when passing from a wet to dry state create a variety of problems. In fact, the clay fraction probably influences more physical properties than any other single component. Some of the effects and conditions involving swelling clays of soils are fragipans, poor drainage and permeability, heaving and breakup of roads, cracking of foundations, excessive moisture, puddling, and land slides.

Soils containing clays that swell and shrink cause road and pavement failure.

This Station in cooperation with the State Health Department has research underway to determine the swell potential of the soils throughout the state. Soils which exceed 3,200 lb./sq. ft. when compacted and allowed to swell under test are considered to have critical swell potential. Those already tested have ranged from non-swelling up to 10,000 lb./sq. ft. To date samples of 75 different soil types from the three physiographic regions have been tested. Twenty-three of these soils have exhibited critical swell indicies. A higher percentage of these swelling soils were found in the Piedmont and Appalachian Mountains and valley regions than in the Coastal Plains region. Those having a consistently high swell potential are Iredell, Helena, Creedmore, Whitestore, Lodi, Frederick, Groseclose, Carbo, Robertsville, Mecklenburg, and some silty and clayey sediments of the Coastal Plains.

This information is proving invaluable to those people and agencies throughout the state that are concerned with the evaluation and use of our soils. Much more research and information is needed.

New Soils Research

Minor element deficiencies and problems in the production of field crops are becoming of more and more concern in Virginia. The problem seems to be a dilemma — on one side actual deficiencies, while on the other excesses of these essential plant nutrients.

Deficiencies occur usually for several possible reasons. Included are emphasis on increasing yields, thereby drawing on the reserve supply of these elements in soils, a shift toward higher analysis fertilizers which contain smaller quantities of minor elements as impurities, improper nutrient balance in the soil, and soil pH conditions which make reserve supplies of these elements unavailable to plants.

Excessive supply of minor elements may come into the picture primarily for two reasons: (1) improper liming may increase solubilities of certain elements, and (2) possible over-supply if certain mixed fertilizers are used without proper caution.

Minor element research in Virginia, which has been going on for more than 20 years, as well as field observations have indicated the need for an expanded

minor element research program in agronomic crops. The new project is aimed toward having answers for minor element problems before they become acute. Surveys of important soil series in the State should reveal their ability to supply micronutrient elements. Rates needed to correct deficiencies as well as rates which actually result in toxicities are being investigated. Persons observing deficiency symptoms or suspected minor element problems should report them to the Agronomy Department of the Station.

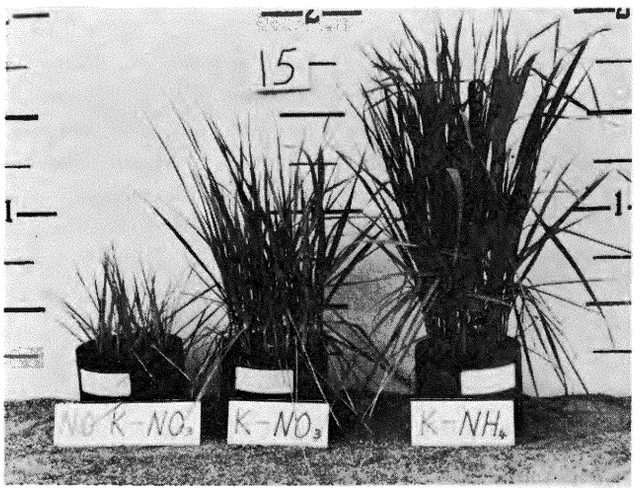
Another project underway recognizes possible contamination of agronomic crops by pesticides, especially the possible contamination in a series of crops grown in normal cropping sequence. Representative soil types and series from throughout the State are being used in these studies.

Soil Chemical Interaction

Ammonium Nitrate May Release Potassium

Ammonium nitrate fertilizer, in addition to furnishing nitrogen to plants, may make soil potassium more available to plants growing in well-limed soils. A recent greenhouse experiment showed this effect. Nason silt loam, limed to pH 7.0, released more potassium to oats when ammonium nitrate was the source of nitrogen than when the same amount of nitrogen was supplied as magnesium nitrate.

Laboratory experiments indicated that these kinds of results would be obtained and that the small ammonium ion (NH_4^+) in ammonium nitrate would more easily replace the similarly sized potassium ion (K^+) than would the large hydrated magnesium ion (Mg^{++}). At neutral pH, magnesium ions and calcium ions (Ca^{2+}), also large, are the only ones normally available to exchange the potassium. This research supports the idea that the sheets of weathered clay-size mica are partially opened and wedge-shaped zones are present for selection of ions of different size.



Effect of source of nitrogen fertilizer on growth of oats: the left and middle pots received magnesium nitrate; the pot on the right received the same amount of nitrogen but as ammonium nitrate. Both pots received potassium; the one on the left did not.

At lower pH, the acid H_3O^+ ion apparently is responsible for exchange of the K^+ ions in these wedge-shaped places.

Field experiments are now underway to test the greenhouse findings. Since many soils may contain 60,000 pounds or more of potassium in the upper three feet of an acre of soil, even a small increase in availability is of practical importance.

Molybdenum Response Found

The first authenticated case of field crop response to the trace element molybdenum was recorded near Orange in 1963 on Tatum silt loam soil.

A statistically significant response of alfalfa to molybdenum was obtained at soil pH values below approximately 6. The yield increases from an application of molybdenum were 84%, 83%, and 27% at pH values of 5.2, 5.4, and 6, respectively. At higher pH values the increases obtained were not significant. Molybdenum responses were characterized by improvement in stand and plant vigor as well as yield.

Land Forming for Tobacco Production

Studies continue to show that appropriate land-forming procedures aid in the solving of certain flue-cured tobacco cultural problems. Fields can usually be graded to provide strips of uniform width and natural waterways, thereby eliminating short rows and individual row layout and drainage problems. The treatment also facilitates crop rotation where alternate strips can be kept in sod crops for better soil and water conservation. More efficient use of machinery, ease of irrigation, and convenience in carrying out production and harvesting operations are additional advantages.

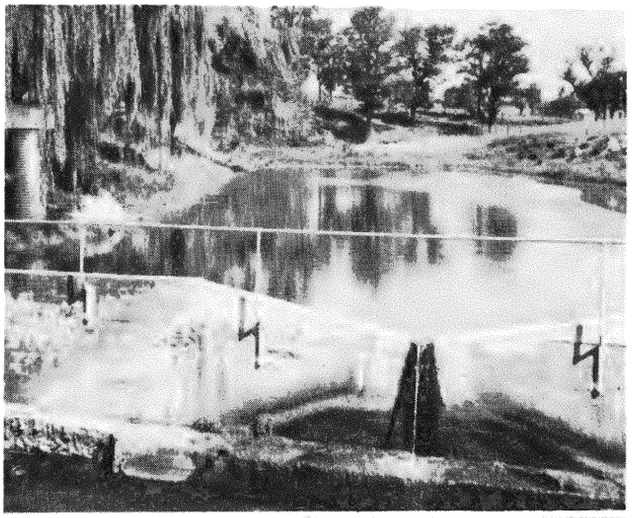
Top photo shows a land-formed experimental area with alternate strips of tobacco and fescue. Lower photo shows the mature crop and one of the vegetated waterways.

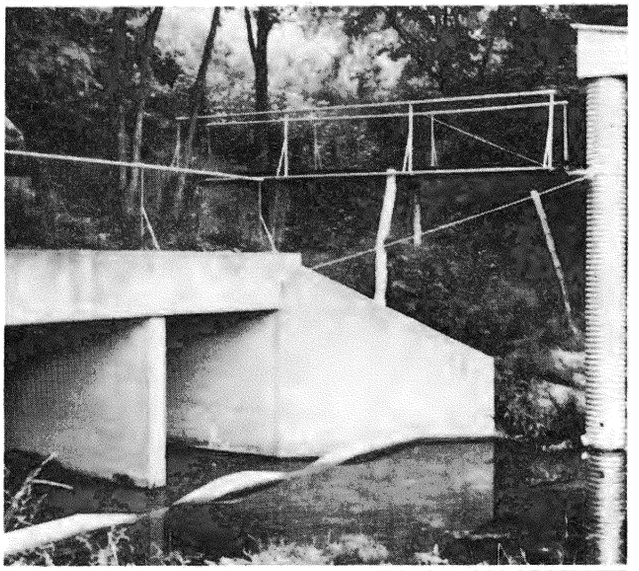
In three years, tobacco yields have been well above 2,000 pounds per acre and of good quality. "Cut" areas yield somewhat lower than the "fills," but differences are less each year, indicating that with proper fertilization and ample soil moisture (irrigation was used) quality tobacco can be produced on graded fields.

Water

Factors affecting runoff rates and yields are being studied intensively on 10 mixed land-use watersheds throughout the Piedmont and mountain and valley regions of the State and on 4 very small, single land-use drainage areas at the main Experiment Station. The complex watersheds, ranging in size from 182 to 3,054 acres, have average annual runoffs ranging from the equivalent of 14 to 50% of their total annual precipitation. Because the 4 small areas (3.4 to 19.3 acres) are under good conservation management, annual losses have been equivalent to only 0.36 to 1.4% of the total precipitation.

Research is directed to identification and evaluation of factors responsible for these extreme variations in runoff. Collection of data is continuing and analyses are kept current through intensive use of a wide range of computer programs. Annual summaries of results are available, together with appropriate analyses, for use in the design of more efficient water control and retention structures and in the upstream flood control and watershed development programs.





Pictured Here →

An old ice-pond dam constructed in 1913 (top photo) was recently converted to an automatic gaging station for measuring rates and amounts of runoff from the 3,054-acre Thorne Creek watershed in Pulaski County. Note the broadcrested V-notch weir installed for accurate low-flow measurements and the flow-measuring instrument shelter on the left bank.

Middle photo shows a standard 2-barrel concrete highway culvert with low-flow weirs which takes runoff from the 786-acre Crab Creek watershed in Montgomery County. The lower photo is a close-up of the automatic recorder located in the instrument shelter.

Field Crops and Turf

Fertilizer Studies

Fertilizer Salts Affect Germination

With higher fertilizer applications the danger of salt injury to germinating seed increases. When highway slopes are seeded, fertilizers, seed, and mulch materials are often mixed together and sprayed onto the soil as a slurry. Large amounts of fertilizer salts in close contact with seed retard or prevent germination. The problem is greatest when soil moisture is limited.

Salts attract water and when little soil water is available, the competition for water between seed and salt may prevent seed from absorbing enough water for germination. Research indicates this to be he main effect of salts, but certain salts such as nitrates have detrimental effects in addition to reducing water absorption.

Use Fertilizer Wisely

Experiments are now being conducted in Virginia to measure the economic production potential of the Frederick soils for corn (silage and grain) and alfalfa. Varying levels of N and K_2O along with an adequate amount of P_2O_5 are being used on the corn. Various levels of P_2O_5 and K_2O are being used on the alfalfa.

Corn yields in excess of 135 bushels and 21 tons per acre of silage have been obtained. When the corn was preceded by a good grass sod, 75 lb. per acre of nitrogen appeared adequate. Nitrogen in excess of 100 lb. per acre is necessary when corn follows grain or a clean-tilled crop. On soils medium in K_2O, 75 lb. per acre appeared sufficient. Alfalfa yields for one year were reduced by insufficient moisture and are not included.

One experiment is in progress to measure the economic production of corn silage and grain on Congaree loam that was medium in P_2O_5 and K_2O. Variables include rates of N, P_2O_5, and K_2O, and irrigation. During the three years of the experiment, maximum yields of 207 bushels and 31 tons per acre of silage were obtained with 300, 200, 200 lb. per acre of N, P_2O_5, and K_2O respectively, plus 20 tons of manure. An excellent response to N was obtained each year of the experiment, to K_2O in 1964 only, and no response to P_2O_5 to date. Irrigation increased yields in 1963 and 1964 but not economically so.

With N at 12¢ per lb. and corn at $1.20 per bushel, the most profitable level of N in 1963 was 205 lb. per acre with a yield of 198 bushels with irrigation and 172 bushels per acre without irrigation. Assuming the same prices in 1964, the most profitable yield of 173 bushels per acre on irrigated plots was obtained with N and K_2O applied at the rates of 152 and 104 lb. per acre respectively. On non-irrigated plots the most profitable yield of 175 bushels per acre was produced when N and K_2O were applied at the rates of 154 and 77 lb. per acre respectively.

Rock Phosphate Evaluated

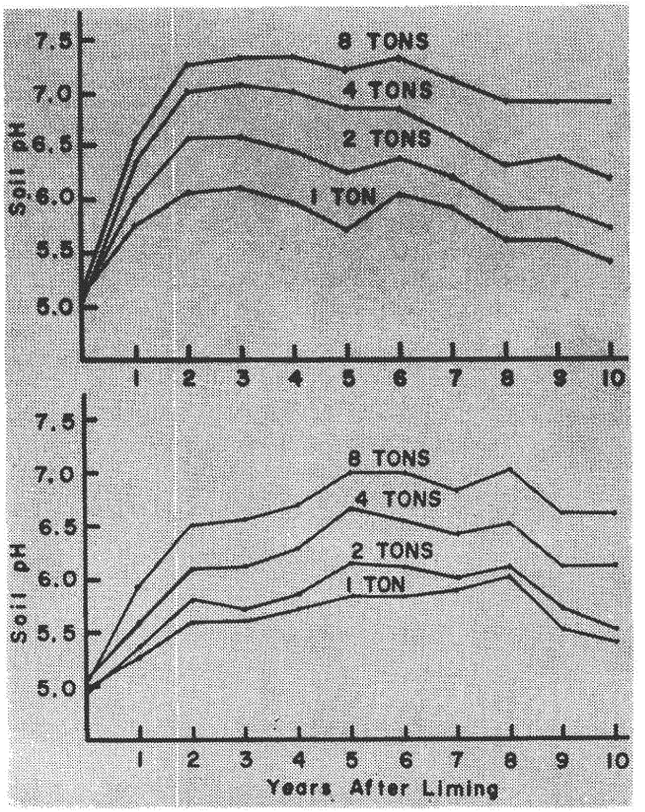
Results of a 14-year evaluation study on rock phosphate fertilizer have been summarized in Technical Bulletin 178, *Field Experiments with Rock Phosphate Fertilizer in Virginia.*

On the average, 2 lb. of phosphorus from rock phosphate was equal to 1 lb. of phosphorus from superphosphate in producing field crops. The use of ½ to 1 ton of rock phosphate at intervals of 5 to 6 years supplemented by annual applications of superphosphate proved to be an effective method of supplying available phosphorus for growing crops and building phosphate reserve in the soil. Nearly all Virginia soil types are naturally deficient in available phosphorus and must be enriched for current and sustained productivity.

Corn, red clover, and alfalfa responded better to rock phosphate than did wheat. Soil pH values higher than 6.0 to 6.3 reduced rock phosphate effectiveness on all crops. Both superphosphate and rock phosphate were shown to have important residual value.

Guidelines for Liming

Lime recommendations are more specific and accurate as a result of "on the farm" lime experiments conducted since 1954 on 13 Virginia soil types.



Yearly change in soil pH after application of lime to a coarse-textured and a fine-textured soil: top, Sassafras sandy loam; bottom, Dunmore silt loam.

Soil behaviour after liming was found to be relatively simple and consistent. When lime was applied to pH increased rapidly the first year and at a lesser rate for the next several years. Sandy textured soil reached maximum pH during the second or third year after liming, whereas the finer textured soils, such as silt and clay loams, required 4 or 5 years. After the maximum pH from a given rate of lime was reached, there followed a period of 3 or 4 years of relative stability. Then the pH began to decline and the rate of decline was approximately the same for each rate of lime on any particular soil.

Some practical recommendations derived from the experiments are:

1. Lime acid soils with an initial rate calculated to raise the pH to the desired point and make smaller supplementary applications at intervals to hold it there.
2. Apply the lime well in advance of the time maximum pH is desired.
3. Use smaller quantities of lime on sandy, easily leached soils, but lime more frequently.

Hay and Silage Studies

Photosynthesis in Forages

Techniques are being developed for estimating the growth potential of forage plants by measuring carbon dioxide (CO_2) absorbed from the air during short periods. Emphasis is placed on photosynthetic rates under natural conditions in the field. (Photosynthesis is the process by which plants gain energy for growth. Measurements of photosynthesis allow the researcher to make rapid estimates of potential growth rate.)

Photosynthesis of forage plants is being measured as a rapid estimate of growth potential. Recording instruments are located in the pickup truck. The chamber with temperature control is placed over various sods. Changes in carbon dioxide content of the air passing through give data on photosynthesis. By placing a dark cloth over the chamber, respiration can be measured.

Plants growing in the field are enclosed in plastic chambers for 10 to 30 minutes. Temperature is kept constant by a refrigeration unit. Air is metered into the chamber and carbon dioxide content is measured in the air entering and leaving the chamber. The difference in the amount of CO_2 entering and leaving the chamber is a measure of photosynthesis by the plants. In darkness, plants lose CO_2 through respiration.

CO_2 and light (the energy source for photosynthesis) is absorbed mainly by the flat surfaces of leaves. So photosynthesis of a pasture or hay field should increase as the total leaf area increases to the point where all available light falls on leaves and none strikes the soil. Studies are underway to find the amount of leafage needed to produce maximum growth rates in various forage crops.

Photosynthesis rates of pastures depend on the amount of leafage, but also on efficiency of individual leaves. Experiments are being conducted to determine photosynthesis of leaves of various forage plants as affected by leafage and nutrition.

Energy Value of Grass Hay

Experiments were conducted during 1963 and 1964 to determine the changes in digestibility of hay from Pennlate and Potomac orchardgrass and Clair and Essex timothy for harvests during early May to mid-June. The digestibility of hay measured with sheep decreased as the grasses became more mature. Decreases in leaf content of the hay paralleled the drop in digestibility. Leaf percentage appears to be a better index of digestibility than harvest date. Daily hay intake by sheep also decreased as the hay became more mature.

Lespedeza Potential

A study of annual lespedeza yields was prompted by requests stating the belie that yields per acre were declining and that investigation might reveal the cause.

Study revealed that lespedeza yields have remained essentially unchanged over the last 33 years. For the 1931-1963 period they averaged 1.02 tons per acre. Experiment Station yields run 50 to 100% higher and represent the potential of the crop under good fertility and management with the varieties presently available.

The biggest single factor necessary for best yields is ample and well-distributed summer rainfall. Because of its shallow root system, the crop does not produce its maximum growth in dry seasons. It has responded to lime, phosphorus, and potassium, but not to applied nitrogen nor commercial inoculation. Under favorable fertility and moisture conditions, weeds grew vigorously and were severely competitive.

Evaluating Orchardgrass Strains

Very limited quantities of seed generally are available for early testing of experimental strains of orchardgrass. To determine whether strains can be adequately evaluated with small quantities of seed, experimental orchardgrass synthetic varieties were planted in small, solid planted plots, in drilled rows, and as spaced plants. Three years data were obtained. The yield performance of these strains ranked in a similar manner for the different methods of planting and ratings for disease reaction, maturity, and seed production were closely correlated between methods.

We concluded that space-planted trials which require very small quantities of seed give adequate evaluation of yield and other characteristics. This procedure is especially useful for determining heterosis from single-cross combinations of selected plants.

Silage for Fattening Beef

Research at the Northern Virginia Pasture Research Station shows that yearling cattle can be fattened with rations made up of corn silage and high quality perennial grass-legume silage. Alfalfa-orchardgrass silages (wilted or direct cut) are too low in energy when fed alone for high gains and fattening. Corn silage is high in energy, but its low protein may limit gain. Grass-legume silages harvested at proper maturity are high in protein; thus, feeding a mixture of corn silage and grass-legume silage offers an economical source of energy and protein for fattening cattle in Virginia.

Yearling steers have been fattened to good to high choice slaughter grades with corn silage plus 2 lb. 41% cottonseed meal or a mixture of 80% corn silage and 20% alfalfa-orchardgrass silage plus 1.75 lb. 41% cottonseed meal. Average daily gains of 1.8 lb. and average carcass grades (high good) were only slightly lower than for steers fed on conventional high concentrate rations.

Experiments were conducted during the winters 1962-63 and 1964-65 to find if higher protein and/or energy supplementation would increase gains. Corn silage was fed as the only forage and also fed in mixtures with alfalfa-orchardgrass low moisture and high moisture silages in a 1:1 ratio (dry matter basis). Corn silage alone was supplemented with cottonseed meal. The corn silage-alfalfa-orchardgrass low moisture or high moisture silage mixtures were supplemented with 41% cottonseed meal and compared with 4 lb. ground ear corn and cottonseed meal or ground ear corn only. A high concentrate ration was used as a control. All rations were 10% digestible protein except for the corn silage-low moisture alfalfa-orchardgrass silage plus ground ear corn (7.5% D.P.), and corn silage-high moisture alfalfa-orchardgrass silage plus ground ear corn only (6.5% D.P.). The steers were implanted with 24 mg. stilbestrol which had not been done in the previous test. During the first year, yearling heifers were fat in 119 days and the steers in 139 days. In the second year, yearling steers were fat in 140 days.

Average daily gains for all rations were very satisfactory. Highest gaining steers were those fed the high concentrate ration, 2.71 lb. daily. Steers fed corn silage plus 3.3 lb. cottonseed meal gained only slightly slower, 2.57 lb. daily. Carcass quality as determined by grade was slightly lower for the steers fed corn silage. Such results have been consistent with past experimental results. Feeding a mixture of corn silage and alfalfa-orchardgrass silage was not nutritionally superior to feeding only corn silage supplemented with cottonseed meal. Although differences in daily gains and carcass grade were small for steers fed the mixtures of low moisture or high moisture alfalfa-orchardgrass silage plus corn silage, there was a trend for steers fed low moisture silage plus corn silage to gain faster. The high daily gains are attributed to higher intake energy (TDN) and also to implanting the steers with stilbestrol.

The results do not clearly indicate the level of protein needed with high rates of corn silage or a mixture of corn silage and grass-legume silage. However, it appears that protein and energy supplementation was more beneficial than either alone when feeding a 1:1 mixture of corn silage and alfalfa-orchardgrass low moisture or high moisture silage.

Feeding Value of the Corn Plant

The Middleburg Station steers are used to study the feeding value of corn silage and parts of the plant. The corn was spaced to have plant populations of 16,000 to 24,000 plants per acre. Ears made up about half the plant weight, and the stalks averaged one-fourth. During the dry year of 1964, more silage and grain was produced with the higher planting rate, as shown in Table 1.

The total digestible nutrients were 63.5 and 62.5 for the low and high plant population, respectively.

Table 1. Characteristics of corn silage harvested from different plant populations.

	Plant Population 16,000	Plant Population 24,000
% of whole plant		
Ears	47.6	47.2
Leaves	22.0	25.8
Stalks	23.2	21.4
Husks	7.3	5.6
Yield		
Silage (30% D.M.), ton	14.8	16.6
Grain (84.5% D.M.), bushel	72.4	86.2

In another experiment, corn was cut for silage at three different maturities, as shown in Table 2. Note that ears made up 65% of the plant weight when cut in the hard dent stage as compared to about 32% when cut in the milk stage. The digestibility of the silage

made of the entire plants averaged 59% for the milk stage, 64% for the dent stage, and 61% for the hard dent stage. Digestibility of the stover (leaves, stalks, and husks) was lower than that for the whole plant in all cases. Digestibility of the ears was much higher than that for the whole plant.

Table 2. Characteristics of corn silage harvested at different maturities.

	Maturities		
	Milk	Dent	Hard
% of whole plant			
Ears	31.6	64.2	65.0
Leaves	27.2	16.0	14.9
Stalks	26.2	14.1	14.9
Husks	15.0	5.7	5.2
Yield			
Silage (30% D.M.), ton	14	20	17
Grain (84.5% D.M.), bushel	29	132	117

Silage value also depends on how much is eaten. More silage was consumed as it was allowed to get more mature before harvesting. This increase is attributed to higher dry matter content which apparently improves the fermentation and palatability of silage to cattle.

Silage from Barley

An experiment was conducted at the Southside Virginia Research Station in 1963-64 to determine the silage yield of barley cut at various stages of growth. Five varieties were harvested at the bloom, milk, soft-dough, and maturity stages, with dry-matter yields of 5,536, 6,943, 7,350, and 7,371 pounds per acre, respectively, for these stages. Percentage dry matter was 19.3% at bloom, 39.7% at milk, 47.0% at soft-dough, and 90.2% at maturity.

The harvested material was separated into leaves, stems, and heads to determine how the various plant parts varied with stage of growth. Percentage of leaves and stems in the total dry matter decreased with each stage of harvest, while percentage of heads increased.. Percentage of total digestible nutrients tended to decrease with ach stage of harvest.

Since the quantity of dry matter was increasing, the yield per acre of digestible nutrients increased from 3,335 pounds at bloom to 4,525 at the soft-dough stage. There was a slight decrease in yield of digestible nutrients from the soft-dough stage to maturity.

This experiment is being continued to determine the optimum stage of growth for harvesting barley for silage.

Long Rotations Needed To Control Alfalfa Stem Nematode

In rotation plots for control of alfalfa stem nematode, the initial population of the nematode was low after 3 years for each crop, but increased substantially when alfalfa was grown for one year. The population changes were as follows: Lespedeza-oats, .3% infection when plowed under to 22% after one year in alfalfa; red clover, 0% to 24%; orchardgrass, .2% to 50%; fescue, 0% to 49%; timothy, .8% to 27%; and orchardgrass-ladino clover, .3% to 50%. Low populations were also recovered from scattered samples in the 4-year plots prior to planting alfalfa. Alfalfa yield per unit area was 6.5 lb. (average for all treatments) in the 3-year rotation, and 4.3 lb. in the 2-year rotation. The rapid population build-up of the stem nematode in alfalfa after 3 years in rotation indicates that longer rotations may be needed.

Inoculation of seedlings obtained from crosses between clones resistant to the stem nematode and selected desirable clones from the susceptible Williamsburg variety has produced several promising resistant parents.

Corn

Serious Virus Disease

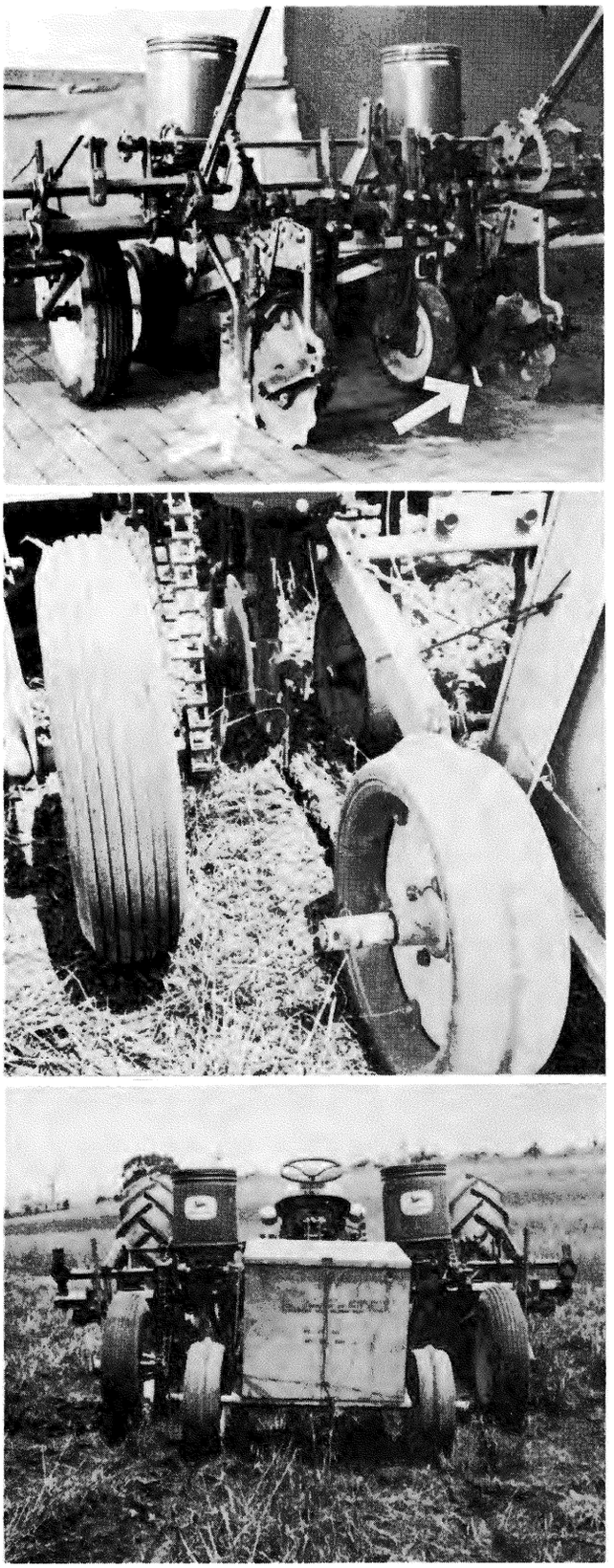
A serious virus disease of corn was observed in 13 counties of Virginia for the first time in 1964. The virus was subsequently transferred mechanically from corn to corn and has been maintained in the greenhouse. What appears to be the same virus was transferred to corn from Johnson grass and sorghum found naturally infected among diseased corn plants. Using the corn leaf aphid as a vector, the virus has been transferred to corn from corn, sorghum, and Johnson grass. It has been mechanically transferred to sorghum-sudan grass hybrids, hybrid sorghums and sudan-grasses, pearl millet, and toosinte. The virus could not be transferred to and recovered from Hordeum, Avena, Triticum, Agropyron, Bromus, Lolium, Elymus, Festuca, Phalaris, and Poa. spp. Based on the host range and mode of transmission, the disease appears to be caused by the sugarcane mosaic virus.

This disease is the most serious observed on corn in Virginia and its control is essential. The tentative identification of the disease as sugarcane mosaic suggests that Johnson grass should be controlled or else corn must be moved to land free of Johnson grass, as this weed will be the perennial source of the virus.

No-Tillage Corn

Experiments in growing corn on chemically-killed sod seedbed without tillage which were begun at this Station in 1960 are continuing and have been resolved into several investigations of specific associated problems which require further research. One of these is the physical environment of the immediate seed zone necessary for optimum germination and plant emergence and the equipment required to create this condition and achieve proper placement of the seed.

Because the killed sod cover has an insulating effect, no tillage seedbeds are 3 to 5 F. cooler at planting season and usually have high soil moisture. In years with warm, dry spring weather these characteristics



This sequence of photos illustrates one of the experimental no-tillage corn planters; it uses a modified chisel-type row-opener (see arrows, upper picture). The center of the middle photo shows an opened seed row just ahead of a pack wheel. The lower photo shows the rows after compaction, amount of which is controlled by varying the load on the press wheels.

are advantageous, but in cold, wet spring weather, they pose real germination problems.

Research has shown that firm contact between the seed and the soil is essential and that large air voids in this region cannot be tolerated. This requires the tillage of a small area in the immediate seedling zone, the proper placement of the seed, and the recompaction of the loosened soil around the seed. Since soil moisture at planting is usually high and often too high for good tilth, this poses special problems for the planting equipment in that the soil tends to compress around the openers rather than shatter and losen as is desired.

A combination of low temperature and high moisture in the seed zone favors shallow planting depths, but the surface layer of dead vegetation plus the presence of extensive sod root crowns near the surface make uniform planting and good coverage at the shallow depths more difficult.

Many types of planting equipment are being studied and their performance checked through carefully controlled laboratory measurements as well as in field plot tests.

Devising the type of assisting tool and/or seed-row opener which provides the necessary seeling zone tilth together with minimum disturbance of the surface mulch over the wide range of soil and cover conditions likely to be encountered is the major consideration. Depth control, seed coverer, press wheel shape, and optimum row compaction are other planting criteria which must be fitted to the special requirements of no tillage seedbeds.

Cropping Systems for No-Tillage Corn

Adapting the newly developed method of no-tillage row crop production to different cropping systems is of major importance. In Eastern Virginia where perennial sods are not generally available, winter cover crops can be used successfully as mulches in which to plant no-tillage corn. In the hilly, more readily erodable soils of Central and Western Virginia, perennial sods are used as well as winter cover crops where needed.

