



# Agricultural Progress

Virginia Agricultural Experiment Station---Research Report 75



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*Virginia Agricultural Experiment Station*

RESEARCH REPORT 75, DECEMBER, 1963

This report covers the results of research on agricultural and home economics problems conducted by the Virginia Agricultural Experiment Station from July 1, 1961 to June 30, 1963.

Only the principal highlights of the Station's research results are presented in this report. More complete information is given in other publications. A complete list of publications issued by the Station, and a list of articles written by members of the staff and published in scientific journals and elsewhere, is contained in the later pages of this publication. Also given is a list of all research projects now underway.

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 for 75 years.

## **We Acknowledge with Gratitude---**

The contributions made by the United States Department of Agriculture and other divisions of government are a part of the research reported in this publication. Business and industrial organizations, as well as private individuals, have contributed funds or other material aid. Many farmers have supplied land on which experiments have been conducted. Acknowledgments as related to each item reported would be unduely long; therefore, the Experiment Station here takes grateful recognition of the aid received from these various sources.



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## Foreword

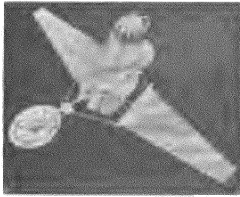
Agricultural is the largest single industry in Virginia. It is comprised of farmers, those businesses which supply farmers with equipment, supplies, and services, and those businesses which manufacture and market farm products. The Virginia Agricultural Experiment Station serves the total industry of agriculture and all consumers of food.

The Virginia Agricultural Experiment Station is part of a nation-wide system of agricultural experiment stations. It is supported jointly by State, Federal, and private funds. While it serves the entire nation as well as the State, it belongs primarily to the people of Virginia. It is *your* experiment station — whether you are a farmer, a supplier of farm machinery and equipment, or of raw materials for farm production; whether you are a manufacturer or distributor of the products of the farm, a city dweller, or a housewife.

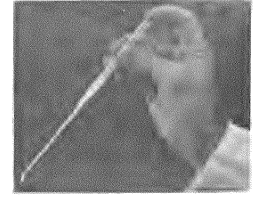
The research program of the Agricultural Experiment Station deals with problems ranging from the soil to the consumer, and includes those of the home. It includes basic as well as applied research. Its efforts provide the foundation upon which technological improvements in agriculture are made. The Agricultural Experiment Station develops information for the improvement of housing, home management, foods and diets, family economic planning, and human nutrition. Research at this and other stations is the foundation for the Resident Instruction and Extension Educational programs of the Colleges of Agriculture and Home Economics and in high schools throughout the State.

Under conditions imposed by the ever-increasing tempo of change, the most important single problem facing agriculture and the American home is that of adjusting to change. In the struggle to adapt to change, science and education occupy key positions. That segment of the economy which does not make use of them is doomed to occupy a subordinate position in the economic world.

*Harold N. Young, Director*



# Soil, Land, and Water



## The Laboratory

Many plant food elements are held on clay minerals in soils by electrical attraction, otherwise these elements would leach out of the soil with the first heavy rain.

Research is underway to determine how different plant food elements are held by clay minerals in soils and released to growing plants.

Many clay minerals in Virginia's soils are related to the mica minerals from which they have often formed. Every "rock-hound" knows how mica splits apart. This splitting can be continued to a sub-microscopic scale to the basic sheets, only 25/10,000,000 inch thick. Between these thin sheets (see illustration) water and plant food elements (the positively charged ones) occur. Because some sheets remain together, potassium, a natural component of mica, is trapped. Where the sheets are only partially open, small plant food elements (ions) such as potassium ( $K^+$ ) and ammonium ( $NH_4^+$ ) can enter but elements such as magnesium ( $Mg^{++}$ ), large because of the water molecules attracted to them, are excluded.

Potassium must be exchanged by another ion before plants can use this vital element. A knowledge of the structure of the clay minerals is important to an understanding of how plants obtain this and other nutrients.