An evaluation of different cover crops for use in no-tillage corn growing is being made. Rye, wheat, barley, oats, and ryegrass, alone and in combination with legumes, are being compared. Results indicate that rye, wheat, and ryegrass are well-adapted as cover and that maximum corn yields do not depend on maximum top growth of the cover. Rotation experiments, while incomplete at this time, have shown that no-tillage corn can be grown successfully following a perennial forage or a winter cover crop.

Killing of the cover crop and controlling weeds are keys to success of this method. New herbicides and combinations of presently available ones are being tested in a search for more effective as well as more economical vegetation control.

Economics of Harvesting, Drying, and Storing

This study sought to determine the most economical of 5 systems for harvesting and handling corn and small grains in the cash grain area of northeastern Virginia. For a total grain acreage of 250 or more (any combination of more than 60 acres of corn and 180 acres of small grain), the least-cost alternative was ownership of a self-propelled combine with both corn and grain heads. For acreages below 250, the cheapest method of hervesting was to pick the corn with a 1-row picker (owned by the farmer) and to have the small grain custom-combined at $6 per acre.

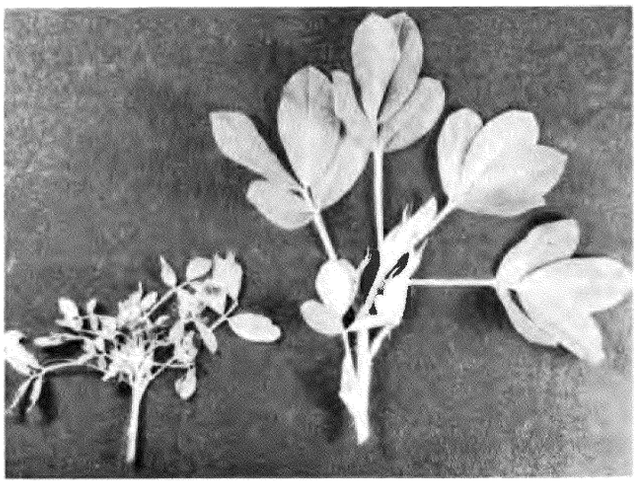
Cost of drying corn varied with size of investment in equipment, annual volume of corn dried, and amount of water removed per bushel. Typical drying costs per bushel for on-farm drying were: (1) for a 10,000-bushel crop, 18.1¢; (2) for a 20,000-bushel crop, 10.8¢. The greatest profit was realized from drying when the corn was harvested, dried, and sold during the first 2 weeks of September when the price of corn was relatively high, field losses were at a minimum, and moisture content was between 24% and 28%.

Corn dried with batch driers was usually sold at harvest. Farmers with bin-type driers who harvested early could make some profit on storing the corn for later sale. Profits from storing corn on the farm were not great enough to encourage many small growers to invest in storage facilities.

Peanuts

New Disease

An undescribed peanut disease, tentatively called stunt, caused severe injury to peanuts on several farms in Virginia in 1964 and 1965. Stunt-infected plants are much smaller than healthy plants and the leaves and fruit are greatly reduced in size. Preliminary experiments indicate that the disorder is caused by a virus.



The distorted branch on the left is infected with peanut stunt. The branch on the right is from a healthy plant.

New Weed Control Chemicals

Field evaluation of pre-plant or post-plant incorporation of Vernam and pre-emergence surface application of combinations of diphenamid with DNBP applied at the cracking stage have indicated that these materials have given longer periods of control of weeds in peanuts. Greenhouse evaluation of the degree of phytotoxicity exhibited by soil treated with many of the commonly available herbicides used on peanuts indicates that the developing pegs may tolerate rates used in layby.

Resistance to the Southern Corn Rootworm

Many peanut lines have been evaluated for resistance to the southern corn rootworm, and several have exhibited apparent resistance. Lines showing resistance have been of the Spanish type. To obtain a desirable type, it was necessary to cross the Spanish type with the Virginia type. F_1 and F_2 generations of crosses between resistant lines and Virginia type lines have been grown and evaluated. Injury was quite variable under conditions of a high infestation, but F_1's generally showed less injury than the susceptible parent. Segregation for resistance occurred in the F_2 generation. Virginia 56R X PI 262048 showed a range of injury from 0 to 56.4%.

Observations indicate that resistance may be correlated with maturity date. Peanut fruits which mature before damaging populations of the rootworm have developed may escape injury. Observations are presently being made on the progeny of F_2 plants to determine if flowering date can be correlated with resistance. Also, progeny of F_2 plants are being studied to see if resistance is heritable. Both bulk and pedigree methods of breeding are being conducted to determine (1) the best method of selection for resistance and (2) if any natural selection will occur in segregating generations.

Progeny of F_2 peanut lines from a cross of lines resistant to southern corn rootworm and Virginia type, for selection of resistant Virginia varieties.

Boron Deficiency

In 1958 it was noted that some lots of Virginia peanuts contained seeds with concentrated discolorations, from off-white or yellowish to several shades of brown, hidden on the interface of one or both cotyledons. Some of the fruits had unusually large cavities between the cotyledons. Previously, a similar disorder (sometimes called hollow heart) had been reported as boron deficiency in peanuts grown elsewhere.

Recent research has confirmed the occurrence of boron deficiency in Virginia-grown peanuts. This deficiency appears to affect fruit quality only. Total yield of fruit and vines remains normal. Although this type of internal damage severely affects peanuts from a relatively small acreage, the problem is important because more than 1% of such damage keeps a crop from being sold as edible foodstuffs.

Peanuts grown on very sandy soils and subjected to drouth are more apt to be boron-deficient and produce internally damaged seeds. Application of 2 lb. per acre of boron equivalent completely eliminated the deficiency. One pound per acre of boron did not eliminate the deficiency but reduced the content of damaged fruits below the 1% limit. Phytotoxicity was noted, particularly at the 2-lb. rate, and yield reductions occurred occasionally. In 1965, ½ lb. per acre of boron was recommended generally for the control of internal damage in peanut fruits without fear of appreciable phytotoxicity. However, experimental results indicate that in cases of severe boron deficiency the 1 or 2 lb. rates of boron may be required for production of marketable fruit.

Harvesting and Curing

The effects of combine harvesting and artitficial curing on peanut quality is being studied. Germination of seed that has been combined is one factor studied. Most of the reduction in germination is due to mechanical damage to the kernel in the combine operation. If peanuts are allowed to partially cure in the window, picked with a well-adjusted combine, and completely cured under recommended conditions, germination may approach that of stack-cured seed.

Price Support Programs and Land Values

Farm price support programs under acreage allotments have been used for 30 years to bolster farm income and enhance the earnings of farm people. Through the programs Congress has sought to erase, at least partially, disparities between returns to labor in farming and returns earned on comparable labor employed in nonfarm sectors of the economy.

Once the price support programs acquired some degree of certainty for continuation in future years, rights to receive future benefits through acreage allotments became an intangible asset with a market price attached. This fact, plus the inability to detach the allotment from cropland, is a reason for raising questions concerning the incidence of the benefits of the programs. Does a significant part of the benefits go to the owner of the allotment? . . . to the laborer who produces the crop? Have the price support programs been a factor in recent rises in farmland values? The objectives of the research was to answer questions like these for the peanut price support programs.

Analysis showed that peanut allotments have an appreciable market value. An acre of peanut allotment, independent of the value of the associated land and buildings, was estimated to sell for $565 during 1956-1960. Estimates of the value of cropland and noncropland were $103 and $30 per acre, respectively.

The study verified the hypothesis that a portion of the selling pdice of peanut farms was paid for the right to produce and market peanuts; that is, the size of the peanut allotment was a factor considered by buyers in deciding what they were willing to pay for a farm. For this portion of sale price, buyers received no tangible property; rather, it was payment for part of later benefits to be derived from the price support program. For those who owned peanut farms when acreage controls began, this increase in sale value represents a substantial capital gain. Conversely, allotment value shows the extent of loss present owners would suffer if the program was suddenly abandoned. Likewise, it represents an increase in capital requirements, and thereby cost of production, for future buyers of farms with allotments.

Can farmers afford to pay $656 for an acre of peanut allotment? To answer this question, estimates of net income derived from an additional acre of peanut production were made for small, medium, and large farms, and discount rates required to reduce the capitalized net incomes below $565 were calculated. With family and regular hired labor considered fixed, it was not profitable to purchase an additional acre of allotment at a cost of $565 if the discount rate exceeded 20.2%, 19.6%, and 19.5%, respectively, for the 3 sizes of farms. When the fixed labor supply was reduced to the amount furnished by the family, comparable discount rates were 17.5%, 14.2%, and 16.8%, respectively. Apparently, farmers use discount rates considerably above the normal rate of interest when making decisions on how much they can afford to pay for an acre of peanut allotment. This indicates considerable uncertainty in farmers' minds regarding continuation of the price support program in its present form and regarding the possibility of loss of allotment through over-all acreage reductions.

The impact of the price support program, now firmly embedded in the economy of the peanut-producing area, extends far beyond farm boundaries. Agencies extending credit to farmers, the storage industry, farm supply businesses, and others have interest dependent to some extent upon a continuation of the program. Any sudden changes in the program that resulted in a reduction of farm income and land values would adversely affect both farmers and many non-farm people.

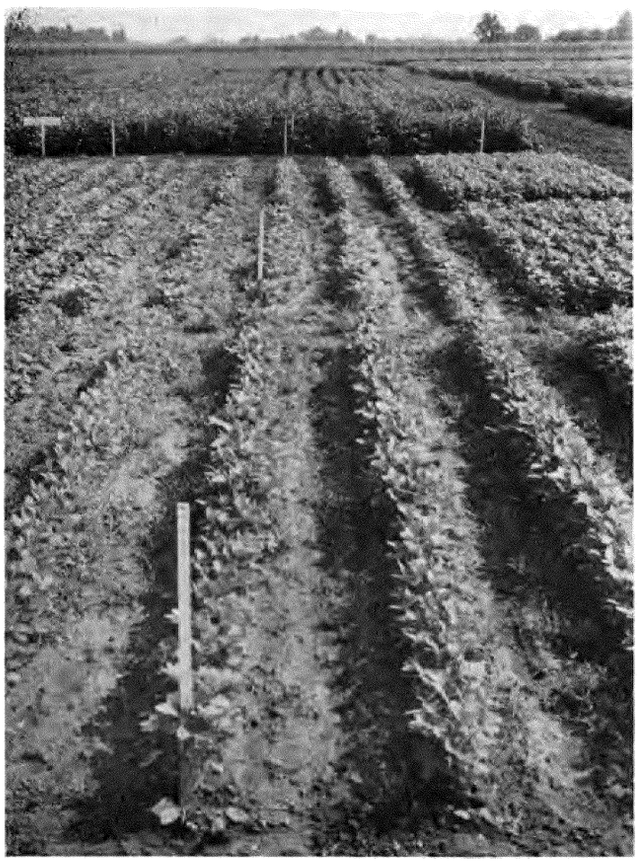
Soybeans

Varietal Developments

The Station has cooperated with the U.S.D.A. and other state stations in the South in the release of most soybean varieties now being grown in Virginia. Although these varieties perform well in Virginia, they were not developed specifically for our conditions and do not meet all of our needs. Problems of seed quality and seed diseases have been encountered.

Varieties with high resistance to seed diseases will need to be developed for this area and the soybean breeding project is designed to meet this need. Several plant introductions which show high resistance to seed diseases and seed deterioration are being used in our breeding program to incorporate desirable seed quality into early varieties suitable for Virginia conditions.

The Station also cooperated with the U.S.D.A. and other state stations in the early evaluation and release in 1965 of two new soybean varieties — Pickett and Dare. Pickett is designed specifically for use on farms infested with the soybean cyst nematode. Dare is a mid-season variety with high yield, high oil content, and good seed quality, including high resistance to purple-seed-stain disease.



A view of the soybean breeding nursery at the Eastern Virginia Research Station.

Resistance to Cyst Nematode

The resistance of 1900 soybean lines and varieties to the Virginia 2 population of the soybean cyst nematode was evaluated on a heavily infested farm in Nansemond County in 1964. The plant introduction line 90763 was the only entry in which no egg-bearing females were observed. A few cysts are produced on roots of this line, however, when grown in the greenhouse in a soil very heavily infested with an isolate of the Virginia 2 population of the soybean cyst nematode.

Isolates of the soybean cyst nematode from 4 different farms in Virginia and 1 farm in each of 7 other states were tested to determine their ability to develop egg-bearing females in interaction with Lee soybean, Korean lespedeza, adzuki bean, yellow sweet clover, and button clover. All of the isolates developed numerous females on Lee soybean, but only certain isolates developed numerous females on the other legumes tested. These results indicate that it will be necessary to take the genetic diversity of the soybean cyst nematode into account in subsequent effort to develop resistant varieties.

Sugarbeets—Potential Crop

The Station in cooperation with the Virginia Truck Station is conducting research on sugarbeets as a potential new crop for the Coastal Plain area of Virginia. Limited tests indicate that the crop can be grown in the area. Yields from experimental plots ranged from 13 to 21 tons of beets per acre with a sugar content from 14 to 16%. Performance varied considerably on different soils. Disease problems have been minor except for one location where Southern wilt, (*Sclerotium rolfsii*) did much damage.

Tobacco

Sod Planting of Tobacco

Tests are being made at the Bright Tobacco Research Station on growing tobacco in a dead-sod cover. Results in 1964 were encouraging and studies of the procedure continue.

The tobacco was hand-transplanted in a tall-fescue sod which had been killed by covering it with black plastic for several weeks in early spring. No tillage was used either before or after transplanting. Fertilizer was placed on the soil surface in one treatment and placed in the soil at the side of the plants in another. Results indicate that either method of fertilizer placement might be suitable. Applying a suitable herbicide shortly after planting gave acceptable weed control.

Yields and quality of tobacco grown in this manner were quite good and some resistance to moderate drought was evident. Further development will test suitable herbicides to kill the sod rather than covering it with plastic, mechanical placement of the fertilizer in the soil, the use of winter cover crops as sod rather than peren-

nial grasses, and eventually mechanical transplanting of the tobacco if results continue to show promise.

Such a method of growing tobacco would surely be advantageous from the standpoint of soil and water conservation and might possibly produce a more uniform rate of growth and a higher quality tobacco.

Tobacco growing in a tall fescue sod killed in early spring before planting.

Resistance to Disease

New Technique Developed

Researchers have found that when the roots of tobacco plants are wounded and then a pre-measured amount of bacteria is incorporated into a nutrient solution around the injured roots, plants susceptible to Ganville wilt are rapidly killed. Also, a correlation between the resistance of excised leaf tissue and the resistance of roots of tobacco plants to infection by the black shank fungus was discovered. Using these procedures will accelerate the screening of tobacco plants for resistance to both diseases.

New Variety

A number of flue-cured tobacco lines with good black shank resistance were found to be satisfactory for agronomic and quality factors. One line tested as Va. 187 has proved acceptable and has been released as a new variety under the name Va. 125. A line with resistance to mosaic, black root rot, and black shank is now in regional tests. Root knot resistant lines in advanced tests have not proved satisfactory in quality but other selections are ready for testing.

Va. 331, a black shank resistant fire-cured variety, has been released. It is a thin leaf type with good resistance, yields well, and has moderate quality. Selections with good resistance in heavy leaf types are ready for advanced tests. Root rot resistance can be selected in some of these lines. A breeding line, Va. 3327, with wild fire and black root rot resistance, is in advanced farm test.

With burley tobacco, the present black shank resistant breeding lines and varieties do not yield as well as other varieties, but their quality and company acceptability is superior. Further selections will have to be made to increase yield for farmer acceptability. A burley 2 type line with high black shank and wild fire resistance is ready for farm tests.

The tobacco plant on the left is growing in soil free of pathogenic nematodes; the one on the right, in soil infested with Osborne's cyst nematode.

Cyst Nematode

The Osborne's cyst nematode, a new pest of tobacco, is known to occur on 4 farms in Amelia County. It has been demonstrated that this nematode is pathogenic to most commercially grown varieties of tobacco. Preliminary experiments in small plots indicate that populations of the nematode may be reduced and a profitable crop of tobacco produced by fumigating the soil with DD at the rate of 25 gallons per acre overall.

An experiment at one of the infested sites in Amelia County seeks to determine how long the nematode will survive in field soil when not planted to a host crop of the nematode. It has been learned that certain lines of tobacco are highly resistant to the nematode. Crosses of these lines to agronomically acceptable tobacco varieties have been made. The resistance of the hybrid in the F_1 generation is intermediate between that of the resistant and susceptible parents.

Tobacco Insects

Many insects attack tobacco, but emphasis is being placed on control of the tobacco flea beetle and the green peach aphid. These insects are not always the most destructive; however, their feeding habits combined with the dense growth of the tobacco plant, make them most difficult for growers to control.

Studies on the feeding habits of the tobacco flea beetle revealed that the insect feeds as much during darkness as in daylight. The insect showed a slight preference for feeding on the upper surface of the leaf. After several leaves had been harvested from the tobacco plant, feeding on the stalk and leaf scars was quite pro-

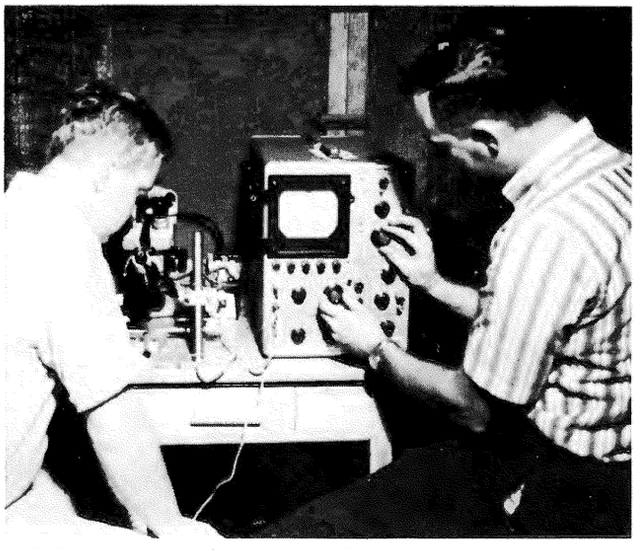
nounced. Migration studies indicate that the beetles begin leaving the tobacco field after harvesting has begun and the maximum migration occurs after mid-August. Studies continue on the use of carbamate and phosphate insecticides applied to the soil and foliage to control the insect.

Ecological studies on the green peach aphid are concerned with effects of abiotic factors, principally temperature and humidity, on the fecundity of the insect. Under controlled laboratory conditions the rate of reproduction increased with each 5 F. rise in temperature until the optimum of 75 F. was reached. The effect of host plant nutrition, particularly nitrogen, on the insect's reproduction and biology is being investigated. Field studies are concerned with population density, and the value of systemic and non-systemic insecticides applied to the soil and foliage.

Radiant Energy for Control

Tobacco hornworms and tobacco budworms destroy over $85,000,000 worth of tobacco annually. Through a research grant from the U. S. Department of Agriculture, VPI entomologists and agricultural engineers and USDA agricultural engineers are studying the effects of various wave lengths of light on the tobacco hornworm moth. From previous study, most promising results were obtained from light of the ultra-violet region. Accordingly "black light"' traps in various densities have been installed in the field and are currently being studied for their ability to lure these moths.

In the laboratory electrophysiological techniques are used to determine the nerve response of the hornworms' compound eye and optic tract. Carefully implanted electrodes monitor the nerve impulses generated in the eye and optic tract in response to light of selected wave lengths and intensities. The resultant waveform is called an etlectroretinogram (ERG). An analysis of ERG's has revealed that there are distinct differences in nervous responses between male and female moths which may relate to the fact that more males than females are attracted to ultraviolet light.



Laboratory equipment used to observe nerve responses of tobacco insects subjected to various types of light.

These data also suggest that the nervous response of the eye photoreceptors may change with age and that particular portions of the eye are more sensitive to light than other areas. In addition to understanding eye function, the cell structure and tissues of the eye are also being studied in order to determine the relationships between optic nerves and the light receptor cells.

Turfgrass and Sod

Bentgrass, adapted to cool climates, and bermudagrass, a semi-tropical grass, are used extensively in Virginia, a climatic transition zone. Bentgrass is often injured by warm weather. Bermudagrasses may be harmed by cold weather.

The effects of temperature, nitrogen, and light intensity were studied on Tifgreen bermudagrass and Cohansey bentgrass grown in environmental control chambers. Increased temperatures from 60 to 90 F. on bentgrass decreased reserve carbohydrates, rot weights, and growth of tops, but increased nitrogen content and respiration. Photosynthesis of bentgrass was highest at 75 F. The respiration rate, top growth, and carbohydrate content of bermudagrass tended to increase with temperature; but root weights and photosynthesis were highest at medium temperatures. High nitrogen fertilization generally increased top growth, photosynthesis, respiration, and nitrogen content, but lowered the carbohydrates and root growth for both grasses.

Growth and metabolism of bentgrass declined as night temperatures increased from 60 to 90 F., but the carbohydrates were highest at medium night temperatures. Bermudagrass, under similar conditions, gave the best growth and photosynthesis at 75 F. and lowest at 90 F. All day temperatures were 95 F. Low light intensity generally decreased yield, photosynthesis, and carbohydrates, but increased nitrogen for both greens.

Under field conditions, bentgrass increased in carbohydrates during the fall and early winter, declined rapidly during the spring and remained low during the summer. The carbohydrates in bermudagrass decreased during the winter and spring, increased during summer, and reached a maximum by late fall.

Heavy traffic on specialized turf areas, such as golf greens, causes soil compaction. Thus, twelve modified soil mixtures for golf greens are being evaluated for compaction, aeration, water requirements, growth, and quality of turf. After applying compaction for three months, the infiltration rate was more than adequate when the modified soil contained more than 43% Weblite, or more than 57% grade A concrete sand. Mixtures, 57% or less Weblite, maintained adequate moisture over a 4-day period during mid-August. The soil

modified with the sand was lower in moisture than with Weblite, and after 4 days without irrigation there was much less moisture for soils modified with sand.

Under good moisture conditions the soils modified with Weblite generally compacted less than soils modified with sand and grass growth was better. Clipping weights declined when modifying materials exceeded 57%.

Turfgrass Diseases

Seventeen fungicides applied weekly were evaluated for effectiveness in control of dollarspot of bentgrass at 2 nitrogen levels. Related excellent at either low or high N were Actidione-thiram and Dyrene at 2 or 4 oz./1000 sq. ft., and Tersan OM at 5 oz./1000 sq. ft. Rated intermediate at low N levels and excellent at high levels were Tersan OM, 3 oz.; Tersan 75, 3 oz. plus PMAS, ½ oz.; Calo Clor, 1 oz.; PMAS, 1 oz.; Thimer, 3 oz. Less effective at low N levels but rated satisfactory at high N were Panogen, 1½ oz.; EP 255, 1½ oz.; Cadminate, ½ oz.; Caddy, 1 oz.; and Emmi, 1 oz. Rated unsatisfactory at either level of N were Ortho Lawn and Turf, Difolatan, Maneb M-22, Dyrene Granular, and Du-Ter.

Helminthosporium vagans control on Kentucky bluegrass was obtained with: Dyrene, 4-6 oz.; Thimer, 6 oz.; Tersan OM, 6 oz.; Panogen, 3 oz.; Difolatan, 6 oz.; Actidione-thiram, 4-6 oz.; Kromad, 6 oz.; and Ortho Lawn and Turf, 6 oz., per 1000 sq. ft., respectively. High N level was the only management practice that increased incidence of disease. Temperature measurements ⅛" below soil in 1" and 2" heights of cut were significantly different (ex. 108 F. for 1" cut, 92 F. at 2" cut, and 88 F. at air temperature on selected day at 2 p.m.). In second year, N levels, but not P and K, affected dollarspot development on bentgrass.

Highway Problems

Slope Facing and Sod Cover

Microclimate conditions on highway cuts are profoundly influenced by slope facings and sod cover. Extreme variations are found in soil surface temperatures between north and south facing slopes with and without sod cover. Temperature differences, often exceeding 30 to 40 F., are caused by the angle at which the sun strikes the ground—the more direct the solar radiation the higher the soil temperature. High temperatures cause rapid transpiration and evaporation. Microclimate influences species adaptation, the seed mixture, fertilizer requirements, and mowing management. Cool season grasses are difficult to establish and maintain when soil temperatures exceed 100 F. Close mowing of sunny slopes causes acute problems in maintenance because of increased soil temperatures and its affect on moisture and plant adaptation.

Steep Subsoil Slopess

It is difficult to obtain stands of grass on highway 1:1 sloping cuts and other sites where soil excavation has left steep erosive areas. Cutting shallow furrows in slopes improves sod establishment. This practice alters the angle of soil to the sun, reducing soil temperature, and improving soil moisture and root penetration. The furrows in the slope make it possible to obtain stands of grass under dry, hot conditions where grass seedings often fail.

Calcium-Potassium Relationship

Fertility status of lime and potassium on roadside areas in the State is frequently critical for sod establishment. Excessively high rates of either lime or potassium may cause unbalanced fertility in some soils. It is a common practice to use 1500 lb./A of a 10-20-10 on slopes at the time of establishment. High levels of potash restrict calcium uptake, or high lime rates also restrict potassium uptake, especially if potassium is low. The proper balance of fertilizer elements is necessary to obtain fast growth and a good sod cover. High rates of potash, 300 lb./A, reduced growth of Kentucky 31 fescue at all lime levels, but to a greater extent where 2 tons of lime were used.

Construction of an experimental golf green, consisting of 12 modified soils, for evaluation of soil compaction, aeration, and water requirements.

Lateral furrows cut on steep roadbanks improve sod establishment. Plot at upper left in picture did not have furrows.

Forestry

Growth and Nutrition

The future of Virginia's forest-based industries depends on the maintenance of a steadily increasing supply of wood. To maintain such a supply will require, to an increasing extent, a thorough knowledge of the growth and nutrition of the forests in Virginia. Work has been initiated to study more closely the annual cycle of growth in a young Virginia pine stand in order to gain a clearer insight into the pattern of growth and nutrient demands of the stand as well as its efficiency in using solar energy for growth.

Greenhouse studies are underway on one of Virginia's most important hardwoods—yellow poplar. The object of this program is to determine the nutrient requirements of yellow poplar as a preliminary step to investigating this species in the forest.

Fertilization of Seedlings Questionable

Fertilization at time of planting of loblolly pine seedlings is being studied. Thirteen lime and fertilizer combinations were tried in 1961 on an Immokalee sand in the Coastal Plain near Franklin. Growth of seedlings through the spring of 1965 was slightly enhanced by some treatments but fertilizer effects were overshadowed by variations in growth due to a hardpan that occurred on the area. Where the hardpan was 2′ or slightly less below the soil surface, growth and survival was best—100% survival and 4.6′ average height for 4-year-old trees. Where the pan occurred at greater depths, 3′ to 5′ or more, tree survival was only 76% and average height was 1.2′.

In the Piedmont, 9 lime and fertilizer combinations were tried in 1959 on a Tatum silt loam near Orange.

Four-year-old loblolly pine seedlings on Coastal Plain area where hardpan depth was less than 2 feet below the surface.

By the end of the fifth growing season there were no differences in height on the fertilized and unfertilized plots. However, average height was less on the fertilized plots, especially those receiving lime, during the first 4 years. Apparently fertilizing stimulated growth of weeds which competed with the tree seedlings.

Results of these studies and others suggest that good results cannot consistently be obtained by fertilizing areas planted with tree seedlings. Reasons for this are: (1) knowledge of nutrient requirements of forest trees is inadequate, (2) fertilization may stimulate growth of plants that compete with the trees, and (3) other factors may be operating which tend to mask the effects of the fertilizer, like the hardpan just cited.

Control of Undesirable Trees

Removal of undesirable hardwood trees for timber stand improvement is a major problem. Effective, economical herbicidal methods that will control undesirable oaks, hickory, and maple are continually in demand.

Experimental studies done in the southern Appalachian mountains have shown that 20 lbs. of esters of 2, 4, 5-T (acid equivalent/100 gallons in No. 2 fuel oil) applied in a complete girdle with an injector will effectively kill the tops and control sprouts on oaks and red maple.

More recent studies using concentrated water-soluble amine 2, 4, 5-T, dicamba, and picloram have proved to be as effective as the fuel oil mixture and more economical. These water-soluble herbicides apparently translocate more readily than the oil-soluble form, and are applied in spaced injector incisions using only one ml of herbicide per incision. More conclusive studies are in progress on red, white, and chestnut oaks, hickories, and red maple.

Insect Damage

Virginia Pine Sawfly

The recent outbreak of the Virginia pine sawfly has declined to non-economic levels. Studies have indicated that the rapid decline of the sawfly population was due to the loss of sex attractiveness by the female. Only 2.5% of the females mated in 1963 and 9.2% in 1964. Unmated females deposit very few eggs.

Nantucket Pine Tipmoth

Studies on the Nantucket pine tipmoth on 6′ tall loblolly pines have shown that the heaviest infestations occur in the tops of trees and are progressively lighter on lower branches. Investigations of 6 types of stands have shown that plantations are more heavily infested than natural old field stands, even though both have approximately the same spacing and the same quality sites. Trees competing with hardwood sprouts, trees

associated with 15′ tall loblolly pine (but not suppressed), and trees in dense stands, were more lightly infested than plantation and old field stands. Understory trees were very lightly infested.

White Pine Weevil

Studies have shown that 30 to 50% of the white pine trees attacked by the white pine weevil did not produce new weevils, but the terminal shoots were killed. The resulting deformity of the tree was the same, but dead white pine terminals can no longer, by themselves, be used as indicators of weevil populations and probable future damage. The weevil larvae frequently drown in resin, especially after passing through nodes. Studies are underway to determine the role of parasites and natural resistant characteristics of the trees where infested shoots fail to produce new weevils.

Forest Management

Forest management decision-making, such as forest regulation decisions, contains inherent uncertainty. To a large extent, this uncertainty results from the long-time periods involved in forest production. Consideration of uncertainty in forest management has received only limited attention from researchers; however, general theoretical models are available for making decisions under uncertainty. This research project has indicated that these general models can be adapted to decision-making problems in forest management. Empirical testing of the adaption is planned as subsequent research.

Linear Programming

To explore the appropriateness of using linear programming to schedule timber harvest activities on a forest property, a linear programming model was adapted to one forest property in southeastern Virginia. The result was a schedule of timber harvests which, subject to certain management and physical constrainst and the assumptions made, is optimal over a 50-year period. It appears that techniques such as linear programming have definite utility in forest management. Continued research in this area is indicated and planned.

Wood Preservation

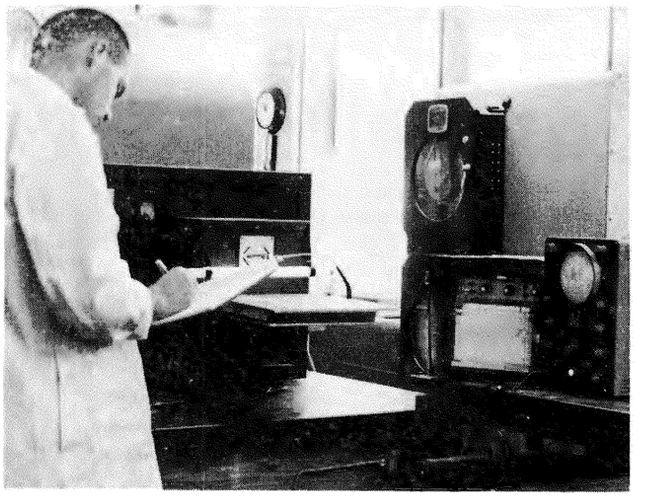
Seasoning of green lumber is one of the most time-consuming and difficult operations in wood processing, and a better understanding of the drying process is required. Solutions to the general diffusion equation are being generated to represent the drying of wood under varying conditions. Those obtained will be compared with the temperature and moisture gradients from actual drying of wood by dielectric and surface heating. The study also seeks to evaluate the improved release of drying stresses through manipulation of drying conditions.

Bonding Phenolics to Wood

Phenols and certain phenolic salts have for some time been used to prevent microbial attack on wood. Outstanding among these preservatives are the chlorinated phenols, especially pentachlorophenol, that have been generally accepted by the wood preserving industry. While these compounds have excellent fungicidal properties, they have the common disadvantage in that their preservative effect in wood diminishes with time. This loss is considered to come from volatility and/or leaching. That these compounds may be degraded by certain micro-organisms has also been suggested. Acidic materials released by these preservatives in service tend to hydrolize the cellulose fraction of wood, which is another adverse effect.

It has long been considered that most of the above disadvantages could be eliminated were the preservative bound to the wood substance through some sort of chemical bond. However, no satisfactory method has yet been devised for durable bonding of phenolic materials to wood while retaining their fungicidal activity.

The primary objective of this study is to investigate the possibility of producing a durable preservative effect of fungitoxic phenolic compounds in wood. Chemical combination of substituted phenols and related chemicals with wood will be studied, using techniques of coordination chemistry. Methods will be developed to apply experimental results to large-dimension lumber and utility poles.



Graduate student checks temperature rise and stray electric fields during dielectric drying of pine.

Livestock, Poultry And Their Products

Animal Diseases

Social Stress and Resistance To Bacterial Infections

Social stress was produced in 8- to 10-week old white leghorn cockrels by placing them in 8 cubic foot isolation cages when they were about 4 weeks old. When they were 8 weeks old, 2 of the 6 birds in each cage were designated as visitors, and the remaining 4 as residents. Every day for 2 weeks the visitors from 6 cages were moved among the 6 cages according to a schedule that kept contact with previously encountered birds to a minimum. In addition to these groups, 2 similar cages of birds that were not moved were kept as controls.

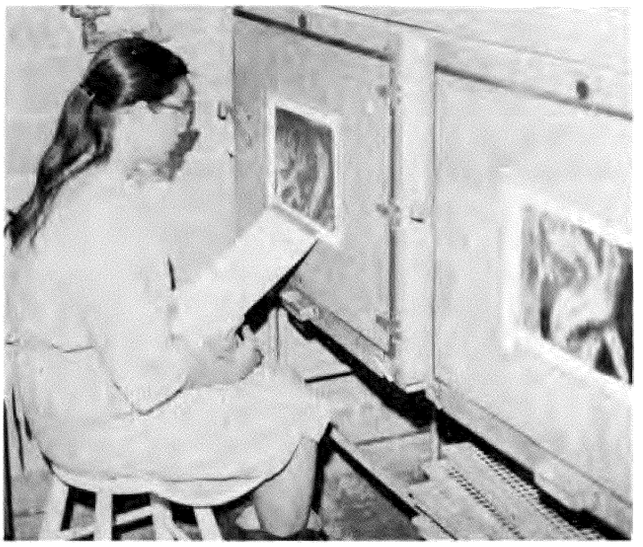
The birds attempted to set up a "peck order" every day, which resulted in considerable commotion in the cages. A bird attempting to assert dominance over another makes a pecking pass toward it (usually without contact). The other bird reacts by ruffling the feathers with an attempt to make a counterattack, or it may make a retreating gesture which recognizes the dominance of the other. Visible injuries from pecking were infrequent.

After 2 weeks of stressing all of the birds were inoculated with the same number of pathogenic coliform bacteria into their air sacs. Two days later the birds were examined for heart lesions, which are characteristic of generalized coliform infection. The results of six similar experiments indicate that 40 of 68 (59%) of the controls had heart lesions while only 55 of 143 (38%) residents and only 12 of 67 (18%) visitors had similar lesions.

Social stressing apparently helps mobilize the bird's disease-fighting mechanism against bacterial infections. Other methods for stimulating this disease-fighting mechanism need exploration. Such social stressing could occur naturally in commercial poultry flocks.

During recent years a great deal of emphasis has been made on the development of drugs and antibiotics for the control of bacterial diseases. By comparison, the very important factor of the bird's natural disease-fighting mechanism has been misunderstood, neglected, and de-emphasized.

Our continuing investigation of this phenomenon will be concerned with the mechanism of increased resistance.



Technician observing social interaction of chickens. Observations are made with the room darkened and with half-silvered plastic over the cage window so that the birds cannot see the technician.

Allergy and Edema Disease in Swine

Edema disease in swine is of significant importance in Virginia as well as in the United States and the rest of the world where hogs are raised. Attempts at transmitting the disease have been unsuccessful, and the disease has only been produced experimentally when bowel extracts from swine with edema disease or supernates from cultures of hemolytic *Escherichia coli* (Fig. I A) were injected intravenously into the animal.

FIGURE 1

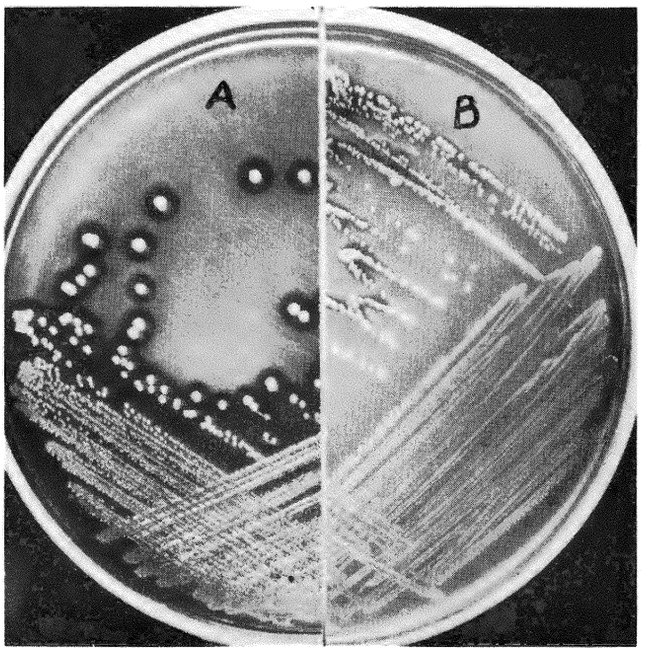
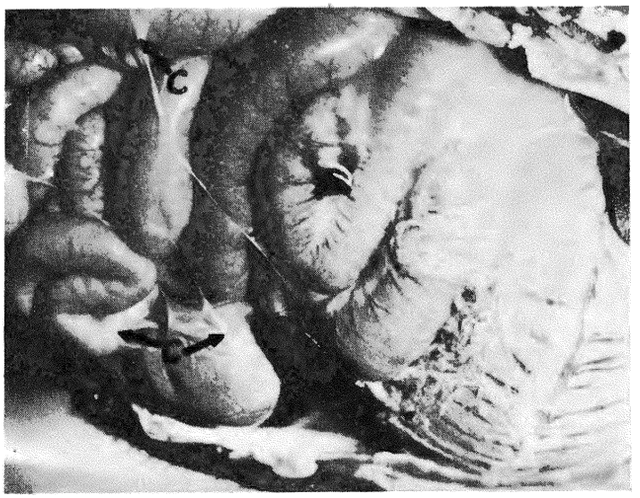


Photo A shows hemolytic *E. coli;* **B. non-hemolytic** *E. coli.*

FIGURE 2



Gelatin-like material in coils of intestine is associated with edema in swine.

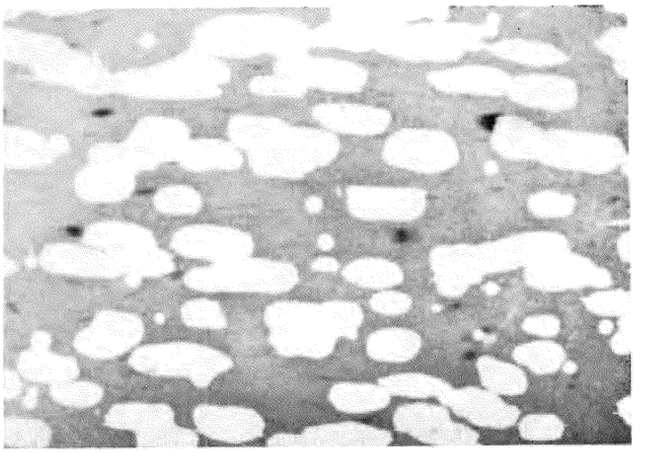
Hemolytic *E. coli* organisms but not non-hemolytic *E. coli* (Fig. I B) have been found in great numbers in the intestinal tract of pigs dead from edema disease. These organisms and their metabolic bi-products have also caused thickening of the wall of the gall bladder of pigs.

Observations of edema disease in pigs indicate that this condition might be due to an allergic reaction. Pigs were given small quantities of the hemolytic *E. coli* intravenously and were sensitized as a person might be when stung by a bee. Other pigs were not injected with the organism. Those pigs that had received the organism intravenously several weeks previously were fed large quantities of a similar hemolytic *E. coli* for a designated period of time. They were autopsied and gelatin-like material similar to that found in field cases of edema disease were seen on the outside of the coils of the intestine (Fig 2 C). The pigs that were not allergic showed no abnormal conditions when autopsied.

It therefore might be that prior exposure to an *E. coli* may be harmful in allowing the production of edema disease in pigs when the previously normal conditions are suddenly changed in the intestinal tract at weaning time. This might result in an incrrease in potentially harmful bacteria production in the intestine. Keeping scours out of pigs during the nursing period may be very helpful in controlling this disease.

Studies of *Vibrio fetus*

Vibrionic abortion in sheep was first reported in 1913. A few years later it was discovered in cattle. Vibriosis has also been associated with abortion, gastro-enteritis, septic arthritis, and prolonged febrile illnesses in man, as well as transmissible enteritis in turkey poults. Thus, vibriosis is a condition that is probably more important both economically and as causes of various diseases than is now recognized. Ovine vibriosis has been reported



Two types of colonies of *V. fetus* var. *intestinalis* biotype 3 isolated from filtrates from sheep feces. (Colonies photographed under dark field illumination; X2.)

in the western United States and also in Kentucky and Virginia.

In sheep the bacterium, *Vibrio fetus*, is transmitted to pregnant ewes when they eat contaminated food and water. In cattle the bacterium is primarily transmitted as a venereal disease, but in some cases cattle may be infected by eating contaminated food.

The bacterium may be classified into subspecies: (1) *V. fetus* var. *venerealis*, which is responsible for abortion in cattle and disease of man; (2) *V. fetus* var. *intestinalis*, which is responsible for abortion in sheep, enteritis in turkeys and man, and sporadic abortion in cattle. The latter can exist in the intestinal tract of animals while the former cannot infect the intestinal tract and is usually found infecting reproductive organs.

Each variety may be further divided into 2 biotypes. The former variety is divided into biotypes 1 and 1A, while the latter variety is divided into biotypes 2 and 3. Biotype 2 is responsible for most of the disease in sheep and sporadic abortion in cattle. Work done at this station has prompted the establishment of biotype 3, which is responsible for enteritis in man and turkey poults, is isolated from chickens with hepatitis, and occasionally causes abortion in cattle and sheep.

Knowledge of the reservoirs of infection of *V. fetus* is inadequate. This information is necessary for a complete understanding of the epizootiology and epidemiology of vibriosis in animals and man. Long-range studies in these areas are being conducted by the veterinary science department.

Investigations have shown that the organism which we designated as *V. vetus* var. *intestinalis* biotype 3 could be found in the intestinal tract of clinically normal sheep, goats, cattle, pigs, and birds. The organism was found in the rectum, colon, cecum, and ileal contents of sheep, but was not isolated from the duodenum, abomasum, rumen contents, or bile. The vibrios were isolated from the feces of sheep 3 months to 8 years of age, but not

from lambs younger than 3 months old. Most frequent isolation of vibros was from sheep 3 to 20 months old. In most instances the vibrios were in low numbers and only a minor member of the intestinal flora.

The method of isolation of *V. fetus* used a new membrane filter technique coupled with an antibiotic medium. This method allows the selective filtration of vibrios which are smaller than most bacteria found in the intestinal tract.

The illustration shows the 2 types of colonies of *V. fetus* var. *intestinalis* biotype 3 isolated from intestinal filtrates. The first was grayish, flat, translucent colony with an irregular edge, which tended to swarm and coalesce. The other was smaller, round, smooth, and glistening with an even edge. On subculture the first colony type appeared like the second type of colony.

These strains of *V fetus* var. *intestinalis* were all catalase positive; H_2S positive; reduced selenite and nitrate; grew in media containing 1% bile and 1% glycine, but did not grow in 3.5% NaCl. All of these strains grew at 42C but not at 25C, while biotypes 1, 1A, and 2 grow at 25C but not at 42C. Therefore, these intestinal strains were designated as biotype 3.

The biotype 3 strains of *V. fetus* isolated from clinically normal sheep, goats, cattle, pigs, and birds are identical to strains isolated from man and turkey poults with enteritis. The establishment of *V. fetus* var. *intestinalis* biotype 3 as part of the normal flora of healthy animals and birds is an important step in man's understanding of the epizootiology of vibriosis in animals. It also sheds much light on the epidemiology of gastroenteritis in man associated with *V. fetus*.

Pregnancy and Hypersensitivity

The pregnant animal was shown to be more sensitive to the bacterial endotoxins of *Vibro fetus* and *Escherichia coli*. Both of these gram-negative bacteria, when inoculated intravenously, produced a fatal anaphylactoid shock reaction in pregnant animals. A similar dose produced a non-fatal shock reaction in the non-pregnant animal. It appears that the increased reaction to bacterial endotoxin is associated with hypercoagulability and increased capillary permeability that develops with advancing gestation.

The abortifacient action of *V. fetus* toxin shock, previously reported in cattle, sheep, and goats, was also demonstrated in the pregnant sow following a single intravenous inoculation of *V. fetus* toxin. The generalized and local Schwartzman reactions were produced in the rabbit with *V. fetus* toxin. The systemic pathology was studied and described.

Heart Pathology

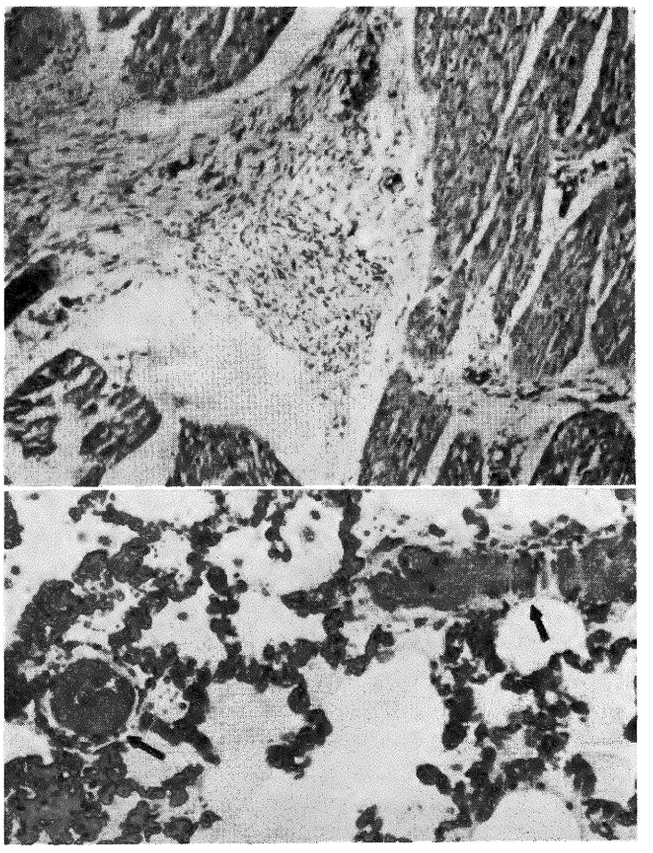
First, second, and third stage Aschoff-like nodules were demonstrated in the myocardium of the young bovine following multiple sublethal inoculations of *V. fetus* toxin. Similar lesions in man are encountered in patients after rheumatic fever.

E. coli Hypersensitivity

E. coli, a bacterial species that may be cultured from the gastrointestinal tract of normal animals and man, was shown to cause severe and often fatal anaphylactoid shock when inoculated intravenously into calves, cows, sheep, pigs, goats, and rabbits.

Five known serotypes of *E. coli* given orally to newborn calves regularly produced severe diarrhea. The same *E. coli* serotypes inoculated intravenously caused a severe and often fatal anaphylactoid shock reaction in young calves. Microscopic study of tissues of the calves that died, revealed similar lesions in the orally and intravenously induced diseases. The lesions involved the microvasculature especially and suggest a common pathogenetic mechanism in the two diseases.

These findings add to the fundamental knowledge of gastroenteric diseases and should lead to more effective means of controlling them.



Heart muscle of calf (upper picture) shows third stage Aschoff-like body in myocardium in calf given multiple intravenous inoculations of *vibrio fetus*.

Pathological changes in the microvasculature of the lung of a calf given *Escherichia coli* endotoxin (lower picture). Note the hyperemic arterioles, capillaries, and venules (→). The alveolar spaces are partially or completely filled with edema fluid. Death was due to anoxia.

Beef

Performance of Bulls

Records on 634 Angus, Polled Hereford, and Horned Herefords, which had completed a 140-day Record of Performance test at Culpeper, were analyzed to determine the effects of various characteristics on several performance traits. These included 3 breeds, 239 sires, 6 years, 3 masculinity ratings, 3 levels of probability of carrying the gene for snorter dwarfism, age of dam, pre-weaning grade, beginning test age, pretest ADG, and selected interaction.

The only significant interactions were breed x masculinity on ROP test gains and weaning grade x dwarfism on end of test grade. Pretest ADG was the only factor to affect significantly lifetime ADG. Sire, pretest ADG, and breed x masculinity interaction all significantly affected ADG on 140 day test. Year, age of dam, beginning test weight, and pretest ADG all significantly influenced the 365 day weight. Grade at end of test was significantly influenced by sire, masculinity development, weaning grade, beginning test age, pretest ADG and the interaction between dwarfism status and weaning grade.

Sale Price of Tested Bulls

Performance tested bulls have been sold annually since 1959 by the Virginia BCIA at Culpeper. The average sale price has generally exceeded the national average for the Angus and Hereford breeds. A total of 338 Angus, 91 Polled Herefords, and 114 Horned Herefords have been sold. Performance data on these bulls were studied to determine their influence on sale price. Factors included in the study were year, breed, herd, age, weight, grade, growth rate (ADG birth to weaning, ADG on 140 day test, and ADG from birth to end of test), probability of carrying the gene for snorter dwarfism, masculinity development, and selected interactions among them.

Factors significantly influencing sale price were year, breed, herd, age, grade, and lifetime gain (birth to end of ROP test). Buyers paid little attention to weight, preweaning performance, masculinity development except as it influenced grade, and ROP test gains. None of the interaction terms was significant. Dwarfism status had a highly significant effect when herd effect was ignored but its effect was greatly reduced when herd effects were removed.

Average sale price was $627.85. Angus bulls sold for the least and Polled Herefords for the most. No estimates of individual herd effects were obtained; however, herd effects greatly influenced sale price. Prices fluctuated from year to year, with highest prices paid in 1961 and 1963 and lowest in 1960 and 1965. Low choice grade bulls brought $140 less than the average, whereas top choice bulls brought $170 above the average. For each .1 lb. above the average, preweaning gain was worth $2.68; ROP test gain, $1.41; and lifetime gain, $86.18.

When lifetime index (which combines ADG from birth to end of test and end of test grade) was included in the analysis in place of gain and grade separately, it was the most important single source of variation in sale price, with buyers paying an additional $25 per point increase above the average.

Heterosis from Crosses among British Breeds

Present purpose of the experiment is to compare producitivity of purebred and crossbred cows in terms of percentage calf crop born and weaned, and birth and weaning weights of the calves, as well as their post-weaning performance. The cow herd, consisting of 60 purebreds (Angus, Hereford, and Shorthorn) and 60 crossbreds (reciprocal 2-breed crosses) among these 3 breeds, was purchased as calves in 1960. Contracts were made with 6 breeders to mate a random ½ of the herd to a bull of a different breed and the remaining ½ to a bull of the same herd. Thus, both purebred and crossbred heifers came from the same herds.

The cows were bred for the second time as 3-year-olds, in 1963. Pairs of bulls were used, 2 purebreds of each of the Angus, Hereford, and Shorthorn breeds and 2 crossbreds of each of the crosses Angus x Hereford, Angus x Shorthorn, and Hereford x Shorthorn (or the reciprocals). The crossbred bulls were bred to the purebred cows, and the purebred bulls were bred to the crossbred cows. Thus, all calves were either 3-breed or backcrosses. This permits valid comparisons between the purebred and crossbred cows without confusion with the effects of crossbreeding in the calves. Five calf crops will be produced. At least half of the bulls are replaced annually. The following table shows the mating plan used.

Table 1. Mating plan, number of cows bred to each pair of bulls each year.

Cows	Bulls					
	Angus	Hereford	Shorthorn	A x H	A x S	H x S
Angus				5	5	10
Hereford				5	10	5
Shorthorn				10	5	5
A x H	5	5	10			
A x S	5	10	5			
H x S	10	5	5			

Cows and calves were grazed on permanent bluegrass pastures, without supplemental feeding, to early October, 1964, when the second calf crop was weaned. After a post-weaning adjustment period of 28 days for the steers and 16 days for the heifers, the calves were placed on fattening rations in feedlots. The heifers were on test

182 days and the steers 192 days, after which they were slaughtered in local packing houses. Table 2 contains weaning weights and post-weaning information on the second calf crop, which was slaughtered in April and May, 1965.

Calves from crossbred dams were heavier at weaning than those from purebreds, 36 lb. in the steers and 43 lb. in the heifers. Both steers and heifers from the crossbred cows had slightly faster feedlot gains, differences of .04 lb./day in the steers and .03 lb./day in the heifers.

With respect to slaughter grade (alive), both sexes from crossbred cows graded a little higher than those from purebred cows, but this was not true for carcass grades. Steer carcasses from the purebred dams graded 1/3 of a grade higher than those from the crossbred cows, but no difference was indicated in the heifer carcass.

This same result was encountered with the first calf crop. Calves from crossbred cows had higher dressing percentage, but the differences were rather small. Data from 3 more calf crops must be accumulated before any detailed explanation of the results will be attempted.

Calving percentages (3 years) were 93.3% and 95.5% for 180 purebred and 179 crossbred cows, respectively. Male calves from crossbred cows were 1.2 kg., and female calves 0.2 kg. heavier at birth than those from purebred cows. Crossbred cows averaged 2 days earlier in calving date. Calves weaned per cow bred was 91.7% for crossbred and 87.5% for purebred cows.

Average weaning weights (230 days average age) for steer and heifer calves from crossbred cows were 201 kg. and 192 kg., respectively. Corresponding weights for calves from purebred cows (228 days average age) were 185 and 180 kg. There was little difference in weaning grade or type score among calves from the 2 groups of cows.

Table 2. Weaning weights, feedlot daily gain, grades and yield, second calf crop.

Type of Cow and Mating	Number Weaned	Weaning Weight	Number Fed	Daily Gain	Slaughter Grade[1]	Carcass Grade[1]	Dressing Percent
Steers							
Purebred dams							
3 Breed cross	18	423	12	2.28	11.9	12.4	59.8
Backcross	16	410	12	2.25	12.1	12.6	59.3
Average	34	417	24	2.26	12.0	12.5	59.6
Crossbred dams							
3 Breed cross	21	457	12	2.31	12.5	11.9	59.9
Backcross	16	448	12	2.29	12.2	11.6	59.8
Average	37	453	24	2.30	12.4	11.8	59.9
Heifers							
Purebred dams							
3 Breed cross	9	420	9	2.00	11.7	12.3	60.5
Backcross	9	362	9	1.92	11.5	11.4	59.6
Average	18	391	18	1.96	11.6	11.9	60.1
Crossbred dams							
3 Breed cross	8	445	8	2.06	12.7	11.9	60.7
Backcross	11	426	9	1.94	12.2	11.5	60.6
Average	19	434	17	1.99	12.4	11.7	60.6

[1] Grade Code: 11, Good Plus; 12, Choice Minus; 13, Choice.

Heritability of Growth and Conformation

The potential for genetic change in traits of economic importance depends largely on the magnitude of the genetic variances and the heritability of the traits under selection. It also depends upon the genetic relationships among the traits, but the single most important genetic parameter needed to make effective breeding plans is accurate estimates of heritability for each trait.

Data were collected for calves between the ages of 120 and 240 days on 12,480 Angus calves by 596 sires and 8,551 Hereford calves by 420 sires. Heritability estimates were obtained for average daily gain (ADG), grade, and index value (ADG and grade).

Phenotypic and genetic correlations were calculated between ADG and grade on the same animal. All estimates were from sire component analysis.

Heritability estimates obtained were .36±.03, .34±.03, and 36±.03 for ADG, grade, and index, respectively, for Angus calves, and .26±.03, .29±.03, and .30±.03 for Hereford calves. The size of these estimates indicate that mass selection for these traits should be effective.

Estimates of the genetic and phenotypic correlation between ADG and grade were .23±.06 and .23±.01 for Angus and .21±.08 and .28±.01, respectively. These findings show that there is no antagonism between growth rate and conformation in beef calves.

Vitamin A Helpful

During the winter of 1962-63 one group of 257 pregnant cows at the Front Royal Station, received a vitamin A supplement in addition to the regular ration of grass silage, hay, and protein supplement, while another group of 112 cows received the same basal ration but no vitamin A. The supplemented cows had a slightly

Effects of winter feeding of Vitamin A supplement to pregnant beef cows.

Calf survival

	Dams fed			
	Vitamin A		No Vitamin A	
Number of calves	No.	%	No.	%
Stillborn	17	6.6	9	8.0
Born alive	240		103	
Died since birth	21	8.8	15	14.6
Alive 4/30/63	219	85.2	88	78.6

Subsequent conception rate

	Cows' previous winter feeding			
	Vitamin A		No Vitamin A	
Breeding result, 1963	No.	%	No.	%
Pregnant	229	90.2	73	81.1
Not pregnant	25	9.8	17	18.9

smaller fraction of stillbirths, and a distinctly smaller fraction of calves dying in the first 4 months, than was true for the cows receiving no vitamin A the previous winter. The conception rate of cows receiving vitamin A during the preceding winter was 9% better than for cows receiving no vitamin A, as shown in the tables.

Non-Genetic Influences on Calf Performance

Performance records on 17,294 Angus and 11,663 Hereford calves were analyzed to determine the influence of several non-genetic sources of variation on growth and conformation. Sources of variation included age, sex, and month of birth of calf, year of record, age of dam, management practice, and weaning. Most sources contributed significantly to the variation, sufficiently to justify the use of correction factors. Age of calf was an exception, within the range of 150 to 240 days. If selection is based on an index combining growth and conformation, the age limit can be extended for 120 to 270 days without need for correction factors. In general. ADG was not significantly different between adjacent age groups of 30-day intervals but did decrease significantly with age over the entire period of 90 to 299 days. On the other hand, type scores (grades) increased with age. Creep-feeding decreased this effect on ADG but increased it on grade.

Steer calves grew 6% faster than heifer calves regardless of whether they were creep-fed or not. Non-creep-fed bull calves grew 6.6% faster than non-creep-fed steers and creep-fed bulls grew 9.7% faster than creep-fed steers. Adjusting to a 210 day weight, steers were 27 lb. heavier than heifers and the non-creep and creep fed bulls were 23 lb. and 35 lb. heavier than steer calves under the same management.

Calves dropped during March and April made fastest gains, whereas August and September calves made slowest gains. These differences were approximately .25 lb. per day for non-creep-fed and .17 lb. for creep-fed calves. The influence of month of birth on grade was of less importance, but the trend was the same as for growth. There was a significant decrease in growth rate and grade associated with weaning.

Inbreeding vs. Selection

Genetic study of 2 mating systems — inbreeding and mass selection — was started at the Front Royal Station using non-inbred sets of 32 daughters from 4 sires each, of the Angus, Hereford, and Shorthorn breeds. Foundation sets were completed first in Shorthorns, next in Angus, and recently in Herefords.

Results of the first 2 generations in Angus and the first 4 generations in Shorthorns, presented in the table, show that (a) inbred lines of both breeds differ in their response to inbreeding, and (b) the selection lines differ in the traits for which they were selected. Calves from the "growth" line are generally faster growing, and from the "type" line generally show better conformation than their counterparts from the opposite selection line.

Average daily gains and conformation scores at weaning.

Line and Generation	No. of calves	Performance of Bulls ADG[a]	Bulls Conf. score[b]	Heifers ADG[a]	Heifers Conf. score[b]
ANGUS					
A-1 Inbred					
0 (Foundation)	38	2.01	11.7	1.73	12.9
1 (1st generation)	41	1.98	11.5	1.75	12.1
2 (2nd generation)	36	1.92	10.9	1.75	11.4
A-2 Inbred					
0	36	1.99	11.7	1.79	12.7
1	60	1.84	11.5	1.63	11.7
2	32	1.88	11.7	1.58	11.2
A-7 Type Selection					
0	30	*	*	1.75	12.1
1	95	1.91	11.9	1.66	12.4
2	44	1.93	12.0	1.76	12.0
A-8 Growth Selection					
0	33	*	*	1.77	11.8
1	101	1.97	11.4	1.71	11.6
2	53	2.07	11.5	1.82	11.9
SHORTHORN					
S-1 Inbred					
0 (Generation)	[d]				
1 (1st Generation)	51	1.65	9.8	1.44	10.5
2 (2nd Generation)	45	1.71	10.4	1.57	10.6
3 (3rd Generation)	19	1.88	10.4	1.54	10.3
4 (4th Generation)	4	1.92	9.6	2.00	12.5
S-2 Inbred					
0	[d]				
1	35	1.72	10.8	1.42	11.3
2	41	1.60	10.7	1.55	11.5
3	17	1.65	10.9	1.55	11.0
4	3	1.92	9.2	1.25	9.8
S-7 Type Selection					
0	14	*	*	1.67	12.2
1	57	1.57	11.0	1.47	11.6
2	43	1.92	12.2	1.60	11.7
3	39	1.73	12.1	1.53	11.9
4	13	1.95	13.7	1.53	13.9
S-8 Growth Selection					
0	18	*	*	1.62	12.0
1	79	1.78	10.9	1.50	11.4
2	69	1.90	11.2	1.58	11.2
3	36	1.90	11.1	1.63	11.6
4	11	2.11	12.0	1.58	10.9

[a] Adjusted for age of dam.
[b] According to a scale in which 9, 10, 11 equals good; 12, 13, 14 equals choice, etc.
[c] Foundation males appear as generation 0 inbreds.
[d] Foundation S-1 and S-2 calves were produced prior to 1949 when the Front Royal project began.

Summer Calving and Feed Efficiency

The Northern Virginia Pasture Research Station is studying beef calf production using a July to October calving. Research is directed toward maximum use of silages and hay for suckling calves and reducing winter feed requirements of the cows.

October calves are old enough by winter to feed on high quality silages and hay. Milk is important for fast gains, but its need is questioned. Thus, feed to cows may be limited, but calves are fed quality silage or hay plus limited concentrates.

Environmental conditions, especially feeding methods and management, are important for high gains and feed efficiency. In a study during 100 days in each of three winters, 30 calves were allowed to stay with their dams and used for creep ration and management studies. Twenty calves were early weaned in late November and used to study their nutrition and low feeding levels of the dry cows.

Gains and feed efficiency for suckling calves and their mothers may be controlled. Creep feeding methods of calves had big effects on growth and gain. Creep-fed calves gained 1.9 lb. daily while calves with similar feed, but fed with their dams, gained only 1.5 lb. daily. Other factors were less important. Calves creep-fed on corn silage plus 1.5 lb. CSM gained 2.03 lb.; those creep-fed alfalfa-orchardgrass hay plus 3 lb. corn gained 1.86 lb. daily. Creep-fed calves separated from dams while they ate tended to gain slightly faster and have a more uniform condition than creep-fed calves also permitted to eat with dams. Gains of creep-fed calves were slightly higher when fed twice as compared to once daily. Calf gains were not influenced when fall feeding was compared to limiting the dams' feed to 10 lb. TDN daily.