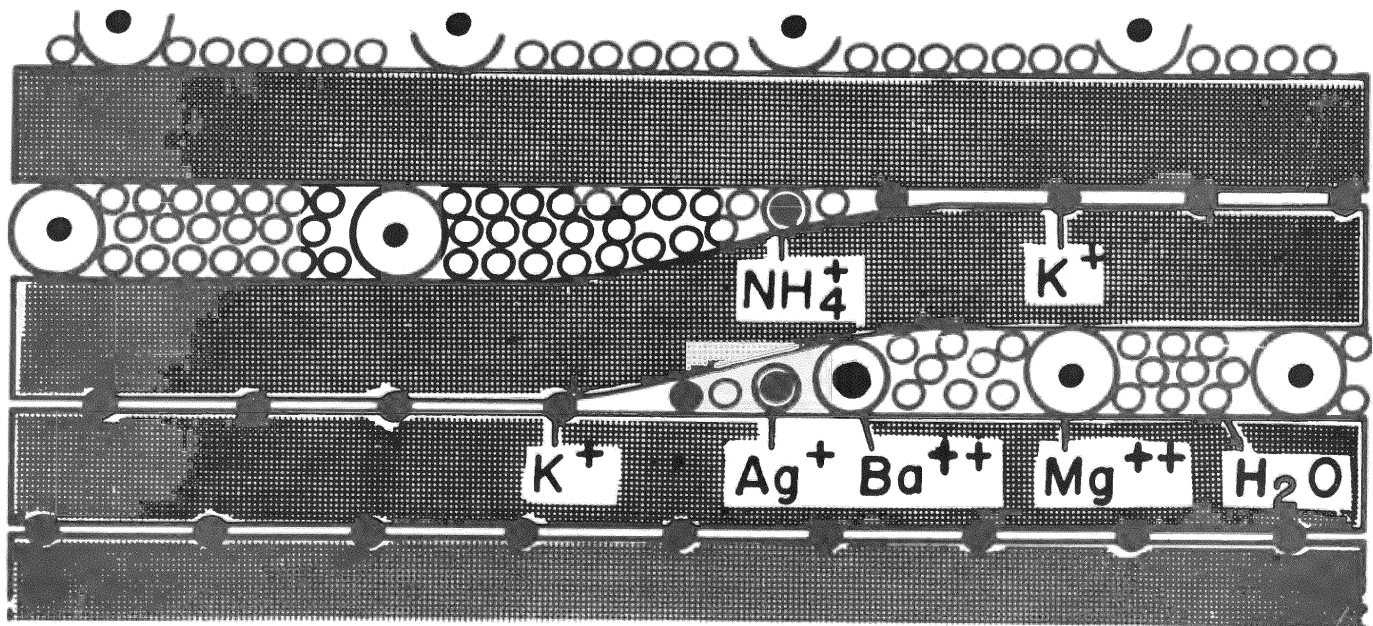
Research indicates that potassium is easily exchanged when the mica layers are far apart, but when this element is in the wedge-like places, it can be easily used only under acid conditions; then, small positive charges (protons)

are responsible for potassium exchange. Potassium is not available to plants when trapped between the layers.

## The Kind of Soil Predetermines Use

The suitability of a soil for both agricultural and non-agricultural uses depends largely upon the physical properties of that soil. The rapid increase in urban development in recent years has created a demand for more detailed soils information by a diversity of non-agricultural users.

Measurements which include swelling pressures, pore space, plasticity, bulk density, and moisture characteristics of several Prince William County soils were recently completed. These data strengthen the soil survey information available on these soils and in general confirm previous evaluations. Several soils have unfavorable physical properties for septic field use. For instance, Beltsville soil has a compact fragipan (bulk density 1.83, non-capillary porosity 6.7%). The Iredell soil and the Silty and Clayey Sediments exhibited high swelling clays throughout. The B2 horizon of the Iredell soil, in particular, showed shrinkage over almost its entire moisture range, slow wetting and very high swelling pressures of compacted samples (5,725 lbs./sq. ft.), little non-capillary porosity (4.0%), and low available moisture capacity (.10 inch/inch soil). In contrast the Penn soil showed very little swelling (875 lbs./sq. ft.), medium shrinkage, high non-capillary pore space (15.3%), and relatively large available moisture capacity (.17 inch/



A diagram showing how one plant food element, potassium ( $K^+$ ) is trapped between the closed silicate layers of mica and how exchange of potassium is affected by the size of other plant food elements. Magnesium ( $Mg^{++}$ ) is too large to exchange the small potassium ( $K^+$ ) when it is located at the wedges in the silicate sheet.

inch soil). This soil has good internal water movement, but the Iredell has very poor water behavior.