Feeding method, management of calf, and nursing had significant effects upon performance of cows. Feeding dams and calves together resulted in the dams gaining .31 lb. daily compared to daily losses of .54 lb. for dams fed separate from calves. Permitting creep-fed calves to eat with their dams reduced the dam's body weight faster than when similarly fed calves were not permitted to eat with the dams. Full feeding (20 lb. TDN) resulted in .24 lb. gain daily as compared to a loss of .94 lb. for dams limited to 10 lb. TDN daily. Dams fed twice a day lost weight at a slightly slower rate than those fed once a day. Nursing dams fed 10 lb. TDN lost .63 lb. daily while similarly fed dry cows of early weaned calves gained .34 lb. Dry dams fed 50% less TDN (5 lb.) lost 1.1 lb. daily.

Feed efficiency based on calf gains was highest for management and feeding practices that produced high calf gains.

Early weaned calves gained at a satisfactory rate of 1.79 lb. daily when fed corn plus 1.5 cottonseed meal and at rates of 2.33 lb. daily, when full-fed 7 lb. ground shelled corn, 1.5 lb. cottonseed meal, 3.0 lb. hay, and 2 lb. dried milk substitute. Gains on other rations were intermediate.

High feed efficiency based on calf gains came from "early weaning" and feeding the dry dam on 5 lb. TDN daily.

Appetite in Beef Cattle

In farm animals, the term "appetite" usually refers to the rate of eating or the total amount of feed eaten. Information is scant concerning the factors causing cattle to start or stop eating and factors which determine the amount of feed eaten in a given period of time.

Studies have been conducted at VPI on the chemostatic regulation of appetite in beef cattle. The effect of single intravenous injections of volatile fatty acids in fattening beef heifers was studied. The volatile fatty acids, principally acetic, proprionic, and butyric acids, are normal end-products of carbohydrate digestion in the rumen. It was found that injection of one liter of 15% solution of acetic, proprionic, or butyric acid affected appetite, and that proprionic and butyric acids had greater effects than acetic acid.

Poultry Litter as a Feed for Ruminants

It had been shown previously by this station that fattening steers fed a mixture containing 25% broiler litter, plus 2 lb. long hay, performed satisfactorily and no undesirable flavor was imparted to the meat. A fattening trial was conducted with yearling steers to study the effect of including 25 and 40% broiler litter containing 4 base materials (ground corn cobs, chopped hay, soybean hulls, peanut hulls) in fattening mixtures. About 2 lb. long hay were fed per head daily.

No significant differences appeared among base litters or between levels of litter. Rate of gain from litter was significantly lower than from chopped hay and soybean meal. Feed cost per pound of gain was lower for the litter lots. Average carcass grade was high Good, with little difference among lots.

In a 56-day winter feeding trial, the feeding of 1.4 lb. of dehydrated broiler litter to weanling beef calves full fed corn silage and a limited amount of mixed hay produced similar gains to those fed 1 lb. cottonseed meal (supplied same protein equivalent as 1.4 lb.. litter).

Metabolism trials with wethers fed semi-purified rations showed that nitrogen (crude protein) in autoclaved peanut hull litter was efficiently used when it supplied as much as 50% of total crude protein in the ration. Metabolism trials were conducted with wethers to determine protein and energy value of autoclaved peanut hull and wood shaving broiler litters. The litters were incorporated in a corn-hay ration at levels of 25 and 50%. Differences between kinds of levels of litter in digestibility of protein and energy were not significant.

Average digestibility values, calculated by difference, were 72.5% for protein and 64.0% for energy. About 45% of the total nitrogen in the litters was in the form of true protein; uric acid accounted for about 30%.

Prior to feeding a given source of litter to livestock, it should probably be tested for harmful drug and pesticide residues, as a safety precaution.

Sheep

Breeding for Rapid Growth

Rapid growth from birth to weaning or market weight at 95 to 100 lb. is, economically, the most important factor in lamb production other than total lambs produced per ewe. The fast-growing lamb is more efficient in feed conversion, will grade higher at a given age or weight, and usually reaches market earlier and at the time of most favorable prices.

Research to improve the breeding ability of Hampshire rams to sire fast-growing lambs has been underway since 1956. Earlier work had indicated that a ram's own growth rate as a lamb is a poor predictor of the growth rate of the lambs he sires. An experiment is now being carried out in which selection is based solely on the growth rate, from birth to weaning or market age, of the lambs sired by the ram. Each year 15 ram lambs, produced in a flock of 60 to 75 purebred Hampshire ewes kept at the main station at VPI, are progeny-tested at the Shenandoah Valley Station. Each ram lamb is bred to 10 Hampshire x Rambouillet crossbred western ewes. The 3 rams with the fastest growing progeny are selected to be used as stud rams in the purebred flock at VPI, replacing the 3 rams used the year before. This breeding system is known as *Recurrent Selection.*

A second flock of purebred Hampshires is maintained at the Southwest Virginia Station as a *Genetic Control* flock. This flock is based on the same foundation stock as the *Recurrent Selection* flock and is bred without selection in an attempt to keep the flock at the same genetic level as the foundation stock. Thus it serves as a "control" or "standard" from which to measure progress made by the recurrent selection program. This flock numbers 10 rams and 50 to 60 ewes. Each year 5 ram lambs from the *Genetic Control* flock are also progeny tested at the Shenandoah Valley Station in comparison with the 15 from the *Recurrent Selection* flock.

Only one year's comparison is available between progeny of the rams from the 2 flocks. The results are encouraging. In 1965 the 15 rams from the *Recurrent Selection* flock had an average progeny daily gain of .52 lb. per day; the 5 *Genetic Control* rams .48 lb. per day. The progenies of the 5 *Genetic Control* rams ranked 6th, 9th, 17th, 19th, and 20th among the 20 rams tested.

Intensive Lamb Production

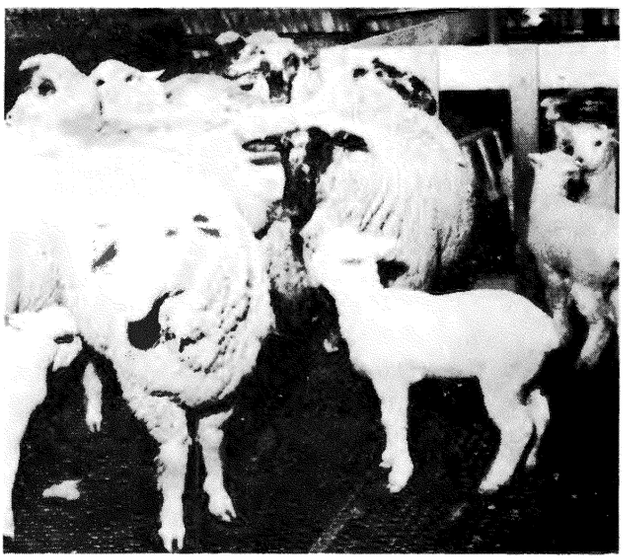
Most flocks of sheep in Virginia are rather small, averaging 25 to 30 ewes. Such flocks, while highly profitable in terms of return on invested capital and labor income, produce a relatively small proportion of total farm income. Many farms, well adapted to lamb production, keep no sheep. Management methods that permit increases of 100% to 1000% in numbers of sheep kept on the average Virginia livestock farm are needed for sheep and lamb production to become a major or the principal livestock enterprise and to take advantage of the high rate of profit that may be realized from sheep.

It has frequently been said that a sheep's worst enemy is another sheep. Concentration of sheep on pastures under conventional management methods usually results in increased infection and losses from parasites and diseases, but particularly from internal parasites. Mature sheep develop resistance to stomach and intestinal worms but lambs are highly susceptible, and, when grazed with their mothers in fairly high concentration, become heavily parasitized. Several management methods that will break the chain of parasite infection from ewe to lamb have been studied at the Blacksburg and Glade Spring Stations during the past 6 years. Some of these show promise of permitting large increases in sheep numbers per farm.

Early Weaning of Lambs

Lambs have few internal parasites before going to pasture in the spring. The build-up of parasite infection is relatively slow in the early part of the grazing season (April and May) but increases rapidly in June and July. Early weaning of the lambs and subsequent finishing to market weight away from their mothers is one method of avoiding this build-up.

For the past 3 years lambs have been weaned at the beginning of the grazing season (about April 20) at average weights of about 60 lb., and finished to market weight either on clean pasture or in dry lot. Both groups were full fed a pelleted ration. Gains on both treatments have been good to excellent. Those finished in dry lot gained .55 to .60 lb. per day and graded top Choice to low Prime at market weights. About 190 lb. of grain and 50 lb. hay were required per lamb. Those finished on pasture averaged about .5 lb. gain per day and top Choice in grade, but required less feed,



A group of ewes and their lambs being raised in confinement.

about 120 lb. grain per lamb. The dry ewes require relatively little feed and have been run at the rate of 8 to 10 per acre of pasture until breeding season. This system should permit stocking 3 to 5 ewes per acre.

A less intensive, but on many farms a more practical system, is to graze ewes and lambs together for about 6 weeks, to about June 1. At this time all lambs heavy enough are marketed, the others weaned, dosed for worms, and finished in dry lot to market weight. The lambs will gain about ½ lb. per day and grade top Choice to low Prime. Much less feed is required than with earlier weaning, about 85 lb. grain and 15 lb. hay per lamb. This system should permit 2 ewes and their lambs to be carried per acre of pasture. Attempts to finish these later weaned lambs on permanent pasture have not been too successful, perhaps because of the lower quality of pasture at this season. Gains have been .4 to .45 lb. per day, with average market grades of Choice. The use of high quality temporary pastures or green chop for the lambs after weaning has not been tested but might offer possibilities under this system.

Very Early Weaning and Multiple Breeding

The most intensive lamb production system tested so far is to wean the lambs at about 7 weeks of age, minimum weaning age of 30 days, and immediately rebreed the ewes in order to raise more than one lamb crop in a 12-month period. The lambs are raised in confinement on slotted floors and full fed a pelleted ration of 65% concentrates and 35% roughage plus a little long hay. This system has been tested on a pilot scale since 1962 and has been quite successful. The early weaned lambs have made excellent gains following weaning, averaging slightly above .6 lb. per day and practically all of them have graded Prime. Deaths have been few—substantially lower than under conventional management. Feed conversion has been good, averaging from 3 to 3.5 lb. feed (grain and roughage combined) per pound of gain.

The ewes have rebred rather quickly following weaning, averaging a little less than 7 months between lambings, except for one season when the breeding period fell in April, May, and early June, when the average lambing interval was about 8 months. An average of 2.4 lambs per ewe bred have been marketed per 12-month period. The ewes used were mature Blackface crossbred western ewes, crosses of Hampshire or Suffolk rams on range ewes of mainly Rambouillet breeding.

This system might be considered the ultimate in intensification of sheep production and should permit rather large numbers to be produced on limited acreage. It also requires the largest capital investment of any of the systems tried so far. However, it appears to be economically practical for a number of farm situations.

Obviously, many problems remain to be worked out and research has been expanded on a number of them.

Environment and Ewe and Lamb Performance

A study of the effects of different geographic and climatic environments on the performance of ewes and lambs of different breeding has been carried out since 1960 in cooperation with the Canada Department of Agriculture. Two groups of ewes of widely different genetic backgrounds and origin are kept at the Southwest Virginia Station and at Central Experimental Farm, Ottawa, Ontario. The 2 kinds of ewes are North Country Cheviot x Leicester crosses, produced in Northern Quebec, and ¾ Hampshire ¼ Rambouillet ewes, produced in Virginia. The ewes at both locations are bred to 3 Suffolk rams which are replaced each season. Because of difference in breeding dates (August 1 to October 1 in Virginia; November 1 to December 15 in Ontario) the same rams can be used at both locations in the same year.

The greatest difference in response to the different environments has been in percentage of ewes lambing and in average lambing dates. In Virginia, 91% of the Hampshire ewes lambed but only 78% of the Cheviot-Leicesters. In Ontario, the percentage of ewes lambing was essentially the same for the two groups, 93 and 92%. The ¾ Hampshire ewes lambed 3 weeks earlier in Virginia than the Cheviot-Leicesters (averaging lambing dates January 14—February 3) — but 3 days later in Ontario (April 15—April 12. The Cheviot-Leicester ewes were more prolific at both locations, averaging about 1¾ lambs born per ewe lambing, compared to about 1½ for the Hampshire ewes, but there was no evidence of differences caused by environment.

Birth weights of the lambs from both kinds of ewes were higher in Ontario than in Virginia, but growth rates of the lambs to weaning and average 120-day weights were higher in Virginia. The Virginia lambs were fatter at weaning or slaughter as indicated by higher carcass grades and dressing percentages as well as fat thickness. However, the loin eye area and cutout values were higher in Canada.

It seems evident that important geneotype x environment interactions exist in ewe performance and that breeding for local adaptation for these traits may be important.

Energy Levels for Wintering

Two trials have been conducted at VPI to examine the possibility of reducing the energy (TDN) fed pregnant and lactating ewes without adversely affecting the ewes or their lambs. Three groups of ewes were used over the two-year period. Group I received the recommended level (National Research Council recommendations) throughout the winter feeding period. Group II received 60% of the recommended energy until four weeks before lambing. At this time they were fed 100% of the recommended level through lambing until 28 days post-lambing. After 28 days post-lambing, the ewes in group II returned to the 60% energy level until the

lambs were weaned. The ewes in group III were fed 60% of the energy level throughout the winter period.

The study has indicated that groups I and II performed essentially the same. The lambs in group III gained slightly less than those in groups I and II in both years. There was essentially no difference in birth weights or number of lambs produced in the three groups.

Marked differences were noted in both trials in the total amount of energy required to carry the ewes through the winter. The TDN consumption for the three groups averaged 424, 308, and 256 lb. per ewe for groups I, II and III, respectively, for the two trials.

Roughages for Lambs

The value of 4 roughages — alfalfa hay, pasture clipping hay, corn cobs, and peanut hulls — in ground or pelleted lamb fattening rations was studied in 2 trials, each involving 8 lots of 10 feeder lambs. Alfalfa and pasture clipping hay were incorporated at a level of 40% of the ration. The peanut hulls and corn cobs were incorporated at levels to equalize the crude fiber contents of the rations containing these roughages with that of the rations containing pasture hay.

Kind of roughage had no marked effect on rate of gain. Feed efficiency was highest for the alfalfa hay rations, lowest for the pasture clipping hay rations, and was intermediate for rations containing peanut hulls and corn cobs. Pelleting resulted in an average increase in rate and efficiency of gain.

Swine

Cost of Producing Pork

To grow hogs to a market weight of 200 to 250 lb., total cost per 100 lb. of pork produced ranged from $13.50 to $22.50 for 25 farms in Southeastern Virginia. Feed required per 100 lb. of gain ranged from 560 lb. for some hogs produced on dirt to less than 300 lb. for the most efficient production on concrete. Average feed requirement per 100 lb. of pork produced was 380 lb. for hogs produced on concrete and 440 lb. for hogs produced on a dirt dry lot.

The higher costs of pork production were generally associated with heavy initial weight of feeder pigs purchased (50 to 80 lb.) and the high percentage of protein fed to hogs weighing 125 lb. and over. At the weight of 125 lb. and more, some farmers fed rations with more than 13% digestible protein. The components of pork production costs for hogs produced on concrete are shown in the table.

Inputs per hog		Costs per 100 lb. of pork produced ($)
Feeder Pig	65 lb.	7.87
Grain	444 lb.	5.07
Protein supplement	87 lb.	1.80
Annual building costs		0.36
Marketing and other		0.76
Labor	1½ hrs.	0.73
TOTAL COSTS	205 lb.	16.59

The feed conversion and related cost of pork production averaged less favorably than results reported from controlled experiments of various Agricultural Experiment Stations. The efficiency attained by some of these farmers indicates that production efficiency attained by controlled experiments can be duplicated under farm conditions.

Feed for Gestating Gilts

Obtaining large litters of healthy pigs at farrowing time is often the difference between profit and loss in swine breeding programs. Two trials have been conducted at the Tidewater Station, in which the pattern of feeding and levels of vitamin supplementation for pregnant gilts were studied. Gilts were individually fed either a graduated level, 3, 5, and 7 lb. of feed daily, or a constant level of 5 lb. of feed during gestation. One-half of each of these 2 groups of gilts received twice the recommended amount of vitamin supplement.

Gilts from each of these 4 treatments were slaughtered at 38 days and 76 days of gestation to estimate prenatal mortality at different stages of gestation. Additional gilts from each group were farrowed out to evaluate the size and weight of the litters at birth.

Results of the 2 trials indicate that the prenatal survival at both periods studied, 38 and 76 days, was improved by increasing the vitamin supplement, 69% vs. 77% at 38 days, and 68% vs. 73% survival at 76 days. Increasing the feed from 3 to 7 lb. during gestation increased survival of the fetuses at 78 days, 67% vs. 74%. The increasing feed level also resulted in somewhat heavier pigs at birth, 2.89 lb. vs. 3.16 lb. The added vitamins increased birth weights in the first trial, but not in the second. Neither treatment had a marked effect on the number of pigs per litter in either trial.

Additional work is underway to further investigate these responses.

Milk Production

Demand Changes and Milk Pricing

There is some evidence that the food market places less emphasis on fat and more on other food components, especially protein, than formerly. Promotion efforts often emphasize protein content. Milk standardized to 2% fat and 10% nonfat solids has been introduced in many markets with considerable success. In 80 major markets across the country, low-fat fluid milk accounts for about 10% of the fluid milk consumed. In spite of these developments, there has been little change in the relative market price of the major components of milk-fat and nonfat solids.

Some indication of the consumer's relative valuation of milk components was obtained by a comparison of 4 typical milk products which differ in composition and price. Based on the prices consumers pay for these 4 products (homogenized) milk, low-fat milk, half and half, and cottage cheese), the values wese estimated at $1.81 per pound for fat, $2.23 for protein, and $1.18 for lactose-minerals.

With some evidence of a developing market for low-fat milk fortified with nonfat milk solids, estimates were made of the price that might be paid for nonfat solids for fortifying. Assuming a wholesale butter market at 58¢ to take the extra fat obtained from standardizing regular milk down to 2% fat, processors could pay approximately 50¢ a pound for nonfat solids to fortify low-fat milk without increasing the cost of low-fat above the cost of the whole milk product. In comparison, if the market for butter were lowered to 40¢ a pound, a processor would be able to pay only 30¢ a pound for nonfat solids to use in fortifying without increasing the cost. If, however, the butter price dropped to the 40¢ level and processors continued to pay the same price per cwt. for milk, the cost of nonfat dry milk could be expected to be about 37¢ a pound.

If a low-fat, fortified milk (2% fat, 10% nonfat) were to account for 20% of fluid milk sales (now 10% of sales), roughly 200,000,000 pounds of additional fat from whole milk would be released to the market. This would be equivalent to a 12% increase in the amount now going into butter and ice cream. On the other hand, more than 200,000,000 pounds of additional nonfat dry milk would be required to fortify the product.

Reducing Milk-Hauling Costs

As local milk markets in Virginia have expanded milk supply areas to meet their needs, overlapping of areas and cross hauling of milk have occurred. Such developments require adjustments in milk movement patterns if hauling costs are to be held to a minimum.

The possibility for cost-reducing adjustments was examined for the areas supplying the major markets of Eastern Virginia. In the analysis, it was estimated that the cost for hauling milk from the supply areas to the Richmond, Petersburg, Newport News, and Norfolk markets averaged 20¢ per cwt. under present arrangements. Under a more coordinated pattern of hauling the same supply, it was estimated that the hauling cost would be reduced to 15¢ per cwt. This reduction would amount to an anual net saving of $190,000 in hauling costs on the milk for these markets. Costs of farm pick-up were not included in these estimates. It seems probable that additional cost savings could be made in the farm pick-up job also by more coordination.

The realization of such reductions in costs depends largely on the industry's ability to coordinate the hauling operations. This would require closer cooperation or federation of producer groups in the area, unrestricted movement of milk among the several markets or consolidation of markets, and pricing provisions to recognize differences in location.

Minimizing Distribution Costs

Major changes are occurring in the number, size, type, and location of dairy processing and marketing facilities in Virginia and elsewhere. These changes may be attributed to many factors, including technological advances, shifts in consumer buying habits, and modifications in institutional factors. In the face of such changes, major adjustments are often necessary to maintain or improve efficiency.

One of the significant changes is the decline in the number of fluid milk processing plants. Associated with this change is the widening of distribution areas through branch distribution points. Expanding distribution areas has helped maintain the number of milk distributors competing for sales in a given market in spite of the decline in total number of processing plants. These types of changes are expected to continue.

The present study is concerned with analyses to determine the size and location of fluid milk processing plants and distribution facilities that would minimize the costs of assembling raw milk, processing it, and distributing the packaged product to consuming centers. The optimum movement patterns of milk from supply areas to processing points and from processing points to consuming centers are being outlined for Virginia and the southern region. The findings will be projected 10 years ahead to serve as long-range planning guides.

Tall Fescue for Milk Production

Tall fescue is one of the best adapted and productive grasses in Virginia; however, it is less palatable than bluegrass or orchardgrass. When a plant breeder in Kentucky developed a more palatable variety of tall fescue, a grazing experiment was established to compare the new variety, Kenwell, with Kentucky 31 fescue, the common commercial variety. During three years, dairy cows grazing Kentucky 31 fescue maintained higher milk production than those grazing Kenwell. When averaging all treatments, the cows grazing Kentucky 31 fescue gained weight whereas those grazing Kenwell lost some weight.

Nutritive Value of Corn Silage

Using corn silage as an energy source for dairy cattle has increased greatly in recent years. However, there are few studies to determine the effect of maturity on the value of corn silage for lactating cows.

Thirty-six cows were used in two trials which compared silages cut in the soft, medium, and hard dough stages. Dry matter content of silages cut at the respective maturities averaged 25, 30 and 33%.

Cows were fed all of the silage they would eat, supplemented with either low levels of soybean meal (about

5 lb. /day) or normal levels of a commercial protein concentrate containing 16% crude protein (about 15 lb./day).

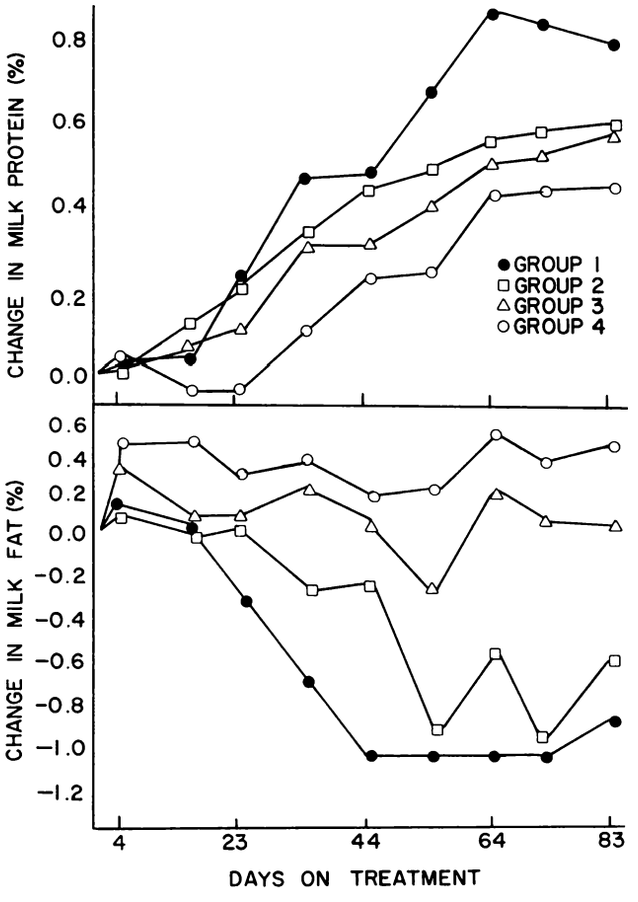
Dry matter intake of the hard dough silage was 20% higher than soft dough when soybean meal was fed and 10% higher while cows were on the concentrate. Greater consumption of the more mature silages resulted in higher milk production. Total digestible nutrient content of the silages ranged from 64 to 68% and no differences due to maturity were detected. Neither were there any differences between the stages of maturity in digestibility of the dry matter components, body weight, or milk composition.

Effect of Feed on Milk Composition

Studies have continued to investigate how the various feeds and feeding systems affect the major constituents of milk.

Results have consistently shown that milk fat is drastically depressed, from about 3.5 to 2.5%, when cows grazing medium quality pasture are fed very high levels of grain(25 to 30 lb./day). When supplemented forage, as corn or grass silage, was fed in sufficient quantity to insure the intake of about 1 lb. of dry forage per 100 lb. body weight, the decreases in milk fat were not as great or did not occur.

The protein and the PLM fractions in milk increased as the level of grain in the ration increased. Since increase in PLM at the highest levels of grain was not as great as the decrease in fat, there was a net decrease in the total solids in the milk.



When rations of widely varying protein content were fed, dietary protein had no effect on the concentration of any of the major milk constituents regardless of level of energy.

The following graph shows the average change from standardization in milk protein and fat in one trial. In addition to pasture, rations for the respective groups included: (1) 26 lb. grain; (2) 25 lb. grain, 24 lb. corn silage; (3) 9 lb. grain, 46 lb. corn silage; (4) 54 lb. corn silage.

Milk Composition

Recording of production of PLM (protein-lactose-mineral fraction of milk) by dairy cows has been conducted in Virginia dairy herds since August 1958. At present, dairy cows in more than 100 herds are sampled one day each month. Preliminary analyses show that heredity plays about as large a role in the determination of PLM percentage and yield as it does for milk fat. Furthermore, fat and PLM percentages and yields appear to be inherited together to a large extent. This means that a breeder of dairy cattle can select for increase in percentage or yield of one fraction of milk and also gain somewhat in the other fraction.

Another finding is that production of PLM follows about the same trend from month to month during the lactation as do milk and fat yields. Daily production is fairly high soon after calving and rises to a peak about the second month, then drops slowly until the cow goes dry. This information has been used to develop factors for "extending" incomplete records.

Milk Replacers for Calves

In one trial 48 calves were fed milk replacers containing 10, 16 and 22% protein. All of the protein was of milk origin. Significant increases in gains to weaning were noted as the protein level in the replacer increased. A subsequent trial compared replacers having 22, 27 and 32% protein. No additional benefit in calf growth was obtained by increasing the protein content of the milk replacer above 22%.

In another study, replacing dried skim milk as a source of protein with fish flour in milk replacers was investigated with 32 Holstein calves. The fish flour successfully substituted for up to 40% of the total protein in the replacer. When 60% of the total protein came from the fish flour, a depression in growth was noted. When the fish flour furnished all of the protein, the animals died.

Protein and mineral digestibilities in the fish flour were slightly lower than in the dried skim milk, as was the biological value of the protein.

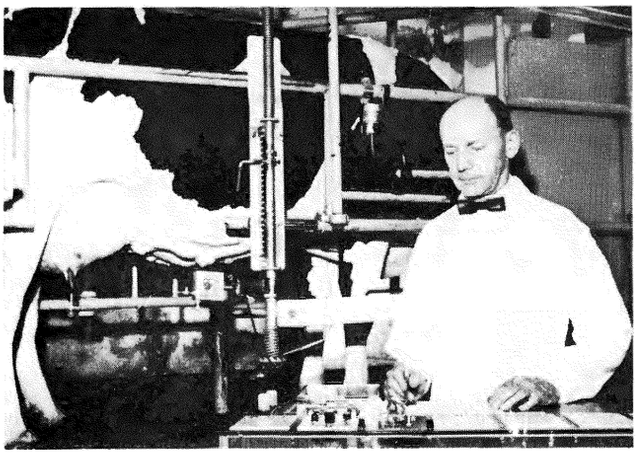
Effect of Intramammary Pressures

If a cow is completely milked out, will intramammary pressures return to zero? Preliminary study shows that most cows have considerable pressure within the udder even though the udder is considered by the milker to be completely milked out. Injecting the let-down harmone after milking and removing this residual milk indicates that the pressures will return to zero.

In a study of 10 cows, intramammary pressures at milking time and before preparation for milking averaged 10.1 mm. Hg.; after preparation (massaging with warm water and removing two streams of milk from each quarter) pressures increased to 26.5 mm. Hg. After machine milking, pressures ranged from 0.0 to 11 mm.

It was also demonstrated on several cows that a more complete let-down and milk-out could be obtained by the injection of 10 U.S.P. units of oxytocin (let-down hormone) after the cows were prepared in the usual manner. These data raise more questions, such as, does the injection of the hormone prolong the time when we can get maximum removal of milk from the udder? Or is there an inadequate supply of oxytocin secreted which in turn does not permit the milker to remove all the milk in the udder at milking time?

Further studies on these problems may result in answers which will give us new and more complete information on milking cows out more completely.



Measuring intramammary pressures of a lactating dairy cow with a machine designed to record biological processes.

Milk Flow Rate Varies with Individual Cows and Breeds

Maximum milk flow rates were measured on 5 Ayrshires, 12 Guernseys, 16 Jerseys, and 82 Holstein cows in the University dairy herd. The rates were obtained at milking time by the use of a weighing and recording instrument that graphically recorded the amount of milk produced at timed intervals. The maximum milk flow rate was considered as the maximum amount of milk removed from the udder by the milking machine in one minute. The maximum usually occurred during the second minute after machine milking started.

The cows were prepared for milking by massaging the udder with a paper towel, which was saturated with warm water, and milking two or more streams of milk from each quarter into a strip cup. The milking machine unit was applied as soon as let-down occurred.

The maximum milk flow rates averaged 6.4 lb./min. for the 115 cows studied. Holsteins averaged the highest with 7.2 lb./min., followed by Jerseys 5.7, Guernseys 3.6, and Ayrshires 3.2. Ranges for maximum milk flow rates were from 2.2 to 12.0 lb./min.

State Differences Not Important

An earlier study showed that herd environment was quite important to dairy cows, but state environment was relatively unimportant. A recent study using 25,836 records on Holstein-Friesian cows in 48 states confirmed the importance of herd environment and showed that states accounted for only 6.2, 1.4, and 6.0% of the total variation in milk yield, fat percentage, and fat yield, respectively. Less than ¼ of these small amounts of variation was of hereditary origin.

Another finding was that sire-by-state interaction (the notion that one sire is preferable for one state, another sire for a second state, etc.) has very little or no basis of fact. In other words, dairymen in several states can use the same sires and expect daughters of comparable producing ability.

Poultry

Adjustments for the Broiler Industry

Present and prospective organization and structure of marketing systems for Virginia broilers are being analyzed to develop alternative organizational arrangements, and operational methods that will help all phases of the broiler industry to better adjust to changing economic conditions. Labor efficiency in poultry processing plants, relative size of broiler grow-out units, and the control exercised by hatcheries over breeder flocks and chick distribution are some of the areas involved. The probable impact of possible changes on the organization and efficiency of various firms within the industry will be delineated for consideration by industry in its search for a sounder development.

Ration Studies

Hatchery Refuse as Poultry Feed

Disposal of hatchery wastes had been a costly problem in the poultry industry until a study at VPI during the last two years showed that the refuse, when properly processed, could be used in poultry rations. The raw material was cooked, dried, and pulverized into a meal which analyzed 26% excellent quality protein and 20% available calcium, also abundant fat and some phosphorus. By chick-growth assay the new feedstuff

was demonstrated to also contain unidentified growth factors.

Actual feeding trials showed that up to 5% hatchery by-product meal could be used in chick-growing rations and up to 15% in laying rations without affecting any performance criteria. The maximums were based on the amount of calcium permitted in the two types of rations. Thus not only has a by-product disposal problem been solved but a new feed source of excellent animal protein has been found — a double benefit to the poultry industry.

Effects of Zinc Bacitracin

This study was designed to obtain information on laying house performance as affected by zinc bacitracin when used for varying periods of the bird's life. The varying periods were 0-8, 0-51, 0-78, 8-51, 8-78 and 51-78 weeks of age, compared to controls that had never been fed the antibiotic. Variables studied were egg production, egg weight, feed conversion, body weight changes, and mortality. Laying house performance data were gathered for fourteen 28-day periods, a total of 392 days. Commercial hybrids of White Leghorn type were used.

The starter diets, calculated to contain 20% protein and 1270 Calories metabolizable energy per pound, were fed free choice from 0 to 8 weeks to 1700 day-old pullet chicks. The grower diets, containing 16% protein and 1280 Calories metabolizable energy per pound, were fed free choice from 8 to 22 weeks. The laying diets, containing 16.5% protein and 1360 Calories metabolizable energy per pound, were fed free choice from 22 weeks of age to 1392 pullets in laying pens. Oyster shell was fed free choice starting at 16 weeks of age. Except for the first 4 weeks of the chick's life, when zinc bacitracin was fed at 200 grams per ton of diet, all other times it was included at the rate of 4 grams per ton.

Significant findings were these: Body weights were greater at 8 and 12 weeks of age for those pullets that either had the antibiotic continuously or up to 8 weeks of age. Egg production, egg weight, feed per dozen eggs, mortality, and body weight changes during the 56 weeks of the total laying period were not significantly affected by the presence or absence of zinc bacitracin for the varying periods of the bird's life.

Vitamin B_{12}, Choline, and Methionine in Laying Diets

The design selected for this 2 cubed experiment was a completely randomized one in which each of the 8 factorial treatment combinations was replicated twice. Each replication had 87 pullets. The stock used were January 23rd hatched, range-reared, commercial hybrids of Leghorn type. They were moved to littered floor pens and started on experimental all-mash laying diets at 23 weeks of age (July 5). A combination of artificial lighting and natural daylight to give no less than 14 hours of light per day was provided throughout the 14 consecutive 28-day production periods. Oyster shell was fed free-choice. The pullets were trapnested and records were kept on egg production, egg weight, feed consumption, and mortality. Each pullet was weighed at the start and each surviving bird was weighed at the end of the experiment. All birds that died were autopsied by the veterinary science department.

All diets contained soybean oil meal as the only protein concentrate. Each diet was calculated to contain 16.4% crude protein and 1360 Calories of metabolizable energy per pound. The calculated cystine content of each diet was .28%. Calculated levels of vitamin B_{12} were 3 and 8 micrograms per pound, methionine .31 and .36%, and choline 448 and 730 milligrams per pound. The calculated contents of the other nutrients in the diets were practically identical.

Statistical analyses showed highly significant better average hen-day egg production on the 3 microgram levels of vitamin B_{12} and on the 448 milligram levels of choline. Highly significant first order interaction was shown between choline and methionine for hen-day egg production. An increase in choline without an increase of methionine depressed egg production. Highly significant first order interaction was shown between vitamin B_{12} and methionine for hen-day egg production. Increasing methionine to .36% with vitamin B_{12} at 3 micrograms per pound improved egg production, or increasing vitamin B_{12} to 8 micrograms per pound with methionine at .31% improved egg production.

Significantly more feed was required to produce one dozen eggs with the 8 microgram per pound level of vitamin B_{12} than for the lower level. The amount of feed to produce one dozen eggs was significantly more with the 730 milligrams of choline per pound of diet. Highly significant first order interaction between choline and methionine was shown for pounds of feed per dozen eggs. Increasing choline without increasing methionine increased the number of pounds of feed to produce a dozen eggs. There were no significant dif ferences in egg weight or body weight changes; these were satisfactory with all combinations. Low mortalities, for this long production period, were experienced and were comparable in amounts from causes seemingly not influenced by diet. Under our experimental conditions and with the stock used, the best egg production and feed efficiency were obtained with 448 milligrams of choline, 3 micrograms of vitamin B_{12}, and .31% methionine per pound.

Feed Additives in Layer Rations Change Egg Charateristics

Leghorn type hens were fed during eight 28-day feeding periods on a layer ration to which Amprolium, Reserpine and Fortracin "25" were added continuously

at the recommended levels. Pacitran 5% was added in the drinking water in one pen of layers at the start of the study. These additives were used to determine their influence on production, feed conversion, egg size, Haugh units, percentage yolk of egg weight, yolk solid content, and shell breaking strength.

Production, based on hen-housed days, was slightly higher from hens fed the control ration than from those receiving the additives. Feed conversion, based on pounds of feed consumed per pound of eggs produced, was the most favorable in the pen fed Amprolium. Differences were significant in Haugh units of eggs among the different treatments and periods and were highest from hens on control diet. Yolk percentages increased in freshly laid eggs and in eggs held in the egg cooler as laying time continued. Yolks from hens fed the different additives increased from 10 to 15% more during 3 weeks storage than did those from the control hens, indicating that the additives permitted moisture from albumen to pass into the yolks in greater amounts.

Yolk solids decreased at a faster rate and at a much greater magnitude than did yolk weight increase. This indicates that these values are negatively correlated.

A larger percentage of eggs from the control hens were classified in the 3 largest egg-weight classifiications from those hens on different additives. Differences were noted in egg shell strength but the use of these additives did not prohibit shells from becoming weaker as production time continued.

Fish Meal, Methionine and Cereal Grains in Turkey Diets

Three experiments were conducted to determine: (1) the feeding value of fish meal, (2) the effects of methionine supplementation, and (3) the relative feeding values of various cereal grains in diets of small white turkeys raised from 1 day to 8 weeks of age. In each experiment, each of 24 different diets were fed to male and female turkeys kept in separate pens. Fish meal at levels of 0, 4 and 8% was used in diets containing equal amounts of protein, metabolizable energy, calcium, and available phosphorus by replacing dehulled soybean oil meal, defluorinated phosphate, and fat with fish meal, ground yellow corn, and ground limestone. To each of these diets, DL methionine was added at the 0 and .5% levels. In addition the cereal grains, yellow corn, barley, wheat, and milo replaced one another in these diets to form a total of 24 diets in a factorial arrangement.

The final body weights of turkeys fed 0, 4 and 8% fish meal were 1707, 1724, and 1724 grams, and the feed efficiencies were .5024, .5120, and .5103, respectively. The average body weights of turkeys fed diets containing 0 and .05% added methionine were 1708 and 1728 grams, and their feed efficiencies were .5104 and .5090, respectively. Differences among the preceding values failed to be significant. The average body weights and feed efficiencies of the turkeys fed diets containing corn, barley, wheat, and milo were 1731, 1660, 1763, and 1720 grams, and .5269, .4855, .5098, and .5165, respectively. The relative feeding values of the 4 cereal grains for turkeys were found to be highly correlated with the metabolizable energy values of the respective cereal grains reported from experiments with chickens.

Value of Added Fat for Turkey Diets

An attempt has been made to determine the effects of added fat in starting diets for turkeys. Five experiments involving a total of 240 battery pens, each containing 27, 30, 33, and 36% protein at 0, 4, 8, 12, 16, and 20% levels. With each 4% fat, .82% dehulled soybean oil meal was added at the expense of 4.82% ground yellow corn. All 24 diets were fed to turkeys from 1 day to 8 weeks of age, in each experiment.

At the end of the experiments, turkeys fed diets containing 8 to 12% added fat were about 5% heavier than those fed diets containing no added fat. Feed efficiency increased in a linear manner, .9% for each 2% added fat from beef tallow, which was used in 2 of the experiments, whereas the feed efficiency increased 1.2% for each 1% added fat from hydrolyzed animal and vegetable fat in the other 3 experiments.

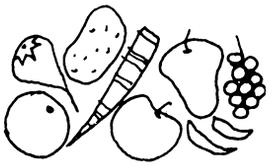
Light Environment Affects Egg Production in Turkeys

This study sought to determine the feasibility of using altered light environment as a technique for obtaining satisfactory year-round egg production in turkeys.

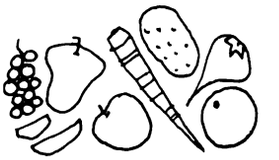
Both sexes were assigned to treatments involving restriction of light to 6 hours per day for 0, 4, 8, or 12 weeks starting at 17, 21, or 25 weeks of age. Upon completion of the restricted light treatment, males and females were assigned to range pens and exposed to 15 hours of light per day. All females were trapnested, and data were obtained on egg production, fertility, and hatchability over a 10- to 12-month production period.

Results demonstrated conclusively that turkey females could be induced to lay at a satisfactory level of production for as long as 10 to 12 months. This was accomplished by simply restricting light prior to sexual maturity for either an 8- or 12-week period followed by subsequent exposure to 15-hour lights during the late fall. The females went through two distinct cycles of high egg production. The first occurred during the first 5 months following exposure to 15-hour lights. The second occurred during the spring and early summer.

Restricting light on males prior to placing them in the breeding pens had no apparent effect on fertility or hatchability, whereas females previously held under restricted light conditions displayed higher fertility than the controls.



Fruits, Vegetables And Ornamentals



Testing Fruit Varieties

Tests are conducted constantly on varieties of all kinds of fruits that have possible value in Virginia. Present tests include apples, flowering crab apples, pears, peaches, nectarines, plums, cherries, apricots, bunch grapes, blueberries, raspberries, blackberries, currants, gooseberries, strawberries, black walnuts, hardy Persian (English) walnuts, and Chinese chestnuts. Each year notes are taken on the growth characteristics, vigor, winter hardiness, productiveness, disease resistance, and fruit qualities of all the material under observation. Yield records are taken on much of the material. Information derived from these tests is used in making recommendations of varieties for planting in Virginia.

Varieties of recent introduction that have given exceptional performance in the tests and are worthy of trial in Virginia include the following:

Apples: **Redspur, Wellspur, Starkrimson and Wayne-spur, Red Delicious, Spartan, and Jonadel**
Peaches: **Sunhaven, Loring, and the VPI Presidential varieties**
Nectarines: **Cavalier, Lexington, Redbud, and Redchief**
Bunch Grapes: **Steuben, Buffalo, Schuyler, and Alden**
Red Raspberries: **September**
Blackberries: **Bailey, Hedrick, and Darrow**
Strawberries: **Earlidawn, Surecrop, Empire, and Fletcher**
Blueberries: **Berkeley, Coville, Bluecrop, and Herbert**

Breeding New Varieties

Apples

The apple breeding program at VPI is giving results after many years of painstaking and often uninteresting research. Two selections, VPI 2 and VPI 4, were selected in 1964 for naming and releasing in September of 1966. VPI 2 is a highly colored, very firm apple that ripens in mid-September with exceptional qualities for processing. It was developed by crossing Winesap with Opalescent. VPI 4 ripens about September 20 and is a brightly colored, firm fleshed variety of long keeping quality. Its parents are Rome Beauty crossed with Schoharie.

Peaches and Nectarines

Progress is being made in developing new varieties of peaches and nectarines that are adapted to Virginia conditions and which will fill the needs of Virginia growers in providing varieties that ripen during periods of the season for which no suitable varieties are available.

The Madison variety developed by crossing Ideal with Redhaven was released August 1, 1963 and is the third member of the VPI Presidential Series of peach varieties. This frost-tolerant, very firm yellow-fleshed, highly colored, and high quality variety ripens a week before Elberta, a season for which no really superior variety has been available. VPI 58 is a firm yellow-fleshed, highly colored variety of high quality which ripens 12 days after Elberta. It was selected for releasing in August of 1966 under the name Monroe and will be the fourth member of the VPI Presidential Series.

Nectarine selections VPI 57N and 59N were selected for release in August 1965 under the names Pocahontas and Cherokee. These are yellow-fleshed nectarines of attractive skin color and finish and good quality that ripen 3 weeks and 2 weeks before Redbud, the earliest ripening variety of nectarine worthy of recommendation for planting in Virginia. Like the other VPI nectarines, these selections have shown much greater ability to escape infection from brown rot than varieties available in the past and are tolerant to frosts at blossoming time.

Grapes

Grape varieties that are less susceptible to black rot, anthracnose, and powdery mildew, and less prone to cracking of the berries if rains fall as they ripen, have long been needed by Virginia grape growers, along with types that color and ripen uniformly under the relatively hot conditions that prevail here when grapes ripen. The grape breeding program at VPI is providing at least partial solution to these problems in two selections that will be named and released in 1966 and 1967.

VPI 5 will be named *Alwood* in honor of the late William B. Alwood, the first horticulturist on the VPI staff. This blue grape ripens the first week in August. Its fruit is sweet and of pleasant flavor, and it has been easy to protect against diseases. The clusters ripen uniformly and the vine has been amply winter hardy.

VPI 26 is an early season red grape that has been selected for naming as soon as sufficient propagating material can be made available to interested nurseries. The vines of this selection are vigorous, disease-resistant, hardy, and productive. The fruit ripens uniformly, is sweet, and has a pronounced American grape flavor.

Raspberries

The high level of diseases that attack red raspberries in Virginia and the fluctuating winter temperatures prevalent here that frequently result in severe winter injury to the plants, have often prevented successful growing of this delicious fruit. A breeding program at VPI has provided potential solution to these problems, at least in part. VPI selections 4 and 5 will be named and re-

leased as soon as sufficient propagating material can be supplied to interested commercial nurseries.

VPI 4 is a very early ripening variety with berries of medium size, pleasant flavor, but rather dark color. In addition to the crop which ripens early in June, it produces another crop of berries on the new canes, which begins to ripen about July 25 and continues until about September 1. The berries of the second crop have superior size and color to those of the June crop.

VPI 5 bears only one crop of berries a year, ripening from June 20 to July 20. The berries are above average in size, of attractive conic shape, bright pinkish red in color, firm and highly flavored. The plants of both selections have been consistently productive with little evidence of being susceptible to winter injury.

Insects of Apples

Research on apple insects must deal with many factors in several areas. For example, biology and life history of the insects involved, design and development of control programs, study of the mechanisms of and degree to which resistance to pesticides has developed, evaluation of current and new insecticides and acaricides, techniques of application, compatibility of the various components of the spray mixtures, phytotoxicity, and influence on yield are among the many factors to be considered.

The arthropod pests of apples include codling moth, leaf rollers, aphids, curculio, scale insects, leaf miners, and phytophagous mites as major pests. A number of minor pests are frequently troublesome in some seasons, in some localities—cicada, yellownecked caterpillar, Japanese beetle, tree borers, apple maggot, and others. Many of these pests must be controlled each season.

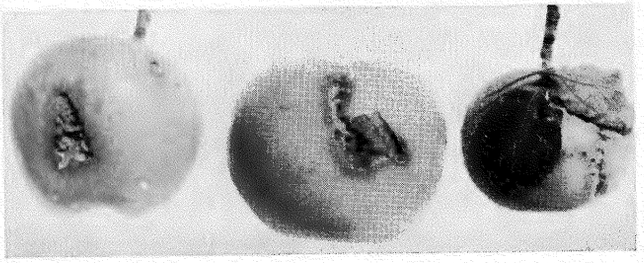
Some valuable insecticides and acaricides have lost a large share of their effectiveness because the target pest has developed resistance. Therefore, a continuous program of evaluating currently used insecticides and acaricides is carried on.

Presently, codling moth and red-banded leaf roller are adequately controlled by Guthion and Sevin when properly used. Malathion and parathion are currently used in control of these pests also. Aphids are controlled with Phosphamidon, demeton and other phosphate insecticides.

Satisfactory control of phytophagous mites has been difficult. Among approaches now recommended is that of starting soon after the dormant season with petroleum oil and subsequently using several acaricides or combinations of them.

Several experimental materials show promise for mite control. Morestan has recently been registered and is quite effective. It has some phytotoxic liabilities and is as yet not thoroughly commercially evaluated. Two others may complete registration in time for use next year—one a carbamate type compound, another a dinitro compound—both quite effective in mite control.

Novel ways of control of apple insect pests are also considered, and research is underway on nutritional factors, pathology of pest, and cultural practices. Soon chemosterilants will be tried on certain pests.



Red-banded leaf roller injury to apples caused by feeding of the larvae.

Pine Mouse Hazard in Orchards

In varying degrees, orchards in herbaceous ground cover simulate forest margins, which are transition zones between 2 or more plant communities. Such zones, when fully developed, exhibit the important so-called *edge effect.* This effect is exhibited in a variety of flora in which trees and sub-maximal populations of pine mice may live together in more or less harmony. Apparently, the extreme devastation that may occur to apple trees in the usual and more simple tree-and-grass-only plant community, does not happen where native woody-herbaceous plant mixtures are present in older orchards. The edge effect is operative.

According to present findings, a wealth of vegetative ground cover in orchards contributes to biological control, with endrin as the toxicant. It is moreover supposed, with a measure of verification, that a nearly complete elimination of pine-mouse hazard occurs, although much less endrin than usual is applied to trailways if the cover plants are suitably varied as to types. It is believed that control is better because contact in surface trailing is more direct and the mice eat a variety of vegetation more readily.

A 4-part ecological series is observed in developing orchards. The steps in the succession are: (1) clean cultivation, (2) annual and biennial weeds, (3) perennial grasses, and (4)) mixed herbaceous perennials. The series is not perfectly distinct, but shades gradually from one step to the next.

In many orchards the hazardous step 3 may long persist. A sizeable edge effect, like that of the forest margin, is associated with both steps 2 and 4. Consequently, endrin is likely to be 100% effective only in the second and fourth stage of the series. Less success to practical failure seems to plague a thoroughly established stage 3. Planting trees in a stage 3 quack grass pasture is thought to be the most hazardous of possible starts.

The present proposal for an orchard, backed by 15 years of experimental work, is to establish the edge effect by combining orchard grass and broadleaf herbs in ground cover.

Intensifying Apple Production

The use of smaller trees planted in tight hedgerows is a major divergence from current standard production systems. However, such an approach offers considerable promise for increased production and harvest efficiency. It also offers promise of improved fruit quality. Because of mounting labor problems, the industry is conditioned to major shifts in production systems.

The objective of this research is to refine intensive fruit production systems through the integrated use of tree size-controlling techniques. At this time, work with spur-type scion varieties, size-controlling clonal rootstocks, growth regulating chemicals, and intensive tree training systems is in progress. Ten individual experimental plantings totaling more than 2,500 trees and about 20 acres are involved. These plantings are all located in the orchards of grower cooperators.

The results, though limited, are starting to accumulate:

1. MM 111 rootstock seems somewhat tolerant of drought conditions and may have a place in Virginia orchards where irrigation is impractical.

2. Trees of the 7 important varieties grown in Virginia have in general made better growth and a more desirable tree form on MM 106 than on EM VII in the semi-dwarf tree size category.

3. Trees can be grafted and set directly in their permanent orchard locations with satisfactory results. This could save money for growers considering high population densities. Such trees can be made up for 1/3 the cost of one-year-old nursery-grown trees.

4. The growth regulating chemical Alar (B-995) has shown promise in that it results in a reduction in terminal growth through a shortening of internodes, can be used to regulate flowering, increases red color of fruit, and delays softening and drop.

5. Spur-type scion varieties can be used in conjunction with size-controlling clonal rootstocks.

Apple Harvest Efficiency

In 1963, two commercial mobile pruning towers were modified for research use in picking apples. A special conveyor and bin filler was added to one of the towers. On the other, a 2½ bushel hopper was installed. The bushels-per-hour picked by selected harvest laborers on these mechanical aids was compared with their picking speed using the conventional ladder and picking bag method. In tests on 135 trees, speed of picking was reduced with the mechanical aids. Bruise damage was reduced slightly. It was concluded that aids of this type, even with further refinement, would not likely increase picking speed or reduce bruise damage sufficiently in conventional trees to justify the cost of owning and operating them.

Because of the limitations of the aids, current work to increase harvest efficiency is directed toward reducing tree size and the development of experimental, high-density hedgerow plantings. Test plantings of this type were established in the spring of 1964. Factors being investigated are dwarfing root stock-scion variety combinations, growth regulating chemicals, training techniques, and tree spacings. Also under investigation are the forces required for mechanical detachment of the apple at the abscission layer. Optimum combinations of shear, tension and bending forces are being measured.

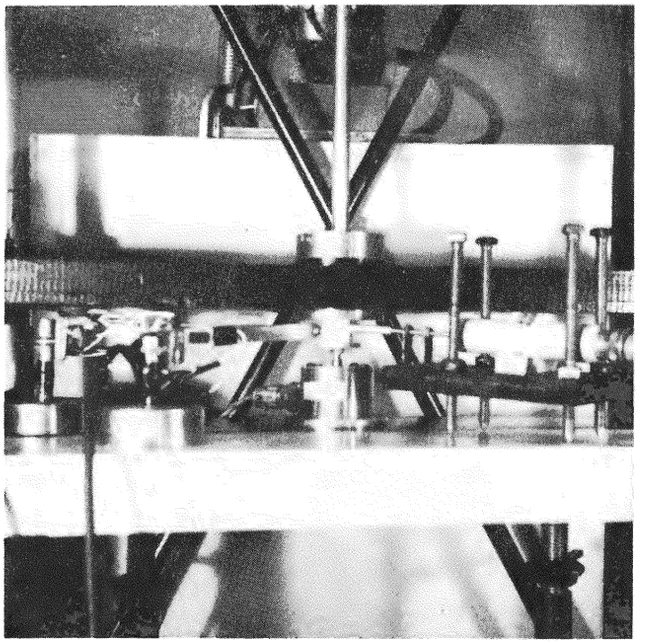
Above, tower with experimental picking conveyor. Below, tower with 2½-bushel hopper.

Effect of Impact on Fruit

The experimental design of fruit-harvesting or -handling equipment must counteract possible bruise damage and researchers must know what forces can be applied to fruit without affecting market quality.

A procedure for determining the effect of different impact forces on fruits is under study. Since fruit consists of a high percentage of water as well as dry matter, it behaves neither as a solid or a liquid when force is applied. It has been found that the length of time that a force acts as well as the magnitude of the force effects the amount of deformation of the fruit, as would be expected for a viscous liquid.

Work is now under way to see if a force-time-deformation relationship for predicting damage to a specific fruit specimen can be developed.



Apparatus for determining the effect of forces on fruit flesh.

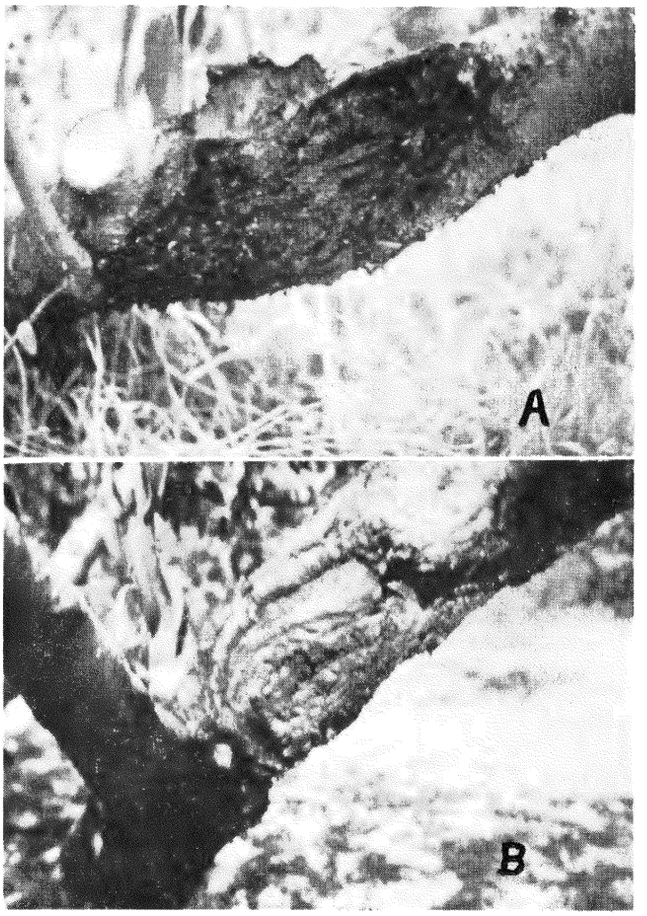
Insects of Peaches

Although the grower is primarily interested in the control of insects injurious to the peach tree and its fruit, research on peach insects must be concerned with insect biology, compatibility of spray mixtures, insect resistance to sprays, as well as the evaluation of insecticides.

Many insects attack the peach but fortunately only these few are prolific enough to necessitate annual control programs: the plum curculio, San Jose scale, oriental fruit moth, tarnished plant bug, and peach tree borers.

A combination of dieldrin and parathion gave outstanding control of the plum curculio and San Jose scale when used in three postbloom applications. Guthion was also effective in the control of these pests, although not as effective as parathion for scale control. Sevin and dieldrin were highly effective in the control of the tarnished plant bug but cannot be recommended because of their high toxicity to pollinating bees. DDT, although only moderately effective, is the recommended insecticide in prebloom sprays.

The peach tree borer is effectively controlled with DDT applied to the tree trunks, but this insecticide is not effective in the control of the lesser peach tree borer. Thiodan was the most effective insecticide tested for control of the lesser peach tree borer, and with properly timed applications was also effective in the control of the peach tree borer.



Lesser peach tree borer injury: A—active wound from check tree; B—tree treated with thiodan showing healing tissue around wound.

Weed Control

In Apple and Peach Orchard

Young fruit trees where undergrowth was treated with herbicides grew much more rapidly than those in untreated areas. This increased growth was greater than that which can be attributed to a lack of weed competition. Peaches appeared to be much more responsive than apples when treated with simazine for weed control. They showed as much as 33% more growth than untreated checks.

A mixture of 3 lb. simazine and 2 lb. 2,4-D applied in the fall appears to be the best treatment for weed control around young trees. Golden delicious apples are not as tolerant to this treatment as are other varieties. Studies are being continued to determine the long-time effect of weed control treatments on apple and peach orchards.

In Ornamental Nursery Crops

In growing woody ornamentals in nurseries, several herbicides are observed successful for various weed problems. Amazine, simazine, and dichobenil have reduced labor requirements for weed control more than 50% with annual applications. Fall applications of

these herbicides in conjunction with spring applications of DCPA or diphenamid have further reduced labor needed.

Dichlobenil has also been found to partially control mugwort (Artemisia) when applied in the dormant stage during cold periods.

With the aid of C^{14} labeled material, simazine was observed to move rapidly into leaves of many woody ornamentals. However, it did not enter these plants from foliar treatments. In leaves of ornamentals this herbicide is gradually degraded to various products, including hydroxysimazine which is inactive as a herbicide.

Large Cuttings for Rapid Production of Landscape Plants

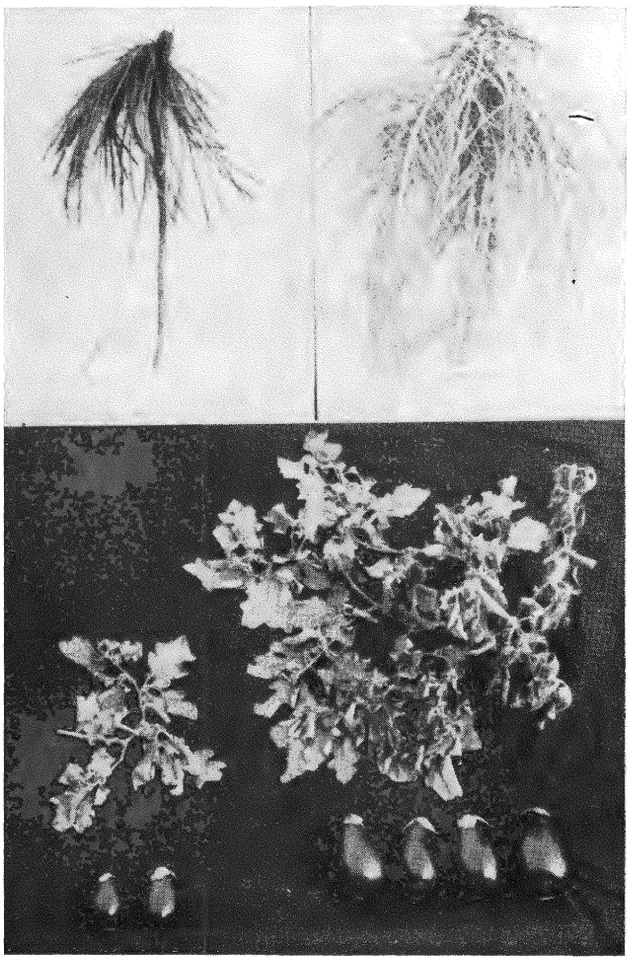
One important cost in nursery production is overhead. In the usual cycle of landscape plant production, overhead may continue for 4 to 6 years. By using intensive methods of production, this time has been reduced to 6 to 12 months. This is accomplished by placing two or more large cuttings in a 3-gallon container and rooting them in a peat and perlite mixture. Intermittent mist and fertilizer are provided and all growth factors are maintained near optimum. For example, 36″ branches of pyracantha with green berries can be placed in a container under mist in June. This plant will have a retail value of about $4 in October with attractive red fruit to help sales.

Sixteen species of landscape plants have been produced under this method of intensive production. By circumventing several usual steps of production, less labor is required. There is no transplanting and no hand weeding required.

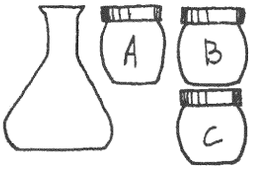
Well-rooted pyracantha with red fruit 4 months after start of rooting. Rooted under mist on peat and perlite mixture in 3-gallon container.

New Cyst Nematode Pest of Eggplant

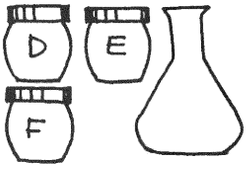
Experiments conducted in the greenhouse and microplots in the field have shown that the horsenettle cyst nematode infects and causes reduced yields of Black Beauty eggplant. It is not known, however, whether eggplant in Virginia or any place in the United States is grown in soil infested with the horsenettle cyst nematode. This basic work was initiated in order to determine the complete host range of the horsenettle cyst nematode, since it morphologically resembles the golden nematode, which also attacks eggplant.



The eggplant root, fruit, and foliar parts on the left are from soil infested with the horsenettle cyst nematode; the parts on the right are from uninfested soil.



Human Nutrition And Food Technology



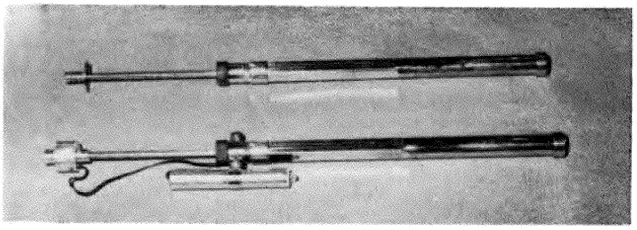
Apple Products

Testing Apple Firmness

To help indicate apple conditions for the fresh and processing markets, apple firmness is tested with apple pressure testers. However, in testing, a hole is punched in the fruit which results in its loss and limits commercial use of the tester.

Extensive tests have been conducted with experimental and commercial models of mechanical thumb attachments for the pressure tester which permit firmness testing without destroying the market value of the fruit.

Although apple firmness determined by use of a mechanical thumb is influenced by variety and fruit condition, use of the mechanical thumb is feasible and, within limits, indicates general apple firmness ranges.



Pressure tester and tester with a mechanical thumb attachment.

Developing New Ones

Taste panel tests have shown that apple and grapefruit juices are compatible. When mixed in proportion of 3½ parts of apple juice to 1 of grapefruit juice, a blend results having characteristics that make a product different from either of the 2 juices. These characteristics result from the sweetness of apple juice, which masks the excess bitterness of pure grapefruit juice, and from the acidity of grapefruit juice which gives desirable zest to the blend.

The same tests indicate that the level of consumer acceptance for the product is probably high. A consumer preference test, including 300 households in a city, is being organized to obtain more information on the marketng potential of this fruit juice blend. Storage tests made on the canned, single strength product indicate that it holds its quality after prolonged storage. Both apple juice and grapefruit juice are relatively low-priced fruit juices, and the resulting blend is competitive in production cost.

Development and testing work has also been conducted on apple nectar, apple crush, gelled applesauce, and canned apple salad products.

Apple nectar is characterized by a rather thick consistency and a turbid appearance produced by small apple particles in suspension in the product. Sugar is added to the product to a level of about 15%. Thus, apple nectar is similar to apricot nectar, and quite different from apple juice.

Apple crush is a product containing apple pulp together with discrete apple particles of different sizes, up to ½", giving the product a chewy texture. The sugar content is raised to about 33%. These characteristics make apple crush a product suitable for dessert.

Gelled applesauce is similar to gelled cranberry sauce. A pleasant, sweet-sour flavor is developed in the product by adjustment of its acidity and addition of sugar. The product is opaque and is colored green or red to increase its visual appeal. It is preserved by canning.

Canned apple salad is produced by gelling apple juice or blends of apple juice with other juices, with apple pieces, and with or without pieces of other fruits. Acidity and sugar content are regulated. The product is preserved by canning.

New Juice Concentrate

A high quality apple juice concentrate that would offer consumers advantages over the canned or bottled single-strength product should have a good market.

A project is investigating methods for commercial preparation of a concentrate with the characteristics mentioned above. Two newly developed processes are being used — an electronic process that makes use of high-frequency energy, and a thin-film evaporator. Under both processes, water from the juice is evaporated under high vacuum conditions at a low temperature to protect quality. The physical, chemical, bacteriological, and organoleptic qualities of the apple juice concentrate products obtained are being evaluated.

Results indicate that the electronic process produces a concentrate of high quality, which, when marketed as a frozen product, has excellent keeping characteristics. The high level of concentration achieved, 7 times that of the single strength juice, gives the product advantages from the standpoints of economics of packaging, refrigeration, transportation, and merchandising.

Canning Studies

Tomato Canning Efficiency

A study by the Department of Agricultural Economics of quality characteristics affecting tomato canning plant efficiency is in advanced stages.

Objective measurements of raw product sizes, defect trim waste, and color have been related to yield of canned product, product preparation time, and quality of canned product. These relationships have been determined both under experimental and commercial operating conditions.

The experimental work was carried out in the 1962 season at Big Stone Gap, in cooperation with the Big Seven Canning Company. From this study these relationships were determined:

(1) Yield of finished product — (a) 1% increase in defect trim waste resulted in .93% decrease in yield. (b) An increase of 10 tomatoes per 100 lb. resulted in .27% decrease in yield. (c) An increase of 1 point in colorimeter reading resulted in 16% increase in yield.

(2) Preparation time requirements — (a) An increase of 10 tomatoes per 100 lb. resulted in a decrease of 1.6 lb. of raw product handled per worker per hour. (b) An increase of one point in colorimeter reading resulted in an increase of 2.27 lb. of raw product handled per person per hour. (c) An increase of 1% in defect trim waste resulted in a decrease of .86 lb. of raw product handled per worker per hour.

(3) Quality (total grade points) — (a) An increase of one point in colorimeter reading resulted in an increase of .55 grade points in quality rating. (b) Neither of the other quality characteristics were found to affect quality to a measurable degree.

In the 1964 season these relationships were tested under commercial operating conditions in 3 canning plants in Maryland. They explained satisfactorily the variations in yield and canning efficiency in those plants.

Canning in Aluminum

Certain chemical and physical characteristics of aluminum make it a desirable metal for food containers. In the last few years, prices for aluminum have gone steadily lower.

Twenty-two diffferent fruit and vegetable products were packed under different conditions in aluminum cans to study the effect of certain container factors, food characteristics, processing factors, and storage conditions upon shelf-life of the food products included in the investigation.

Evaluation of stored samples is still under way. Preliminary results to date have indicated that, undre certain conditions of packaging and processing, aluminum cans may be used for most of the foods included in the research. When the r search is completed, it should be possible to state the conditions for canning these foods in aluminum cans.

Dairy Products

Bitter Flavor in Cottage Cheese

Bitterness that develops in cottage cheese during marketing may cause economic loss to processors and discourage repeat purchases by consumers. Bitter flavor was observed in 16% to 25% of retail cottage cheese from Eastern, Southeastern, and Midwestern markets.

Analyses of retail cottage cheese samples in Virginia showed high yeast and mold counts in 80%; high coliform counts in 68%; and high psychrophilic counts in 90% of samples. After 7 days at 45 F, the soluble N fraction increased significantly and 62% of the samples developed bitterness, ranging from slight to definite.

Yeasts and molds, coliform, and psychrophilic bacteria were low in experimental cheese. After 7 days at 45 F, a bitter flavor was observed in only 2% of samples.

The low incidence of bitter flavor development in the experimental cheese was attributed to thorough cooking of curd, heat treatment of wash-water at 190 F, pasteurization of the cottage cheese dressing at 175 F for 30 min., and preventing recontamination during packaging.

Bitter flavor development in retail cottage cheese would be nearly eliminated by application of these procedures.

Salad Dressings and Vegetable Topping

Formulations for dairy salad dressings and a laboratory processing procedure that permitted mixing under vacuum were developed. Experimental products were packaged hot at the homogenizer in self-sealing polypropylene containers. Physical stability was determined by absence of microbiological spoilage and whey separation after 60 days at 100 F.

The dairy salad dressings contained 5% milk solids, 32% fat, 10% sugar, and 2.5% salt. Additions of concentrated vinegar were made to adjust the pH to 3.8. One percent low-pH stabilizer or 4% low-pH starch was required to obtain physical stability at 100 F.

Oxidative rancidity developed during storage was the principal flavor defect. Selection of raw cream with a low peroxide value, additions of antioxidant, and processing under vacuum delayed rancidity for 30 days at 75 F.

Research is in progress to improve the flavor stability of dairy salad dressing.

Homemakers' Food-Buying Practices

Willingness to Try New Foods

What factors influence the food-buying practices of Virginia homemakers? Which homemakers are most likely to be influenced to try some new food or to change old marketing habits?

To help find answers to these questions, home economists questioned 1,915 urban Virginia homemakers about sources of information which influenced them to buy particular foods and about their willingness to try certain new foods and recipes. The answers may indicate some effective methods for reaching various types of homemakers with nutrition information.

In general, younger homemakers were more willing to try new products and were more readily influenced by information and advertisements from various sources. Very young homemakers, 19 years old or younger, were less receptive to such influence than women 20 to 59 years old. Homemakers more than 60 years old were more likely to maintain established food-buying and meal-preparation patterns. The importance of educating young homemakers to the value of certain foods and of

well-balanced meals before their routines are set is therefore evident.

Additionally, receptiveness to new ideas increased with an increase in level of education. Perhaps the better-educated women had more open minds or perhaps they had more nutrition knowledge.

In general, grocery store advertisements in newspapers had the most influence on homemakers' food-buying practices. These advertisements influenced 53% of the homemakers questioned. Other factors influencing at last 40% were recipes or information on labels and boxes, recipes in cookbooks, requests of children or other family members, and food articles in magazines.

Acceptance of relatively new foods such as cake mixes and instant powdered milk, decreased as age of the homemaker increased. However, a higher percentage of homemakers more than 60 years old used cottage cheese than did younger homemakers; this seems to be a good market toward which to direct sales promotion of cottage cheese, since people in this age group often do not drink much milk.

Use of dry milk was greatest among women with lowest per capita incomes, indicating that they recognized the economy of such milk. Women in highest per capita income brackets valued instant dry milk for diet purposes or convenience more than for its economy.

More homemakers said they were willing to try a new recipe using foods tried before than one using unfamiliar food. Women more than 60 years old were less willing than younger women to try most types of new recipes. Homemakers with less than an eighth grade education or under $600 per capita yearly income were less willing to try a new recipe using familiar foods than were their opposite numbers.

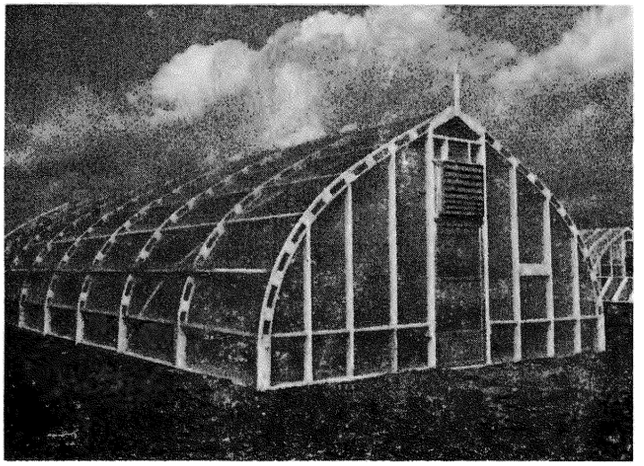
However, when the recipe for a specific fruit dessert was shown alone, college-educated women were less willing to try it than were women with less education. Women more than 60 were also less willing to try such a recipe.

In contrast to homemakers' answers about willingness to try a recipe in general were their answers when they were asked if they would try a particular fruit dessert shown with a picture. Homemakers with less than an eighth grade education or less than $600 per capita income were the most willing to try this particular recipe.

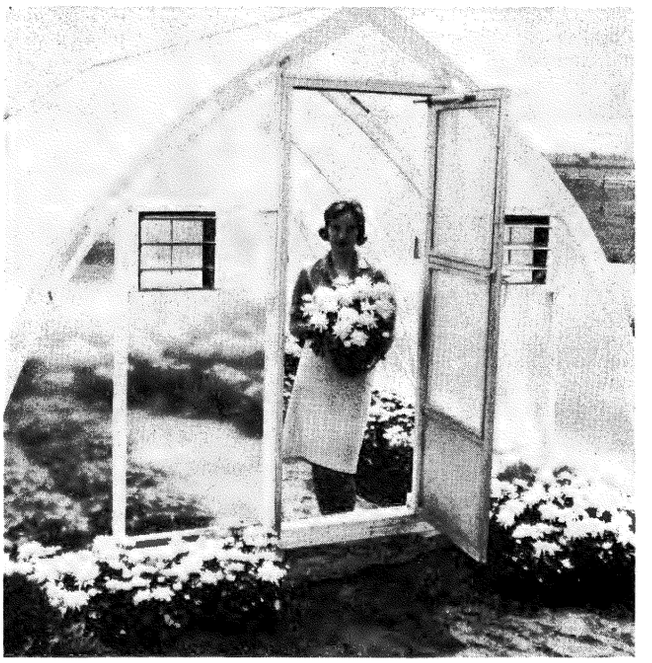
Buildings and Equipment

Plastic Greenhouses

The VPI gothic rafters result in an attractive greenhouse of unusual structural strength for the amount of material in them. The curved, gothic rafters also serve a functional purpose. The plastic film covering tends to hug the rafters and to remain taut all of the time; whereas on A-roof frameworks the covering moves considerably when the wind blows. This favorable characteristic has allowed improvement in the covering technique for the gothic greenhouse, and wider rafter spacing. In field tests rafter spacings have ranged from 36″ in the first gothic house built in 1960 to 96″ in a house completed in 1963. Observations indicate that gothic rafters spaced 96″ on centers, with or without



This gothic greenhouse has rafters spaced 8′ on center and has gone through 2 winters on the campus, withstanding winds up to 70 mph.



This hobby-type gothic greenhouse (12′ x 16′), incorporating design features of the larger commercial size, has proved very popular with homeowners.

intermediate bowed strips midway between them, supported the plastic film covering as well as rafters spaced 48″ on center.

Plastic Costs Less

Lightweight wood-framed structures covered with plastic film provide excellent plant-growing facilities when properly heated and ventilated. Their low cost and ease of construction make them popular.

Two types of plastic greenhouses have been designed and developed. (a) The scissors-rafter A-roofed house is easily built and is a functional facility. (b) The gothic shaped greenhouse is distinctive and pleasing in appearance as well as being easy to build and functional. These houses cost about the same to construct; however, maintenance for the gothic structure is less because annual replacement of plastic covering has been simplified.

Recommended spacing of scissors rafters is 4′ on centers. The gothic rafter spacing has been extended to 8′ by using 2 glued-together ½″ x 2″ strips halfway between and parallel to the rafters.

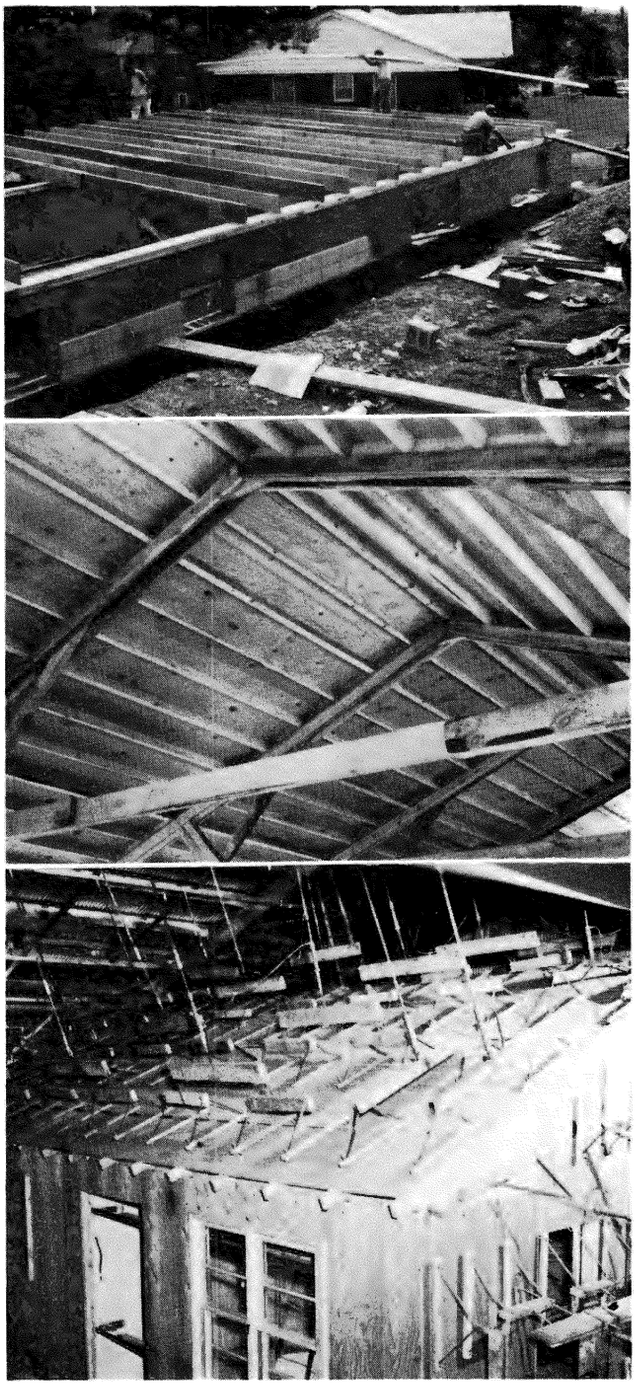
Under identical environmental conditions, plant growth and productivity in plastic greenhouses are no different from that under glass, and the quality of product is equally good. Economical production of horticultural crops and flowers is being increased through expanded usage of the low-cost plastic houses.

COMPARATIVE GREENHOUSE COSTS

	21′ x 40′ PLASTIC		GLASS
	SCISSORS	GOTHIC	840 sq. ft.
MATERIALS	$ 160	$ 135	
LABOR	100	100	
HEATING SYSTEM	350	350	
VENTILATION	210	210	
WIRING	20	20	
TOTAL	$ 840	$ 815	
COST PER SQ. FT.	$ 1.00	$ 0.97	$ 6 TO 10

ANNUAL MAINTENANCE COSTS
(ESTIMATES)

	21′ x 40′ PLASTIC		GLASS
	SCISSORS	GOTHIC	840 sq. ft.
MATERIALS:			
PLASTIC FILM	$ 30	$ 25	
STRIPS	15	5	
LABOR	30	10	
EQUIPMENT:			
MISC.	25	25	
TOTAL	$ 100	$ 65	
COST PER SQ. FT.	$ 0.12	$ 0.08	$ 0.10 EST.



The upper picture shows how rough-sawed continuous joists were installed in a floor system that required less than ½ the lumber of conventional designs but proved to be twice as stiff as required by FHA and the National Building Code.

The middle photo shows an experimental roof structure that uses trusses on 8′ centers and prefabricated roof panels. Lumber requirements are less than ½ that of conventional rafter and ceiling joist designs. Laboratory tests prove that it exceeds FHA and National Building Code requirements.

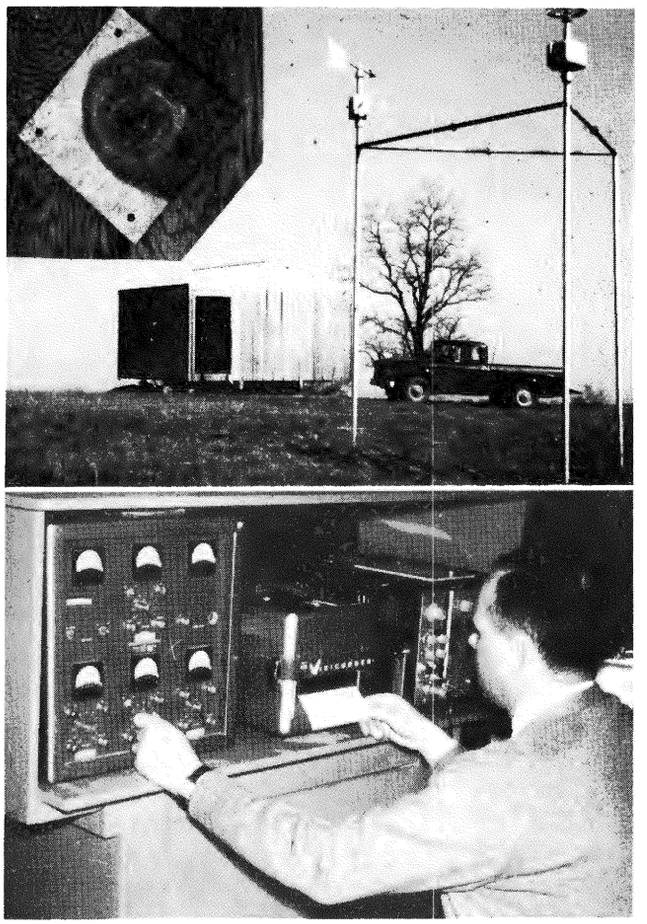
In the lower picture, a structurally complete wood frame house is being subjected to simulated snow and wind loads. Any desired gravity load can be held constant while wind loads are automatically cycled on and off. Many years of natural loading can be simulated in a few days.

Experimental Design for House Structures

Floor and roof structures were designed for a 31′ x 50′ house, as pictured here. Eventually both designs were evaluated in the Agricultural Engineering Structures Laboratory. This laboratory is used for evaluating complete buildings as structural units. Design information based on actual strength of a complete building allows highly significant reduction in building material. For example, it was determined that the floor structure in partitioned areas of a typical low-cost house, which utilizes slightly less material than required by FHA, was 3 times more rigid than required by FHA and the National Building Code. Non-partitioned areas were 1½ times more rigid than required.

Wind Loads on Buildings

Design procedures currently included in building codes have been derived almost entirely from wind-tunnel studies. The application of present recommendations in controlled experiments has repeatedly shown the need for better wind-load information. Wind tunnel measurements on agricultural structures are complicated by building shape, the relatively low profile, and the intermittent, turbulent nature of the wind resulting from local effects of terrain and ground cover.



Top picture shows the prototype building used in wind studies. It is mounted on casters to allow rotation, and wind speed and direction-sensing devices are on the tower. The inset shows a pressure port on an outside wall. Each port has a pressure-sensitive transducer which converts pressure to an electrical signal, which in turn is amplified and recorded (lower picture), giving a continuous record of wind pressure.

Quantitative wind pressure measurements are being made on a prototype building, including both magnitude and dynamic behavior. Through quantitative evaluation and analysis of the prevailing wind and the resulting pressures, procedures will be developed for improving the wind-tunnel techniques of simulating the model structure in the natural air stream. The prototype study will also provide general knowledge of natural wind pressures, especially of the pressures resulting from gusts.

The instrumented prototype building was used successfully, though limitedly, during the winter of 1965. The recorded pressures were for relatively low velocity winds. The most significant result was the rapid variation of pressure on the surfaces. This dynamic characteristic has not been simulated in wind tunnels in previous work.

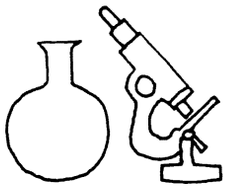
Confinement Swine Housing

Growing swine in confinement allows production of more hogs in a smaller area. It enables a farmer to use automatic feeding systems and efficient waste removal methods. Confinement housing is prerequisite to temperature-controlled housing.

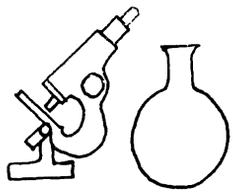
Facilities at the Tidewater Research Station were used in a research study to determine if optimum temperature-controlled conditions 65 to 70 F were beneficial in growing hogs from weaning to market-weight in confinement buildings.

Four tests, using 120 hogs each, resulted in no significant increased growth rate or feed efficiency in winter or summer when hogs were grown in the optimum temperature controlled building and compared to like animals grown in a naturally ventilated ½-open conventional building.

Present research studies include the control of temperature extremes only in the confinement building. This study involves cooling when above 85 F and heating when below 40 F. Results will be compared with conventional ½-open housing in natural conditions. Studies are also in progress on slotted floors for swine and range from completely slotted floors to ½ and ¼ slotted. Animal concentration is being studied with respect to the slotted and partially slotted floor types.



Other Research



Goals of Rural Youth

A questionnaire pertaining to educational and vocational goals, the Hieronymous Scale for measuring attitudes toward education, and the Kuder Profile Record—Vocational were administered to each of 285 rural Virginia ninth and tenth grade students, their fathers, and their mothers. Results, as related to students' sex, level-of-living, place of residence, family size, area of state, and membership or non-membership in certain youth organizations, were analyzed statistically.

Educational and Vocational Questions

Level-of-living was the main factor influencing educational plans. Generally, the higher the level-of-living, the longer the length of schooling planned by students and by parents for them. More parents than students expected the students to continue education beyond the high school level.

Additionally, the higher the level-of-living, the greater the amount of financial assistance with schooling students expected and the more often they felt strongly encouraged to continue their education. Except for girls from homes of low income, children overestimated the amount of financial assistance parents planned to provide. Children were more likely to discuss educational plans with mothers than with fathers.

For boys and their mothers only, non-members of rural youth groups planned longer schooling than did members. Additionally, more member boys considered the study of agriculture important for their futures and both desired and expected to be farmers. More non-member boys thought the study of foreign languages was important and both desired and expected to enter non-farm-related professions.

As would be expected, more farm boys than non-farm boys desired and expected to be farmers. Boys had similar desired and expected occupations. Fewer girls expected to enter professions than wanted to do so, while more expected to be fulltime homemakers than desired to be. Parents were more ambitious than sons concerning desired occupations but had similar occupational expectations. Parents had higher occupational desires and lower occupational expectations than daughters did.

Children from small families felt more strongly encouraged to continue their educations than did children from larger families. Parental answers showed no such difference.

More mothers of small families wanted children to take various types of training before working; more mothers of large families wanted daughters to work immediately after high school graduation.

Measuring Educational Attitudes

Girls, non-members of rural youth organizations, and students from the two upper levels-of-living groups valued education more highly than did boys, members of the youth organizations, and students from the low level-of-living group.

From comparison with results obtained from similar studies conducted in Kentucky, North Carolina, and Tennessee, Virginia students had an average score significantly lower than did students from Kentucky and North Carolina, but similar to the average score of students from Tennessee.

Vocational Preference Record

Sex was the factor most often related to vocational choices. Boys showed more preference than girls for the outdoor, mechanical, computational, and scientific areas. Girls showed more preference than boys for the artistic, literary, musical, social science, and clerical areas. Both sexes scored similarly in the persuasive area.

In every area except two there was a significant difference between scores of children and scores of parents due to sex of the child. In general, fathers agreed more closely with sons and mothers agreed more closely with daughters.

Members of youth groups preferred the outdoor and mechanical areas more than did non-members, who showed more preference for literary and computational fields.

Middle and high level-of-living students showed more preference for the scientific area than did low-level students. Level-of-living was also related to students' preferences for the persuasive and social science areas.

Students from farm families showed greater preference for th outdoor interest area than did students from non-farm families.

Children from large families showed more preference for the clerical area than did those from small families.

Increased Income by Farm Adjustment

An operator's labor income as high as $3,000 annually can be attained only with good management and with the optimum use of available resources, for approximately 13,000 farms in Southside Virginia. A typical farm resource situation includes 30.5 acres of open land, 2.5 to 3.1 acres of flue-cured tobacco allotment, and less than $10,000 available for added investments.

Opportunities to improve income have always been important to the farm business manager. Determining

the combination of enterprises which will make best use of available resources is an adjustment problem which the farm manager continually faces.

Alternative adjustment possibilities for typical resource situations in 4 areas of Virginia are being analyzed by researchers in the Department of Agricultural Economics.

For larger farms in Southside Virginia, farms with 150 acres or more of open land, added capital investments would be used most profitably to add a Grade-A milk enterprise where a market is available. Several of the more profitable combinations of enterprises for the larger farms are summarized in the accompanying table for a typical farm with 180 acres of open land of which 158 are tillable.

Three farm organization possibilities, 180 acres open land, Southside Virginia.

Enterprise	Unit	Grade-A Dairy	Hogs & Steers	Beef
Tobacco	Acres	8	8	8
Dairy cows	Number	75	—	—
Market hogs	Number	—	800	—
Beef cows	Number	—	—	30
Finished steers	Number	—	12	45
Corn grain	Acres	—	72	45
Corn silage	Acres	96	6	22
Cropland pasture	Acres	48	—	38
Alfalfa	Acres	6	—	—
Permanent pasture	Acres	21	21	21
Small grain and lespedeza	Acres	—	72	45
Non-operator labor	Men	2 2/5	2	1
Investment capital*	$1000	80	27	19
Operator's labor income	$1000	12	8	6½

*Investment capital for breeding livestock, added buildings, and equipment.

It has been determined from a study of 178 cash grain farms in Northeastern Virginia that in 1961 these farmers had almost 92% equity in a median investment per farm of $75,000. Yet 82 of these farmers stated that they would not borrow additional capital even if it permitted profitable adjustments — a forceful illustration of internal capital rationing. Of those who would borrow, 50% more would use the funds for the purpose of additional land rather than for any other specific purpose, particularly the addition of livestock. Since 73% of the open land in this area is reported to be suitable for continuous corn, improvement in methods of harvesting and handling corn and expansion of grain-consuming livestock seem to be the most promising adjustment opportunities.

Tenure Adjustments in Farm Consolidation

Adoption of new technology, especially mechanization of production, often requires an increase in the size of farms for efficient operation. Accordingly, during the past 2 decades, the average size of farms in Virginia increased by 40 acres. This growth in average size of farms occurred primarily through consolidation of 2 or more farms.

Analysis of data reported in the *United States Census of Agriculture* revealed that highly significant changes occurred between 1954 and 1959. In 1954, 68% of all farms in Virginia were smaller than the average size farm. By 1959, this percentage had dropped to 60% of all farms smaller than the average size. Farm size increased by ¼ in 5 years.

Based on census information, it was found that 14 counties in Virginia showed indications of a considerable amount of farm-land consolidation between 1954 and 1959. Four counties scattered throughout the state had an increase in land in farms while the remaining 93 counties had a decrease in land in farms.

In 1960, 45% of the purchases of farm property in the nation were for farm enlargement. Consolidation of operating units does not occur entirely through purchase, however. In the eastern ½ of Virginia, part-owners have become concentrated, particularly in the northeastern cash-grain area, indicating the importance of renting as a means of consolidation.

Operators who consolidate evidently view the process as achieving the solidarity desired in modern farming operations.

Underemployment on Virginia Farms

Gross incomes on Virginia farms are among the lowest in the nation. Sixty-two percent of the commercial farms in the State had gross incomes below $5,000 in 1959. The on-farm employment of regular farm labor was investigated in search of an explanation.

It was discovered that between 35% and 40% of regular farm labor on Virginia farms in 1959 should not have been needed to produce what was produced. This represents the extent of underemployment on Virginia farms. An investigation of off-farm employment opportunities and work force expansion in the State from 1960 to 1964 indicates that off-farm opportunities have been extremely limited for those not needed on farms. The 1965 labor situation is therefore estimated to be similar to that found for 1959.

Total annual underemployment among the regular farm work force was more than 26,000 full-time man-equivalents, even if no seasonal labor had been employed. About 80% of the underemployed are south of a line along the south border of Augusta County, east through Richmond, and down the James River to the Bay. The heaviest concentrations per county are in south-central and southeastern Virginia.

Annual underemployment varied from a high of 50% in southeastern Virginia to a low of about 20% in the Shenandoah Valley. It was fairly uniform throughout the year except for the months of harvest for apples

and planting and harvesting of tobacco, corn, and soybeans. Monthly underemployment ranged from 67% for 7 months of the year in southeastern Virginia, to a requirement for 45% more labor during tobacco harvest in south-central Virginia than is normally available on farms.

Evaluation of Land-Use Patterns in Expanding Metropolitan Regions

Urban expansion into rural areas and the accompanying shifts in resource use have become a national phenomenon sufficiently great that it requires the attention of all sectors of our society. Generally, orderly development is achieved only partially, even though carefully prepared land-use plans are administered through subdivision and zoning ordinances and other local control measures. Problems invariably arise, whose nature is best described by several questions. How can effective provisions for desirable open space areas be provided? What measures can be taken to avoid a shift of current land use to "idle use" before the land is needed for urban development? To what extent do low-density restrictions and similar development measures contribute to an artificial scarcity of land accompanied by (a) undesirable urban sprawl, (b) high costs of public services, (c) shifts in incidence of costs of public services, and (d) an absence of desirable variety and amenities in land use?

Urban growth processes are exceedingly complex and highly dynamic. They require a continuous program of research to provide knowledge for decision making by agencies responsible for planning the growth of metropolitan regions. Burgeoning urban expansion has brought new problems and magnified the intensity of old ones, solutions to which require that we know more about the results of past efforts to bring order to urban expansion.

Efforts are being made to determine if low intensity uses of land can complement preservation of open spaces without creating excessive urban sprawl and if artificial scarcities of urban land arise from such restrictions. Also, relationships between land-use control measures and (a) ownership and development rights in land, (b) land values, (c) variety and amenities in land use, and (d) the local tax base for public services are being studied. Such information will be very useful to planning agencies in their job of guiding urban growth.

Changes in Resource Use in the Appalachia Area

The number of families depending on income from farm sales has decreased in much of the Appalachian area. However, in certain ways, farming is in a better position now than it was 10 or 15 years ago. At least this is the conclusion arrived at after studying changes in resource use in Alleghany and Bath Counties, Virginia, and Greenbrier County, West Virginia.

In these counties, the number of farms has decreased but the volume of farm sales has increased. In the study, we were concerned with what farms or families made these changes, but changes do not follow any preconceived pattern. We had assumed that older operators did not expand their farming operations to any great extent, but in this area the older operators as well as the younger have expanded. We had assumed that owners of farm units with sales of less than $2,500 were going out of farming. They are, but a sizeable number of these operators have greatly expanded their unit. We had assumed that larger units were getting larger, but many of the large units of 1949 had smaller farm sales in 1962 than in 1949. Many of the large farms in 1962 were not large farms in 1949.

We had assumed that the greatest change took place when a farm unit passed from one person to another. To a great extent, this is true. When the unit passed to a person of the same generation, farming activity was greatly reduced. When the unit passed to the younger generation, there were 2 main movements. For one group of farms, farming activity was reduced; but for the other group, the younger operator greatly expanded farming activity.

Much land that was in farms in 1949 is not in farm use now. To a large extent, changes in ownership are not bringing about any significant amount of land consolidation. Much of the land of these 3 counties is held in relatively small ownership units. The present pattern of ownership does not encourage economic development of the woodland area.

Rural Recreation Opportunities

Increasing population, income, and leisure contribute to an expanding demand for outdoor recreation. Publicly owned and operated facilities such as local, state, and national parks, as well as state and national forests, have traditionally provided the sources of this type recreation. As the demand has expanded, such facilities have also been expanded. However, the rate of expansion of facilities has not kept pace with the rate of expansion of demand.

Implementation of plans for further expansion of public recreation facilities will probably be retarded by more pressing demands on public funds. As a result, alternative means of providing opportunities for recreation are being investigated. Establishment of recreation enterprises on private land is being advocated as a potential solution to the problem.

Initial investment requirements and profitability are being determined for several types of rural recreation enterprises. Such information will be useful to farmers and others who are considering establishing recreation enterprises in a rural area.

Cellular Biochemistry

Every animal or plant owes its form, function, and heredity to a giant molecule, called deoxyribonucleic acid (DNA), located within the cells which comprise the living tissues of these organisms. DNA is constructed from four different building blocks (deoxyribonucleotides) which are linked together to form a long-chain macromolecule. The sequence or order in which these four different deoxyribonucleotides are arranged in the DNA chain dictate all of the characteristics of the organism in which the DNA is located; thus, the code of life can be said to be locked in this macromolecule.

During the growth or maintenance of animal or plant, the cells within the tissues reproduce by cell division to increase or replace their kind. When a cell divides, it first duplicates its DNA and then passes one-half of it to its offspring so that the daughter cells will have the exact characteristics of the parent cell. Currently little is known of the factors which control the biochemical reactions associated with synthesis or duplication of DNA within the cell. It is known, however, that cells cannot reproduce until their DNA has duplicated; thus, the rate of growth and maintenance of the entire animal or plant may in turn be regulated by the biochemical factors which control the time and rate of DNA synthesis in the tissue cell.

Research is currently underway at VPI to reveal the biochemical mechanisms which control DNA synthesis in a single cell. To approach this problem, mass cultures of single-celled plants, which are metabolically similar to the tissue cells in higher plants and animals, are synchronized so that all of the cells develop through all stages of their growth cycles at the same rate and divide at nearly the same time. In essence, a mass culture of synchronized cells behaves physiologically and biochemically as a single cell, thereby providing a large quantity of uniform cellular material from different stages of the cell cycle.

Using microchemical methods, the DNA content of cells from different stages of development was measured. The cellular DNA was found to be only synthesized immediately prior to cell division. DNA synthesis ceased as soon as the cell completed the division process. The observed trend for DNA synthesis seemed reasonable from a biological point of view; however, from a chemical point of view, why did replication take place only during one particular period of cellular development?

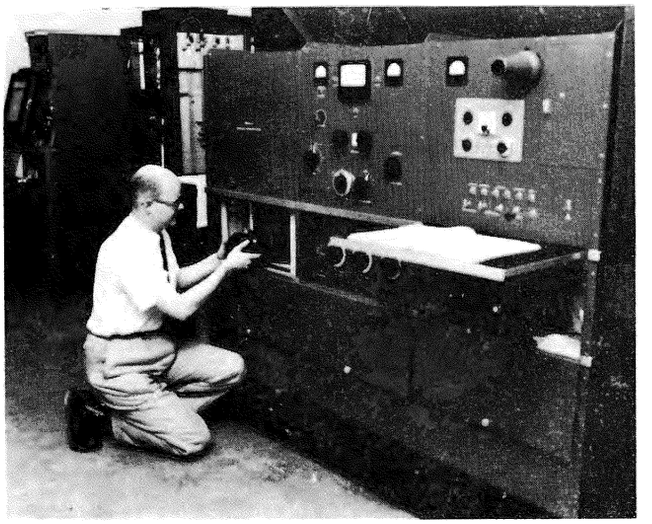
The rate at which most chemical reactions proceed within a cell (or even the existence of certain cellular chemical reactions) is controlled by special proteins called enzymes. These enzymes act as catalysts and make it possible for chemical reactions such as DNA synthesis to proceed at a significant rate at the temperature of the living cell. It was anticipated, therefore, that the active levels of one or more of the enzymes involved in the synthesis of the DNA precursors or in the assembling of these precursors into the DNA molecule, was regulating the time and rate of DNA synthesis during the cell cycle. Measurement of the levels of many of these enzymes throughout the cell cycle revealed that the levels of the enzymes involved in the synthesis of deoxythymidine triphosphate, one of the four DNA building-blocks, are probably controlling DNA synthesis. These particular enzymes were found to be at very low levels until immediately prior to cell division, when their levels increased dramatically. DNA synthesis rapidly accelerated shortly following the increase in these enzymes. At the onset of cell division, the levels of these enzymes sharply decreased, followed by a similar decline in the rate of DNA synthesis.

Although these observations strongly support the enzymatic control of DNA synthesis, our research is only beginning. We must now determine the nature of the biochemical mechanism controlling the active levels of the enzymes in the deoxythymidine triphosphate biosynthetic pathway, which is in turn controlling DNA synthesis during the cell cycle.

Searching Inside the Cell

An analytical ultracentrifuge given to the Station by an anomyous donor, has enabled research workers to study the size and shape of small substances which occur inside the living cell. This centrifuge is capable of a maximum speed of 60,000 revolutions per minute and can generate a force of 250,000 times that of gravity. Larger particles are thrown out of solution faster than smaller ones, permitting the purity of samples to be observed as well as the size of the principle components.

The ultracentrifuge has been used in studies concerned with the synthesis of the enzyme, cellulase, by the bacterium, *Cellvibrio gilvus*. To do this, it is necessary to break the cell wall of the organism to get at the various components. Within the cell are particles



The analytical ultracentrifuge, an instrument for looking at particles which come from inside the cell.

called ribosomes, which have been shown to be a major site of protein synthesis in all living organism that have been studied. Ultracentrifugal patterns of *Cellvibrio gilvus* ribosomes, such as that shown below, reveal that these ribosomes are isolated in various sized clusters, called polyribosomes, evidenced by the several dark bands through the center of the photograph. (Since sedimentation is from right to left, the polyribosomes increase in size from right to left in the picture.)

These ribosomes have been shown to contain cellulase activity. Extensive studies have been made to obtain the optimum concentrations for protein synthesis by these ribosomes, so that we are now in a position to attempt to obtain cellulase synthesis in the test tube.

The imporance of his enzyme becomes apparent when we realize that millions of tons of cellulose (roughage) are degraded each year by the bacteria in ruminant animals.. This digestion by cellulase of the high fiber feeds such as silage, hay, etc., provides food for the animals which in turn provide meat for the growing world population.

Insect Biochemistry and Nutrition

The control of insect pests is costly. The search for new insecticides sometimes has to be done to meet emergencies, and it is often hampered by a lack of fundamental knowledge about the life processes of insects. To help correct this deficiency, research is aimed at supplying information on the biochemistry and nutrition of certain insect species.

The biochemical studies are concerned with the processes which underlie and support flight and other forms of intense muscular activity. It is known that the demand for energy at the onset of flight far exceeds most other heavy demands for energy in the entire animal kingdom. Thus, it appears that this is a promising area for study, since it could represent an area of difference between insects and other animals which might be open to chemical attack. The questions under investigation are these: how are these huge amounts of energy made available at the onset of flight and how is the energy supplying mechanism controlled at other times?

It has been shown that biochemical pathways used by the insect to supply energy are similar to those of higher animals, although some differences exist. In addition, insect systems have a greater capacity to supply energy on a unit weight basis. They are also very sensitive to the amounts of certain chemicals which are normally available to the system. One of these compounds, adenosine diphosphate, is of great importance because in its absence essentially no energy is made available. When it is present, energy is made available. Since its concentration in the system varies in response to activity, adenosine diphosphate is probably one of the main factors responsible for control of the energy supplying mechanism. That other factors may be involved is currently under study.

Insects feed to satisfy their requirements for essential nutrients and in so doing destroy enormous amounts of food and fiber. To determine which nutrients an insect must have, insects have been fed on synthetic diets in which each constituent is of known chemical structure. The nutritive value of the dietary constituents is evaluated by observing the effects on development when each is omitted or added in the diet.

Certain plant-feeding insects are being studied to determine their dietary requirements for amino acids, the building blocks from which proteins are made. It has been shown that the insects need 10 amino acids, and death occurs if the diet lacks any one of the 10. However, growth is stimulated if the nitrogen supplied by the essential amino acids is supplemented with other nitrogen sources, such a non-essential amino acids. Investigations have shown that it is important to identify not only the essential amino acids, but also the optimal proportional relationships or balance of amino acids.

Because of the possibility that insect-resistance of crop varieties may be related to nutritional factors important to insects, the studies now in progress will attempt to clarify the role that insect nutrition plays in this economic problem.

Pesticides—Their Control

New organic chemicals have made possible more efficient control of harmful pests of cultivated plants and domestic animals. Without them it would be impossible in many instances to maintain our current abundant supply of food.

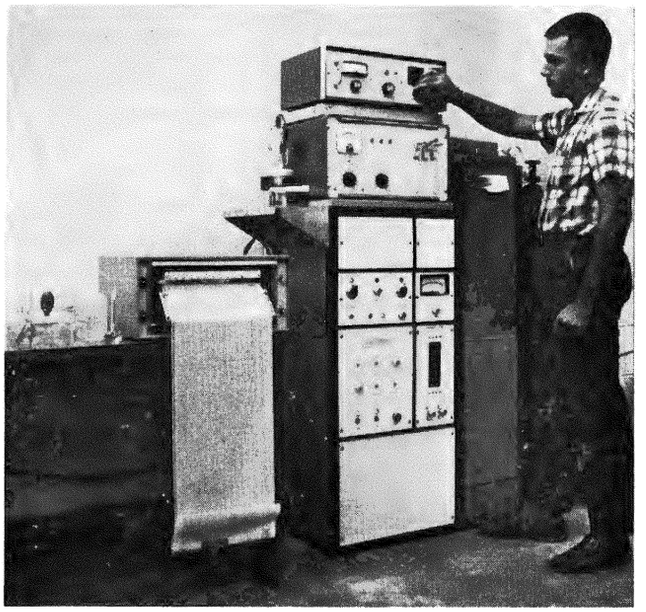
New methods and instrumentation have been adopted for the detection of these pesticides in foodstuffs, to assure that tolerances (measures of harmful quantities) are not exceeded. Only a few of the methods are adequate, making it necessary to continue investigations to improve them.

Studies to obtain data necessary for correct use of chemicals in the control of pests have been underway for several years in Virginia. A much larger program is now developing, to investigate the persistence and the fate of pesticides in soil, water, plants, and animals.

Cooperating with the Station's pesticides laboratory in the biochemistry and nutrition department are the departments of agronomy, animal science, dairy science, entomology, foods and nutrition, forestry and wildlife, horticulture, and the Extension Service.

A few specific problems include the following: determining the time required for residues to disappear from vegetable crops; determining the effects of cooking and freezing on pesticide residues in broiler tissues; pinpointing the pesticide movement into farm ponds where heptachlor has been applied to the watershed for control of the alfalfa weevil, and evaluating the effect of seasonal variation, rainfall and pond-water levels on

residue concentrations; metabolism studies to investigate the degradation of DDT in resistant and susceptible German cockroaches; a study to learn how heptachlor in the soil is absorbed by alfalfa plants. The length of time required for heptachlor to be removed from different soil types by the alfalfa plant is also under study. Insecticide residues in beef cattle are under study to determine the rate and level of accumulation of the insecticide residues in the edible tissue of beef cattle receiving pesticides in a fattening ration, and rate of dissipation when the contamniant is removed from feed.



Pesticides are analyzed in minute amounts by means of this gas chromatograph.

Naturalization of Highway Banks

More than 60 plant species are being screened for use in naturalizing steep highway cuts and fills. Quick plant establishment from stratified seed, bare root, and container grown plants was attained through fertilization at planting time. The optimum amounts and analyses of fertilizers for various soil types and plant species are being determined. Some slow-release fertilizers have shown advantages over the readily available forms on 1:1 slopes where soil moisture is limiting and soluble salt concentration is a problem. Fertilization at planting time has more than doubled the growth of many species where grass was not in competition for fertilizer nutrients.

Direct seeding of woody plants is more economical than planting bare root or B&B nursery stock, but no seeding technique has given consistently satisfactory results. Establishment of honey locust from seed was successful on degenerate sodded slopes when no fertilizer was used. Fertilizer encouraged grass growth which was more aggressive in competition for soil moisture and nutrients.

Brush Control in Pastures and Rights-of-Way

A popular and effective method of controlling woody brush is with esters of 2,4-D and 2,4,5-T mixed with water and applied as a foliage spray. Although this form of phenoxy herbicide has given satisfactory results, volatility near susceptible crops can sometimes be a limiting factor. Recent results with oil soluble amine of 2,4-D and 2,4,5-T indicate that they are as effective as the ester form. Their non-volatile safety qualities should make them valuable for use in susceptible crop areas.

Hunting Expenditures in Virginia

To estimate the impact of hunting on Virginia's economy, questionnaires were mailed to approximately 1,800 purchasers of Virginia hunting licenses. Preliminary analysis of the answers indicated that approximately $100,000,000 were spent in connection with hunting in Virginia between July 1, 1963, and July 1, 1964. Final analysis will provide information useful both to the sportsmen of Virginia and the State Game Commission.

Isolation of *Spirillum Volutans*

Despite the early description of *Spirillum volutans* by Ehrenberg in 1832, attempts by various investigators to grow this organism in pure culture have been unsuccessful; however, by a most ingenious dialysis sac technique, Rittenberg and Rittenberg in 1962 were able to isolate the Pringsheim strain in pure culture. Growth did not occur independently, however, and the sac had to be suspended in a culture of other bacteria which were presumed to supply a nutritional factor required by *S. volutans*, although no chemical supplements added were able to replace this requirement.

Our strain of *S. volutans* was obtained from an infusion of pond water and hay. After 36 aerial transfers

Effect of oxygen concentration on growth of *Spirillum volutans*.

Conditions*	Cells per ml after 3 days at 30 C**
Medium reduced for resazurin, 100% nitrogen atmosphere	10^1
1% oxygen atmosphere	3.2×10^4
3% oxygen atmosphere	3.5×10^4
6% oxygen atmosphere	3.8×10^4
9% oxygen atmosphere	3.9×10^4
12% oxygen atmosphere	10^1
21% oxygen atmosphere, cotton-stoppered flasks	10^1

*Medium — nutrient broth + 100 mg cysteine hydrochloride + 1 mg resazurin per liter; inoculum per flask — 100,000 spirilla in 0.25 ml of culture; volume of medium per flask, 75 ml.

**By microscopic count.

using the Rittenberg method, a pure sac culture was finally obtained. A most striking characteristic of the culture was the regular formation of a ring-shaped band of spirilla when covered wet mounts were prepared and allowed to stand for several minutes; this suggested a possible microaerophilic nature. The Rittenbergs noted a similar ring formation in an uncovered culture drop, but apparently the ring did not contain the enormous numbers of organisms congregated in the sharply limited zone that we have observed in covered mounts.

Successful independent cultivation of the organism from our sac culture was finally accomplished in our laboratroy by inoculating the organism into closed vessels containing nutrient broth and various concentrations of oxygen. The accompanying table indicates the strict microaerophilic nature of *S. volutans*.

Because of the correspondence of our organism with the description of *S. volutans* by Williams and Rittenberg and the failure of our organism to grow on liquid or solid media aerobically (even with enrichment factors added), we believe that we have isolated *S. volutans* in a completely bacteria-free environment for the first time. The previously observed dependence of *S. volutans* on other bacteria outside the dialysis sac would seem to be a function of the removal of dissolved oxygen by these outer bacteria, rather than dependence of the spirilla on a nutritional factor.

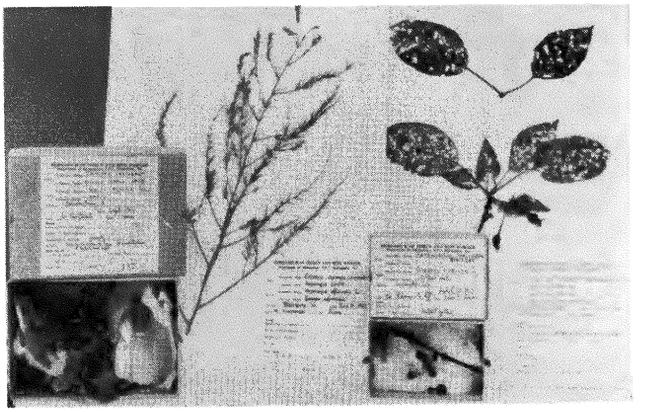
Life Cycle of a New Blood Fluke of Turtles

The larval stages of a new trematode blood parasite of turtles have been discovered in the snail, Helisoma anceps, in Sinking Creek, Giles County. These larvae, when applied to the skin of the legs and neck of several species of turtles, were found to penetrate and ultimately migrate to the cavity of the heart. There they mature and deposit eggs in the blood stream. These eggs are swept through the circulatory system and deposited in various organs (lungs, liver, intestines, etc.) where they induce the formation of fibrous cysts. Eggs of these worms liberated from the turtle give rise to a minute larval form whoch penetrates the body of the snail and undergoes metamorphosis to produce the form which will later leave the snail and enter the turtle.

A large number of these worms infesting the heart of a single host can cause severe to fatal results, primarily by deposition of eggs and subsequent formation of cysts.

Herbarium of Insect and Mite Damage

Pest insects are "criminals" against human welfare. The teethmarks or "fingerprints" which they leave behind help in identifying them. Police agencies have files on the fingerprints of dangerous criminals. Entomologists should have such a file for pest insects, which would enable them to identify these criminals, even after they get away.



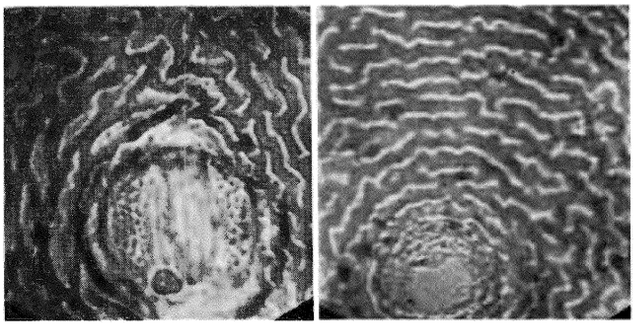
Plant material showing different types of insect injuries is stored in boxes or on herbarium sheets in the Department of Entomology. This type of systematic reference collection will enable entomologists to identify pests by their damage.

Identifying Two Parasitic Nematodes

A nematode designated as the horsenettle cyst nematode (HCN) was first found on the roots of the horsenettle weed on a farm near Suffolk in 1959. Another nematode, designated as Osborne's cyst nematode (OCN) was first found on roots of tobacco and horsenettle on one farm near Scott's Fork in 1961. The HCN and OCN resemble the golden and tobacco cyst nematodes, but they may be easily distinguished from them by certain morphological characters and differential hosts on which they produce cysts.

The HCN and OCN closely resemble each other but they can be distinguished by the shape of the knobs of the females and the cuticle patterns formed by the ridges in the perineal region. A decision as to whether to describe the newly discovered cyst nematodes as two new species of *Heterodera*, the OCN as a subspecies of the HCN, or the OCN as race 2 of the HCN, will await the results of crosses of single larva of HCN isolates with single larva of OCN isolates.

In experiments involving the crosses of 2 larvae each of the HCN and also crosses of 2 larvae each of the OCN, it has been determined that reproduction of both nematodes is by cross fertilization, since embryonated eggs were not produced unless the females had sperm in their spermatheca.



The cystwall patterns, magnified 1000 times, of the Osborn's cyst nematode (left) and that of the horsenettle cyst nematode (right) aid in distinguishing.

Sonic Energy and the Pesky Fly

Do flies hear? What do they hear best? What do they like or dislike to hear? Will sonic energy influence their ability to reproduce? These are some of the questions being studied by agricultural engineers, entomologists, and other scientists with aid from the USDA. A sound-proof facility has been developed in which flies and other insects and animals may be placed for study. The sound may be such that a human being cannot hear it (ultrasound). The amount and intensity is measured by ingenious electronic devices so that researchers can evaluate their findings. If a sound can be found which would either attract or drive away flies — a universal nuisance to man — it would be invaluable around dairies, food processing plants, dock areas, and any place exposed food products are handled.

The scientist uses electronic devices to measure frequency and intensity of sonic energy too high pitched for the human ear.

Statistical Research

The development of statistical research, especially in England, India, and the United States, has produced a large number of fundamental techniques which can be used very profitably in the study and analysis of scientific experiments, in production and operational research, in the assessment of economic or sociological trends, in precision and reliability studies of weapons systems, in the forecast and improvement of crops, in medical and biological research, and in many other situations.

The Department of Statistics and its statistical laboratory engage in fundamental research and applied research for the purpose of promoting and fostering efficient use of statistical methods in research. Besides having research functions, the department is consultant for many sections of the station, to State agencies, and to the university as a whole. It also provides computational services for many research projects.

The department has substantially expanded its program with the aid of grants from the National Institutes of Health, which provides for assistance to students as well as staff.

Other work is supported by such organizations as the U. S. Army Research Office; the American Statistical Association; the National Cancer Institute; the National Institutes of Health; the Office of Naval Research; and the National Science Foundation.

In the statistical laboratory (there are only a half dozen such laboratories in the United States) is a variety of automatic desk calculators. The university's high speed computing center includes an IBM 7040/1401 data-processing system, and related equipment, such as card punching, sorting, and listing machines. The department also has easy access to the high speed computing machines of the Oak Ridge National Laboratory and the Langley Research Center. Most of the leading statistical journals published in this country and abroad are currently received in the university library.

One of the most important research projects recently completed was entitled "Statistical Methodology for the Analysis and Evaluation of Defect Data on the Redstone Missile System." This program provided the guidance for the reliability program of the Redstone Missile, which was responsible for putting the first American into space.

Another project dealt with the allocation of cancer patients to different treatments under comparison. The principal feature of this method is that more patients are allocated to the more successful drugs without loss of the statistical safeguards necessary for a satisfactory interpretation of the experimental results.

Main effort of another project has been to collect data on supplies, demands, and shipments of livestock within the southern region and between the southern and other regions. This work is being done for the Southern Regional Livestock Marketing Project. An analysis of a survey of household food expenditures, with special emphasis on the consumption of dairy products, is being done for the Southern Regional Food Marketing Project.

Other work by the department has embraced such widely varied subjects as recording watershed drainage, analyses of economic production functions, analyses of agriculture field experiments, programming of optimum farm enterprises, and the analysis of data from experimentation on livestock and poultry production. The computing center has helped develop a procedure for the keeping of records of the Virginia Beef Cattle Improvement Association, and one for a more complete analysis of corn variety trials.

List of All Projects

Agricultural Economics Department

FEDERAL FUNDS

An Economic Analysis of Pasture and Harvested Forage Systems.*

Distribution of Milk through Distributing Agencies.

Effects of Production Control and Allotment Programs on Farming Adjustment Opportunities in Dairying, Other Livestock, Poultry, and Specialty Crops in Selected Areas of Virginia.

An Economic Appraisal of Farming Adjustment Opportunities in the Southern Region To Meet Changing Conditions.

The Estimation of Production Functions in Egg Production.

Sampling and Inspection of Apples for Processing.

Pricing Milk on the Basis of Its Component Parts.

Effect of Labor Requirements, Distance, Volume, Frequency of Delivery and Other Factors on Costs of Distributing Table Eggs by Egg Grading and Packing Plants.*

Economic Analysis of Alternative Methods for Handling and Marketing Sweet Potatoes.*

The Effect of the Federal Price Support Program for Peanuts on Farm Land Values.

Multiple Pricing Plans for Peanuts.*

The Optimum Allocation of Farm Resources in Northeastern Virginia.

Tenure Adjustments in Farm Consolidation.

The Optimum Allocation of Farm Resources in Southeastern Virginia.

An Economic Appraisal of Objective Measurements of Beef Characteristics that Would Aid in Predicting Beef Acceptability to Consumers.*

Movement of Slaughter Hogs and Pork Affecting the Virginia Livestock Industry.*

Organization and Structure of the Marketing System for Virginia Broilers.*

Factors Affecting the Value of Raw Tomatoes for Processing as Canned Tomatoes.

Optimum Location of Livestock and Meat Marketing Facilities in the South.

The Impact of Changing Market Structure upon the Competitive Position of the Dairy Industry.

STATE FUNDS

Economic Analysis of Virginia Small Meat Packing and Processing Firms.

Forecasting Beef Cattle Prices for Short Periods.

An Estimation of the Cost of Producing Pork by the Drylot Feeder Pig Method in Virginia.

Resource Allocation within Virginia Farm Equipment Businesses.

A Methodological Approach to the Estimation of Time-Quantity Livestock Production Functions.

Consumer Acceptance and Preference for Packaged Potatoes.

The Dynamics of Changes in Resource Use in Areas Having Concentrations of Low Income Farm Families.

Effects of Size, Defects, and Color on Value of Tomatoes to Processors.

Improving the Efficiency of Shop Operations of Retail Farm Equipment Businesses.

Optimum Movement of Grade A Milk in Eastern Virginia.

Capitalization of Benefits of Flue-Cured Tobacco Price Support Program into Farm Land Values.

Estimating the Potential Supply of Non-Fat Milk Solids For Complementing Aid Programs To Developing Nations.

*Contributing to Regional Project.

Agricultural Engineering Department

FEDERAL FUNDS

Structural Stability of Farm Buildings under Accelerated Cycles of Loading.

Factors Affecting Water Yields from Small Watersheds in the Appalachian, Blue Ridge and Piedmont Divisions of Virginia.*

The Influence of Artificial Drying on Market Quality of Virginia Type Peanuts.

Interaction of Components in Full-Scale Specimen as a Basis for Balanced Structural Designs in Farm Buildings.

STATE FUNDS

Drainage Requirements and Practices for Crop Production.

Irrigation Requirements and Practices for Crop Production: Part A—Forage Crops; Part B—Corn and Burley Tobacco Crops; Part C—Flue-Cured Tobacco.

A Cooperative Research Project To Study the Value and Adaptability of Aluminum to Farm Construction.

Effect of Radiant Energy on Insects.

Drying and Handling Mechanically Harvested Virginia-Type Peanuts.

Swine Research Buildings and Equipment.

Motor Truck Equipment for Field Spreading of Dry Bulk Fertilizer.

Apple Harvesting Mechanization.

Wind Loads on Low-Profile Buildings.

The Effect of Impact Loads on Fruits.

Agronomy Department

FEDERAL FUNDS

Influence of Soil Properties on the Value of Rock Phosphate and Superphosphate as Soil Amendments.

Mineralogical, Chemical and Physical Properties of Representative Soils in Virginia.*

Development and Utilization of Adapted Corn Inbred Lines and Hybrids with High-Protein and High-Oil Grain.

Development and Selection of Adapted Corn Inbreds and Hybrids.

Soil Plant Nutrient Relationships in Peanut Production.

Development of Oat Varieties Adapted to the Coastal Plains Region of Virginia.

Effect of Rates of Nitrogen, Dates of Planting, and Spacing upon Yield and Quality of Burley Tobacco.

Lime Requirements of Virginia Soils.

The Effect of Soil Chemical and Mineralogical Properties on Plant Nutrition.*

Methods for Growing Corn and Soybeans with Reduced and/or No-Tillage Procedures.

Carbohydrate Reserves and Growth of Forages.

Grazing Pressures with Rotational and Continuous Grazing.

The Influence of Natural and Imposed Shifts in Microclimate on Forage Plants.*

Development of Fundamental Information and Procedures for Producing Synthetic Varieties in Orchardgrass.*

STATE FUNDS

Soil Survey of Various Counties in Virginia.
Adaption and Management of Forage Plants.
Soil and Water Management as Related to Forage Crop Production.
Seeding Methods and Renovating Degenerated Sods.
Research Methods and Techniques in Forage Research.
The Value of Pastures, Hay and Silage Crops for Beef Cattle.
Evaluation of Pasture, Silage and Hay Crops with Dairy Cattle.
The Development and Evaluation of Superior Disease-Resistant Varieties of Wheat, Oats and Barley.
Laboratory Methods for Soil and Plant Analysis.
Development of Improved Varieties of Alfalfa.
Evaluation of New and Improved Varieties of Forage Crops.
Developing and Evaluating New and Improved Varieties of Soybeans.
Developing and Evaluating New and Improved Varieties of Peanuts.
Evaluation of Corn and Sorghum Varieties and Hybrids for Use as Silage.
Productivity of Continuous Corn as Grain or Silage under Two Rates of Fertilization and Three Cover-Crop Systems in Southeastern Virginia.
Evaluation of Sorghum Varieties and Hybrids for Grain in Virginia.
Performance Tests of Commercial Corn Hybrids in Virginia.
A Comparison of Different Rates and Ratios of Phosphate and Potash Fertilizers on Tatum Silt Loam.
Forest Fertilization.
Varietal and Strain Evaluation of Big and Birdsfoot Trefoil at Virginia State College and Tidewater Research Station (Supporting ARS Line Project).
Topping and Sucker Control Test with Dark Fired Tobacco.
Tobacco Breeding and Testing.
Effect of Height of Topping, Plant and Leaf Poulation on the Performance of Flue-Cured Tobacco Varieties.
Control of Suckers in Flue-Cured Tobacco.
Fertilizer Experiment with Crop Rotations.
Grasses and Legumes for Lawns, Playgrounds, Roadsides, Golf Courses and Other Turf Uses.
Effect of Lime, Fertilization, Irrigation, Seed Inoculation and Disease on the Performance of Annual Lespedeza.
Evaluation of Variations in Alfalfa Populations Grown from Irradiated and Non-irradiated Seeds.
Study of Certain Physical Properties of Important Soil Types of Virginia as They Relate to Water and Air Behavior and Tillage.
Internal Damage in Virginia-Type Peanuts.
Economic Production of Corn in Virginia.

Animal Science Department

FEDERAL FUNDS

Methods of Intensive Lamb Production from Pasture.
Processing and Merchandising Meats from Animals Produced under Virginia Farm Conditions.
Basic Nutrition of Beef Cattle.
Heterosis from Crosses among British Breeds of Beef Cattle.*
Improvement of Sheep through Recurrent Selection for Combining Ability.*
A Study of Factors Involved in Handling and Packaging Meat Products To Reduce or Prevent Pest Damage in Storage or during Marketing without the Use of Pesticides.

STATE FUNDS

The Improvement of Beef Cattle for Virginia through Breeding Methods.
Nutrition and Management Factors Related to the Fattening of Feeder Lambs.
Effect of Implanting Stilbestrol and Certain Hormones in Fattening Cattle and Sheep.
The Evaluation of the Effectiveness of Selection for Economic Traits in Beef Cattle.
Prenatal and Postnatal Development of Lambs as Affected by Maternal Nutrition.
Cooperative Bull Testing with Virginia Department of Welfare and Institutions.
Muscling Evaluators, Ultrasonic and Others as Tools in the Selection of Meat Animals.
I. Protein Levels Required by the Pig as Affected by T.D.N. Level, T.D.N. and Source. II. Peanut Meal as a Protein for Swine.
Effect of Growth Rate on Muscle and Fat Development in the Growing Pig.
The Relationship of Rate of Gain and Feed Efficiency to Official State Grades of Feeder Pigs.
A Comparison of the Production of Two Breeds of Sheep under Two Environments.
Performance and Progeny Testing of Rams.
Genetic Factors Affecting Litter Size in Swine.
Levels of Nutrition and Reproductive Performance of Gestating Gilts and Sows.
Peanut Meal as a Protein Source for Swine Finishing Rations.
Utilization of Dried Bakery Product by Early Weaned Pigs.
Optimum Time-Space Hog Production Requirements.
Economic Comparison of Three Types of Farrowing Facilities.

Biochemistry and Nutrition Department

FEDERAL FUNDS

The Determination of Certain Minor Elements in Forages, Feedstuffs, and Selected Animal Tissues.
Evaluation of Available Techniques and the Development of New Techniques for Measuring Forage Utilization with Livestock.*
The Isolation, Propagation, and Nutrition Requirements of Cellulose-Decomposing Bacteria Found in the Rumen of Cattle That Are Consuming High-Roughage Feeds.
The Effect of Various Protein and Non-Protein Nitrogen Sources on Protein Assimilation by Rumen Microorganisms.
Micronutrient Elements — Balance Studies in Preadolescent Children.*
The Metabolism of the Major Products of Rumen Fermentation and Gastro-Intestinal Digestion by Tissues from Ruminant Animals.
Biochemical Mechanisms Controlling Nuclear and Cellular Division at the Cellular Level in Green Plants.
The Control of Metabolism by Thyroid Hormones.
The Location and Quantification of Heptachlor in Farm Pond Ecosystems.
Agricultural Chemical Residues in Plant and Animal Products.*

*Contributing to Regional Project.

STATE FUNDS

The Mode of Action of Antibiotics and Other Growth-Promoting Agents Used as Supplements in Chick Diets.

Reversal of Sulfaguanidine Toxicity in the Rat.

Nitrogen Balance in Preadolescent Children.*

Factors Affecting the Oxalate Content of Spinach.

The Use of Purified and Semi-Purified Rations to Determine Nutrient Functions, Metabolism, Requirements and Interrelationships in Ruminants.

Amino Acid and Other Nutrient Requirements of Chicks Selected for Divergent Body Weight.

Biology Department

FEDERAL FUNDS

Identification and Distribution of Fungi Associated with Diseases of Fish and Fish Eggs.

The Decomposition of Cellulose by Soil Microorganisms.

STATE FUNDS

The History of New River, and Distribution Problems of Its Fishes.

Systematic and Ecological Studies of the Family Branchiobdellidae.

Studies of Aquatic and Semi-Aquatic Diptera, with Special Reference to the Ephydridae and Sciomyzidae.

The Degradation of Plant and Animal Tissue by Fungi.

Systematic and Anatomical Studies of the Arachnida.

An Investigation on the Control of Induced Apogamy in Ferns.

Striatal Function in Birds with Special Reference to Afferent Projections and to Thalamo-Striatal and Tecto-Striatal Relations.

Embryology and Development of Trematode Cercariae.

Sulfonamide Action in Relation to Folic Acid.

The Decomposition of Cellulose by Soil Microorganisms.

Studies on the Comparative Behavior of the Lacertilia.

A Comparison of the Hydrological Cycles of Forested and Non-Forested Areas as Influenced by Soils and Mountainous Topography.

Vegetational Composition in Relation to Geology Soils and Topography in the Appalachian Mountains, Virginia.

Studies on the Genetics of Natural Populations, with Reference to Industrial Melanism and the Evolution of Small Populations in the Lepidoptera.

A Monographic Study of the Genus Celtis.

Growth in Mixed Cultures of Microorganisms.

A Taxonomic, Geographical, and Ecological Survey of the Amphibians, Reptiles, and Small Mammals of Virginia and the Appalachian Region.

Effects of Rapidly Induced Environmental Hypoxia on the Cardia-Vascular System in Fresh-Water Fish.

Dairy Science Department

FEDERAL FUNDS

Manufacture, Stroage Life, and Utilization of Concentrated, Dried, and Frozen Milk Products.

The Evaluation of Forages with Dairy Cattle.

Protein Requirements and the Relation of Energy and Minerals to Protein Metabolism of the Young Dairy Calf.

STATE FUNDS

A—Effectiveness of Sires Used in Artifical Breeding toward Improving Milk and Butterfat Production.

B—Factors Which Affect Milk and Butterfat Yields of Dairy Cows; Non-Genetic Effects on Milk and Butterfat Production.

Factors Affecting Amounts and Interrelations of Non-Fat Constituents of the Milk of Individual Cows.

Influence of a Natural Ration Low in Copper on the Nutritional Status of Ruminants.

Entomology Department

FEDERAL FUNDS

Genetical and Biological Studies of Resistance in the German Cockroach and the Large Milkweed Bug.

Bionomics and Control of Subterranean Insects Attacking Seedling Corn, with Special Reference to the Corn Root Webworm.

Life History, Behavior and Control of Insect Pests of Livestock and Poultry.

Seasonal History, Habits, and Control of Insects Affecting Peanuts and Soybeans.

The Bionomics and Control of Insect Pests of Grain Sorghums in Eastern Virginia.

An Ecological Study of the Insects Affecting Red Clover and Birdsfoot Trefoil.

Seasonal Development and Control of Insects Affecting the Production of Stone Fruits.

Insects Affecting Alfalfa.

Ecology and Nature Control of the Nantucket Pine Tip Moth, *Rhyacionia frustrana,* (Comstock), and Related Species.

Seasonal Occurrence, Habits and Control of Insects Attacking Flue-Cured Tobacco.

Attractants and Stimulants for the Alfalfa Weevil.

STATE FUNDS

Seasonal Development, Habits, and Control of Certain Insects Attacking Corn Above Ground.

Aphid Control on Apples, with Special Reference to Post-Harvest Sprays and to the Use of Systematic Insecticides.

Field Evaluation of New Insecticides and Acaricides for Use on Deciduous Fruit Trees.

Ecological and Distributional Studies of Insects of Economic Importance in Virginia.

Mite Infestations on Apple Foliage in Relation to Yield and Fruit Finish.

Insecticidal Residues in Milk and Tissues of Cows Fed Insecticides or Insecticide-Treated Forage Crops.

Taxonomy and Morphology of the Scale Insects of Virginia, with Special Emphasis on the Genus Antonina.

Nutritional Requirements of Insects Affecting Tree Fruits.

Bioecology of the White Pine Weevil *Pissodes Strobi* (Peck) with Special Emphasis on Natural Control Agents and Tree Damage.

The Importance, Habits and Control of Pasture and Meadow Insects in Virginia.

Biochemical Properties of Insect Flight Muscle.

A Study of the Parasites of the Pine Sawfly, *Newdiprion pratti pratti* (Dyar).

Forestry and Wildlife Department

FEDERAL FUNDS

An Economic Model for Southern Industrial Forest Regulation.

Accelerated Seasoning of Large-Dimension Wood Products.

A Study of the Parameters of Site for Certain Tree Species in Virginia.

*Contributing to Regional Project.

STATE FUNDS

The Influence of Hunting on the Population Dynamics of the Gray Squirrel.
The Influence of Forest-Wildlife Management Practices on Game Populations, with Particular Emphasis on the Wild Turkey and the Ruffed Grouse.
Improving Mountain Hardwoods by Poisoning and Underplanting.
The Influence of Forest Cutting on Browse Availability.
The Relative Effects of Soil Changes Associated with Old-Field Succession upon the Growth of Three Upland Tree Species.
The Influence of Hunting on a Rabbit Population in Southeastern Virginia.
Some Economic Considerations Involved in Timber Stand Improvement.
The Incidence and Degree of Infection of *Pneumostrongylus Tenius* in Western Virginia.
Methodology of Sampling Winter Browse.
An Estimation of Consumer Expenditure for Hunting in the Commonwealth of Virginia for the 1963-64 Hunting Season.
Improved Preservation through Bonding Phenolics to wood.
The Economics of Forest Tree Improvement Programs.

Horticulture Department

FEDERAL FUNDS

Breeding New Varieties of Apples Especially Adapted to Conditions in Virginia.
Breeding New Varieties of Peaches and Nectarines Especially Adapted to Conditions in Virginia.
Maturity and Physiological Responses of Apples as Influenced by Fertilization, Spray Practices, Environmental Conditions, Harvesting, and Handling.
Dwarf Woody Ornamental Plants.
Breeding New Varieties of Grapes Especially Adapted to Conditions in Virginia.
The Effect of Method and Rate of Phosphorus and Complete Fertilizer Applications on the Yield, Quality, and Marketability of Tomatoes.
Storage Life and Physiological Responses of Apples for Fresh and Processed Market as Affected by Fruit Condition and Storage Treatments.
Tin Plate Corrosion in Canned Applesauce.
Blending Soft and Firm Apples for Sauce.
Sweet Potato Flaking.
Cleaning Vegetables Prior to Marketing.

STATE FUNDS

Fruit Variety Evaluation.
Mouse Control in Orchards.
Apple and Peach Thinning.
Breeding New Varieties in Raspberries and Blackberries Adapted to Conditions in Virginia.
Physiological Response of Apples to Growth-Regulator Sprays.
Apple and Peach Nutrition.
Apple Rootstocks.
Development, Evaluation, and Adaptation of New Fruit Production Techniques.
Influence of Spray Chemicals on Apple Foliage and Fruit.
Stone Fruit Nutrition.
Apple Production and Harvest Efficiency.
Grape Breeding.
Increasing Young Apple Tree Root and Shoot Growth.
The Effect of Plant Spacing and Nitrogen Levels on Yield Time of Maturity, Ear Size, Pericarp Toughness, Soluble Solids, and Protein Content of Certain Sweet Corn Hybrids.
Powdery Mildew Resistance in Winter-Type Muskmelons.
Vegetable Variety Evaluation — Sweet Potato.
Land Cress Culture, Weed and Pest Control.
Design Improvement and Evaluation of Plastic Greenhouses as Plant Growing Structures.
Evaluation of Woody Ornamental Plants.
Evaluation of Herbaceous Ornamental Plants.
Evaluation of Grasses and Grass Substitutes for Lawns in Tidewater Virginia.
Fruit Variety Trials for Processing.
Vegetable Variety Trials for Processing.
Development, Evaluation and Adaptation of New Commercial Floriculture Techniques.
Factors Affecting Infestation of Processing Tomatoes with *Drosophila* spp. and Their Control.
Miscellaneous Problems in Food Technology.

Human Nutrition and Foods Department

FEDERAL FUNDS

Relationship of Certain Biochemical Characteristics of Beef to Eating Quality.
Nutrient Balance in Preadolescent Children.*
Reduction or Elimination in Commercial Channels of Adverse Effects of Pesticide Residues on Food and Feed Products.*

STATE FUNDS

The Utilization of Energy in Certain Preadolescent Children and the Fatty Acid Composition of a Diet of Plant Foods.*

Management, Housing, and Family Development Department

FEDERAL FUNDS

Consumer Responses to Food Promotion and Education Programs.*
Environmental and Economic Factors Related to Improved Rural Family Housing in the South.

STATE FUNDS

Educational and Vocational Goals of Rural and Urban Youth.

Plant Pathology and Physiology Department

FEDERAL FUNDS

Investigations of Some Aspects of the Etiology and Control of Tobacco Root Rot Disease-Complexes.
The Nature, Cause and Control of the Diseases of Pasture and Forage Legumes.
Breeding Tobacco for Disease Resistance.
Mineral Nutrition of Apples.
Diseases of Barley, Oats, and Wheat and Breeding of Disease-Resistant Varieties.
Pathologic, Physiologic, and Genetic Investigations of Corn Diseases.
The Nature, Cause and Control of the Diseases of Pasture, Forage and Turf Grasses.
Weed Control in Field Crops.
Control of Undesirable Woody Plants and Weeds in Forests, Pastures and Non-Crop Areas.
Chemical Weed Control in Corn and Alfalfa.

*Contributing to Regional Project.

The Occurrence and Control of Undesirable Plant Species Growing in Nurseries, Ornamental Plantings and Turf.
The Pome Fruit Virus Diseases in Virginia.
Mineral Nutrition of Woody Ornamental Plants.
The Effect of Selected Soil Applied Herbicides on the Germination of Certain Weed Seeds.*
Weed Control in Fruit and Vegetable Crops.
Naturally Occurring Plant Growth Regulators in *Artemisia vulgaris* and Other Weed Species.
Factors Influencing Survival and Pathogenicity of Plant Parasitic Nematodes.*

STATE FUNDS

Fruit Diseases.
Bean Diseases.
Tomato Diseases.
Diseases of Tree Fruit.
Ecology of the Black-Shank Disease of Tobacco.
Studies on the Control and Inheritance of Resistance in Tobacco to the Tobacco Ringspot Virus and Other Viruses of Tobacco.
The Relation of Seedbed Cover Materials to the Production of Healthy Tobacco Seedlings.
Diseases of Ornamental Plants.
Causes and Control of Injuries to Newly Transplanted Tobacco Seedlings.
Control of Undesirable Aquatic Plants in Virginia Water.

Poultry Science Department

FEDERAL FUNDS

The Improvement of the Market for Poultry and Poultry Products through the Development and Application of a Broader Knowledge of Processing Technology.
Quantitative Inheritance of Broiler Characteristics.*
The Effects of Genetics and Environment on Broiler Production.
Effect of Age, Sex and Genetics on the Endocrine Glands of Fowl.
Age, and Genetic Interrelationships in the Responses of Chickens to Hormonal and Environmental Stimuli.
Agricultural Chemical Residues in Plant and Animal Products.*

STATE FUNDS

The Nutritional Requirements of High Producing Hens.
Effects and Relationships of Genetics, Physiology and Management in Commercial Turkey Production.
Effects of Various Artificial Light Procedures on the Egg Production of Different Strains of Chickens.
Inbreeding and Selections in the Improvement of Reproductive Performance and Efficiency in Single Comb White Leghorns.
Influence of Diet, Age, Sex and Other Related Environmental Factors on Broiler Growth and Feed Utilization.
Effect of Piperazine Citrate on Egg Yolk Quality and Egg Production.
The Influence of Genetics on Responses to Hormone Administration.
Social Behavior of Chickens During the Growing Period.
Lysine and Methionine Supplementation to Practical Poult Starting Diets Which Vary in Protein and Corn Gluten Meal Content.
The Development of Nutritionally and Economically Sound Poultry Rations To Be Recommended for Commercial Use.
Relationship Between Length-Width Ratio of Eggs and Puncture Strength of Shell Membranes to the Breaking Strength of Market Eggs.
The Effects of Feeding Antibiotics and Other Promotants on Weight and Feed Efficiency of Turkeys.
The Influence of Oiling with Subsequent Washing on Ease of Cleaning Interior Quality and Weight Retention of Market Eggs.
Development of Smoked Poultry Products.
The Influence of Certain Environmental Factors on the Production of Market Turkeys.
A Study of the Effects of Temperature and Holding Time on the Fertilizing Capacity of Undiluted Turkey Semen.
Influence of Feed and Age on Dressing Percentage, Meat, Skin and Bone Yields and Other Carcass Characteristics of Broilers.
The Evaluation of Fats for Turkey and the Effects of Fat on the Utilization of Other Nutrients.
A Study of Various Genetic Photo-Periddic, Physiological, and Environmental Factors Concerned with Reproduction in the Turkey.
Evaluation of Hatchery By-Product as a Poultry Feedstuff.

Veterinary Science Department

FEDERAL FUNDS

Control of Respiratory Diseases of Fowls Other than Newcastle Disease.
Control of Respiratory Diseases of Poultry.*
The Pathologic Physiology of Enterotoxemias in Domestic Animals.
A Study of Effect of Environmental Factors on Parasites of Sheep and Cattle in Virginia.
The Flora of the Animal Intestinal Tract in Disease and in Health.
Infectious Diseases Affecting Reproduction in Cattle and Sheep.*
Study of Structure-Function Relationship at Molecular Interfaces.
A Study of Stomach Ulcers in Swine.
Causes and Control of Prenatal, Neonatal and Postnatal Deaths in Pigs.

STATE FUNDS

Factors in the Cause and Control of Infectious Sinusitis of Turkeys.
Bovine Leptospirosis.
Bacterial Endocarditis of Chickens.
E. coli Hypersensitivity in the Food Producing Animals.

Statistics Department

Consulting Services on Research.

*Contributing to Regional Project.

Publications

Bulletins

547—Beef Cattle Research at the Front Royal Station, 1950-1961. K. P. Bovard. August 1963.

548—The Effect of Defoliation of Four Alfalfa and One Birdsfoot Trefoil Variety on Yield of Tops and Roots. H. T. Bryant and R. E. Blaser. October 1963.

549—Fertilizer Placement Effects on Stand, Growth, Maturity, and Yield of Corn. J. A. Lutz, Jr., H. M. Camper, G. D. Jones, and M. T. Carter. November 1963.

550—Marketing, Slaughter, and Consumption of Hogs and Pork Products in Virginia. M. E. Juillerat. November 1963.

551—Egg Deliveries — Practices and Cost. J. T. Buck. December 1963.

552—Improving the Merchandising of Virginia Potatoes. D. D. Badger. December 1963.

553—Reduced and No-Tillage Practices for Growing Corn in Virginia. W. W. Moschler, J. N. Jones, J. E. Moody, J. H. Lillard, and G. M. Shear. March 1964.

554—Proceedings of the Ninth Annual Experiment Station Staff Conference. R. D. Michael, Editor. June 1964.

555—Yield and Persistency of an Alfalfa-Orchardgrass Mixture as Affected by Cutting Treatment. R. E. Blaser. July 1964.

556—Agriculture and Economic Development. W. L. Gibson, Jr. and D. U. Livermore. July 1964.

557—Feeder Pig Grades as Related to Performance and Certain Carcass Characterisitics. H. R. Thomas. September 1964.

558—Forest Recreation — Estimates and Predictions in the North River Area, George Washington National Forest, Virginia. C. T. Cushwa, B. S. McGinnes, and T. H. Ripley. January 1965.

559—Equitable Pricing of Apples for Processing. J. M. Johnson. June 1965.

560—County Courthouse Records — A Basic Source of Data. J. A. Walrath. April 1965.

561—An Economic Analysis of Corn Harvesting and Handling Systems. P. H. Hoepner and Donald Burrowbridge. May 1965.

562—Temperature and Humidity Effects of Cooking Pot Roasts. Kathryn Philson. June 1965.

563—Underemployment on Virginia Farms. M. E. Juillerat. August 1965.

564—The Value of Combinations of Hay and Pasture with Different Levels of Concentrate for Dairy Cows. H. T. Bryant, R. E. Blaser, R. C. Hammes, Jr., and J. T. Huber. August 1965.

565—Factors Influencing Homemakers' Food-Buying Practices and Their Willingness To Try New Foods and Recipes. Carol Bishop, Blanche Davis, and Laura Jane Harper. September 1965.

Technical Bulletins

164—Effect of Equine Gonodothropic Serum on Ewe Reproductivity. J. W. Gossett, G. H. Kiracose, P. P. Graham, and B. Baker. July 1963.

165—Minor Element Content of Forage Plants from the Central Piedmont Region of Virginia. N. O. Price and W. A. Hardison. July 1963.

166—Resistance to Insecticides by Codling Moth and Red-Banded Leaf Roller. W. S. Hough. September 1963.

167—Use of Plastic Film in Production of Tobacco Seedlings. J. L. LaPrade, J. G. Petty, and W. H. Wills. January 1964.

168—Virginia's Retail Farm Equipment Businesses. Max Glass and Al Ortego. February 1964.

169—Studies of Physical Limnology and Profundal Bottom Fauna. J. C. Roth and S. E. Neff. March 1964.

170—A Methodological Approach to the Estimation of Time-Quantity Broiler Production Functions. P. H. Hoepner. April 1964.

171—Studies of the Host Range and Chemical Control of Fungi Associated with Diseased Tropical Fish. W. W. Scott and C. O. Warren, Jr., (University of Florida). May 1964.

172—A Comparative Study of the Female Copulatory Apparatus of Certain Species in the Spider Genus *Dolomedes* (Pisauridae: Araneae). Paul Carico and Perry Holt. June 1964.

173—Tilt-Up Timber Rigid Frame Buildings. H. T. Hurst, N. F. Meador, and E. L. Townsend. September 1964.

174—Economics of Adjustments for Small Flue-Cured Tobacco Farms, Southside Virginia. R. G. Kline. June 1964.

175—Peanut Acreage Allotments and Farm Land Values. R. F. Boxley, Jr. and W. L. Gibson, Jr. September 1964.

176—Body Composition and Feed Efficiency Changes in Swine. G. W. Litton. October 1964.

177—Minor Element Content for Forage Plants from the Shenandoah Valley and Southwest Virginia. N. O. Price and J. T. Huber. November 1964.

178—Field Experiments with Rock Phosphate in Virginia. W. W. Moschler and J. D. Jones. March 1965.

179—The Wood Frame House as a Structural Unit. Part I — Floor Deflections as Influenced by Various Stages of Construction. H. T. Hurst. June 1965.

180—Optimum Enterprise Combinations for Beef Cow and Calf Farms in Southwest Virginia. J. D. Oliver and R. G. Kline. June 1965.

Research Reports

73—Laying House Environment Study. McNeil Marshall and E. S. Bell. July 1963.

74—Results of Small Grain Varietal Tests Conducted in Virginia in 1963. T. M. Starling. October 1963.

75—Agricultural Progress (Biennial Report of the Station). R. D. Michael, Editor. June 1963.

76—Performance of Hybrid Corn Varieties in Virginia, 1957-1963. Edward Shulkcum. December 1963.

77—Results of Sudangrass and Pearl Millet Performance Tests in Virginia, 1961-1963. P. T. Gish. January 1964.

78—Tomato Variety Trials for Fresh Market. F. H. Scott. January 1964.

79—Canning Tomato Variety Trials — 1963. F. W. Cooler, H. M. Camper, and F. H. Scott. June 1964.

80—1963 Sweet Potato Variety Trials. F. H. Scott and F. W. Cooler. February 1964.

81—1963 Variety Trials — Annual Flowers. Paul Smeal. February 1964.

82—Corn Performance Tests in Virginia in 1963. Edward Shulkcum. January 1964.

83—Estimated Costs and Returns for Selected Crop and Livestock Enterprises in the Cash-Grain Area of Northeastern Virginia. R. L. Chambliss and P. H. Hoepner. March 1964.

84—Performance of Soybean Varieties in Virginia. T. J. Smith and H. M. Camper. June 1964.

85—Economic Corn Production on Congaree Loam. J. A. Lutz, Jr., G. D. Jones, J. E. Moody, and P. H. Hoepner. July 1964.

86—Evaluation of Flue-Cured Tobacco Breeding Material. J. L. LaPrade and J. G. Petty. August 1964.

87—Performance of Tobacco Varieties and Breeding Lines Tested in Virginia in 1963. J. W. Crews, M. J. Rogers, J. L. LaPrade, J. L. Troutman, and R. G. Henderson. August 1964.

88—Fertility Investigations with a Ladino-Orchardgrass Mixture in Southeastern Virginia. D. L. Hallock and R. E. Blaser. September 1964.

89—Response of Soybeans to Gypsum, Lime, and Fertilizer on Three Soils in Southeastern Virginia. D. L. Hallock. August 1964.

90—Va. 331, A Fire-Cured Variety with Black Shank Resistance. R. G. Hendersan, R. D. Sears, and Luben Spasoff. October 1964.

91—Results of Small Grain Varietal Tests Conducted in Virginia in 1964. T. M. Starling. November 1964.

92—Fresh Market Tomato Variety Trials — 1964. F. H. Scott, F. W. Cooler, and H. M. Camper. December 1964.

94—1964 Sweet Potato Variety Trials. F. H. Scott, F. W. Cooler, A. V. Watts, and H. L. Dunton. May 1965.

95—Corn Performance Tests in Virginia in 1964. Edward Shulkcum and C. F. Genter. January 1965.

96—Va. 115 — A New Flue-Cured Variety with Blank Shank Resistance. J. L. LaPrade, J. W. Crews, and M. J. Rogers. January 1965.

97—Results of Sudangrass and Pearl Millet Performance Tests in Virginia — 1962-1964. P. T. Gish. February 1965.

98—Experiments with Annual Lespedeza. W. W. Moschler, P. T. Gish, and T. J. Smith. February 1965.

99—Annual Flowers — 1964 Variety Trials. Paul L. Smeal and Francis J. Marousky. February 1965.

100—Unsuccessful Attacks by the White Pine Weevil in Virginia. H. M. Kulman and D. M. Harman. July 1965.

101—Temperature and Precipitation Predictions for the Holland, Virginia, Area. D. L. Hallock. August 1965.

Southern Regional Cooperative Series

93—Desserts and Snacks Used by Families in the Urban South, with Special Reference to Ice Cream. Blanche Davis, Margaret Collins, Laura J. Harper, and Marian E. Moore. June 1964.

94—Metabolic Patterns in Preadolescent Children. Marian E. Moore. September 1964.

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Articles in Popular Publications

Staff members of the Station have also written a great many articles reporting on research and appearing in less technical magazines, such as *Crops & Soils, Southern Planter, Progressive Farmer, Virginia Fruit, Virginia Poultryman, Virginia-Carolina Peanut News, Vegetable Growers News,* and many others. In addition, many popularized accounts have been prepared by the Information and Publications Department and have been widely used in farm magazines and newspapers and in the *Extension Service News.*

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Statement of Income and Expenditures

July 1, 1964 - June 30, 1965

Income

CURRENT FUNDS:	
Unspent Federal Appropriation from Previous Year	$ 22,969.00
Federal Government Appropriation	1,116,622.00
State Government Appropriation	2,254,706.00
Other Educational and General	5,633.16
Resident Facilities	11,728.60
Sale of Dairy and Farm Products	255,401.47
Total	$3,667,060.23
RESTRICTED FUNDS:	
Commercial Research Grant Balance from Previous Year	$ 190,144.86
Commercial Research Grant	675,552.43
Total	$ 865,697.29

Expenditures

CURRENT FUNDS:	
General Administration	$ 98,437.28
Organized Research	3,385,166.18
Library	11,336.33
Maintenance of Physical Plant	151,899.04
Total	$3,646,838.83
RESTRICTED FUNDS:	
Commercial Research Grant	$ 636,702.58
Total	$ 636,702.58

PLANT FUND ACCOUNTS

July 1, 1964 — June 30, 1965

	Amount of Appropriation	*Spent*
State Insurance Reserve Trust Fund	$ 1,265.00	$ 1,265.00
Drying, Curing and Seed Storage Facility at Holland	1,796.58	.00
Greenhouse at the Tidewater Research Station	15,050.00	854.14
Additional Equipment	105,000.00	105,000.00
Greenhouses	16,000.00	.00
Tobacco Curing Barn at Charlotte Courthouse	3,000.00	468.00
Completion of Beef Cattle Unit at Steele's Tavern	6,500.00	.00
Surplus Property Disposal Fund	5,123.12	3,054.78
Total	$153,734.70	$110,641.92

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Poultry Science

Cecil Edgar Howes, B.S., M.S., Ph.D., Professor (Head)
Eskel Oren Essary, B.S., M.S., Ph.D., Professor
Clayton Ernest Holmes, B.S., Ph.D., Professor
Paul Benjamin Siegel, B.S., M.S., Ph.D., Professor
Alvah Theodore Leighton, Jr., B.S., M.S., Ph.D., Associate Professor
Lawrence Merle Potter, B.S., M.S., Ph.D., Associate Professor
Winston Lewellyn Beane, B.S., M.S., Assistant Professor

Statistics

Boyd Harshbarger, B.A., M.A., M.S., Ph.D., D.Sc., Professor (Head)
Clyde Young Kramer, B.S., M.S., Ph.D., Professor
Raymond Harold Myers, B.S., M.S., Ph.D., Associate Professor
John Grenville Saw, B.S., Ph.D., Associate Professor
Murray Alan Aitkin, B.S., Assistant Professor
Richard Gerald Krutchkoff, A.B., A.M., Ph.D., Assistant Professor
James Pickands, III, B.A., Ph.D., Assistant Professor

Veterinary Science

Douglas Fleming Watson, V.M.D., Professor (Head)
Germille Colmano, B.A., D.V.M., Ph.D., Professor
John William Davis, D.V.M., B.S., M.S., Ph.D., Professor
Robert Trafton DuBose, D.V.M., B.S., M.S., Professor
Walter Burnham Gross, D.V.M., M.S., Ph.D., Professor
Keith George Libke, D.V.M., M.S., Professor
Walter E. C. Moore, B.S., M.S., Ph.D., Professor
John Clark Osborne, B.S., M.S., D.V.M., Professor
Robert Merrall Smibert, II, B.A., M.S., Ph.D., Associate Professor
Thomas Lynn Bibb, B.S., D.V.M., Assistant Professor
Herbert Lamarr Klewer, B.A., M.S., Assistant Professor

Outlying Research Stations

Beef Cattle Research Station, Front Royal

Bob McDowell Priode, B.S., M.S., Superintendent (USDA-ARS)
Kenly Paul Bovard, B.S., M.S., Ph.D., Associate Professor of Animal Science

Eastern Virginia Research Station, Warsaw

Houston Marshall Camper, B.S., Assistant Professor of Agronomy

Northern Virginia Pasture Research Station, Middleburg

Harry Talbot Bryant, B.S., M.S., Ph.D., Associate Professor of Agronomy
Roy Campbell Hammes, Jr., B.S., Assistant Professor of Agronomy
James Robert Peterson, B.S., M.S., Instructor

Piedmont Research Laboratory, Charlottesville

Marvin Lester Bobb, B.S., M.S., Ph.D., Professor of Entomology
Edsel L. Phillips, B.S., M.S., Associate Professor of Horticulture

Piedmont Research Station, Orange

George Davis Jones, B.S., Assistant Professor of Agronomy

Shenandoah Valley Research Station, Steeles Tavern

Archie McFarland Woodside, B.S., M.S., Associate Professor of Entomology
William Howard McClure, B.S., M.S., Assistant Professor of Animal Science

Southside Virginia Research Station, Charlotte Court House

Robert Daniel Sears, B.S., Assistant Professor of Agronomy

Southwest Virginia Research Station, Glade Spring

Frank Shannon McClaugherty, B.S., M.S., Assistant Professor of Animal Science

Tidewater Research Station, Holland

Henry Marshall Clark, B.S., Professor (Superintendent)
Kenneth Howard Garren, A.B., M.A., Ph.D., Professor of Plant Pathology (USDA-ARS)
Lawrence Ingram Miller, A.B., M.S., Ph.D., Professor of Plant Pathology
George B. Duke, B.S., Associate Professor of Agricultural Engineering (USDA-ARS)
Daniel Leroy Hallock, B.S., Ph.D., Associate Professor of Agronomy
Horace Randolph Thomas, B.S., M.S., Associate Professor of Animal Science
Morris Wilburn Alexander, B.S., M.S., Assistant Professor of Agronomy
John Cole Smith, B.S., M.S., Ph.D., Assistant Professor of Entomology

Tobacco Disease Research Station, Chatham

John Lovelace LaPrade, B.S., M.S., Associate Professor of Plant Pathology
Joseph Lawrence Troutman, B.S., Ph.D., Associate Professor of Plant Pathology
Wirt Henry Wills, B.A., M.A., Ph.D., Associate Professor of Plant Pathology

Tobacco Research Station, Chatham

Clarence Benjamin Dominick, B.S., M.S., Associate Professor of Entomology

Malcolm James Rogers, B.S., Assistant Professor of Agronomy

Virginia State College Research Station, Petersburg

Millard Tennyson Carter, B.S., M.S., Associate Professor of Agronomy

Winchester Research Laboratory, Winchester

Ancell Byron Groves, B.S., M.S., Ph.D., Professor of Plant Pathology

Clarence Howell Hill, B.S., M.S., Ph.D., Professor of Entomology

George Robertson Williams, B.S., M.S., Professor of Horticulture

George Calvert Rock, B.S., M.S., Ph.D., Assistant Professor of Entomology

John Joseph Albert, B.S., M.S., Instructor

Deceased

Dr. Julian Wright Crews, assistant professor of agronomy, died April 13, 1965 from injuries in an automobile wreck two weeks earlier. He was only 29 years old. Dr. Crews received B.S. and M.S. degrees at the University of Georgia, the latter in plant breeding in 1958, and the Ph.D. in the same field from North Carolina State University in 1961. He was a native of Hoboken, Ga. His work dealt with breeding and evaluating flue-cured tobacco varieties, searching especially for disease resistance.

Retired

Peyton Terry Gish retired April 13, 1965, closing out many years of agronomic research and teaching that began when he became superintendent of the Shenandoah Valley Research Station in February 1926. Except for a year of graduate study at VPI, he was in charge of that station until its closing in 1957, at which time Mr. Gish joined the agronomy research work on campus. He obtained a B.S. degree from VPI and a master's in 1931. He also did graduate work in biology at the University of Virginia.

Robert Catchings Moore retired June 30, 1964, ending 42 years of service in horticultural research, which began shortly after his graduation from VPI in 1922. His undergraduate work was interrupted by World War I, during whih he served several years with the Marines. He received an M.S. degree from VPI in 1932. Breeding new varieties of fruit and evaluation of nut varieties and of various fruit-growing practices were his chief fields. He has been most successful in breeding new grape varieties.

Closing out the longest VPI research career on record, **Samuel Andrew Wingard,** head of the department of plant pathology and plant physiology, retired November 1, 1964. Dr. Wingard, a native of Alabama, received his B.S. and M.S. degrees from Alabama Polytechnic Institute in 1916 and 1917. He joined the VPI staff in 1917 and received his Ph.D. from Columbia University in 1925. As department head he supervised research on many plant disease problems but was best known for his own work in developing disease-resistant varieties of beans.

On June 30, 1965 **Harold Newell Young** turned over the directorship of the Virginia Agricultural Experiment Station to his successor, Dr. Coyt T. Wilson. Dr. Young had been director since 1946 and before that had been head of the department of agricultural economics and rural sociology for 15 years. He received his B.S. degree from Cornell in 1917, served in the armed forces during World War I, headed the animal husbandry department of New York State School of Agriculture, and then earned his Ph. D. degree from Cornell just before coming to VPI in 1930. As department head and as director, he has served on many important state and national committees and commissions associated with agriculture and has, of course, written widely, especially in the field of economics.