Since data of this nature is very useful in evaluating different soils, a laboratory is being set up to make measurements of this kind.

### Water in the Soil

Where does the water come from that keeps trees alive in extremely dry periods? The water table is usually more than 18 feet below the land surface and may be very much deeper. Ground water, which fills wells, will rise in rock or soil by capillarity only a short distance above the water table. Few trees can reach down to water tables for their water needs. Consequently, ground water is usually not the water that trees and crops use.

Most of the water that plants use in times of severe drought is stored as suspended or capillarily held water. Water so stored in the soil moves very slowly. The crops will extend their roots into moist but not dry soil.

Work with a Lodi loam shows that it will hold in its top 20", about 2¼" of capillarily stored water that trees and crops can use. When this is gone, the soil will still not be entirely dry but the remaining moisture is held very tightly. To a depth of 9 feet this soil could hold approximately 9 inches of water, equivalent to 243,000 gallons per acre. In spite of this amount of water the soil will be *only moist* — not wet. To fill the available water storage capacity, this 243,000 gallons per acre must enter the soil at the surface and move downward after each overlying layer is filled to its capacity. Usually the available water capacity of soil is filled in the winter or spring.

An acre of trees or crops can transpire more than ¼" of water a day, if the water is plentiful and weather conditions favor evaporation and transpiration; this amounts to 6,750 gallons of water per acre per day. As the loosely held water is used, transpiration slows down until the plant is no longer growing, and if this continues, the plant may die.



Shallow soils like this have very little storage capacity for water.

Since capillarily stored water is the source for use of trees and crops, and since soils vary greatly in available moisture-holding capacity, this project will be extended to determine the capacity of important soil types.

### Runoff Rates and Watershed Yields

In continuing hydrology studies, major research effort has been directed toward characterizing the important physical factors of ten experimental watersheds, such as land use, soil types and capabilities, soil moisture relationships, and topographic features. As data are collected, suitable programs for electronic computation and card storage are devised. Computer programs will be developed to relate these major watershed characteristics, singly and in various combinations, to rainfall and runoff records from each area. This is a comprehensive long-time research program but tabulations are kept current and used to meet the need for more efficient design of water control and retention structures on farms and in the small watershed development programs.



This runoff gaging station located on Powell's Creek in Halifax County, uses a Virginia V-notch weir for low-flow measurement and, in the corrugated stilling well at the right, an automatic flow depth recorder. A 1.3" per hour runoff from the 182-acre watershed has been recorded.

## Land Forming

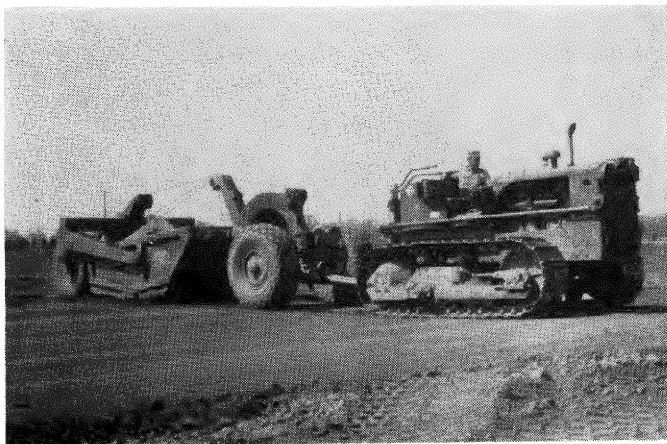
### Improved Surface Drainage

Surface irregularities of only a few inches in magnitude can greatly affect the optimum timing of tillage and planting operations, production costs, and crop yields. Studies on Elkton soil near Norfolk, Va., show that land forming will (1) eliminate the costly "hand" draining of individual wet spots, (2) permit two or more times the normal spacing between lateral ditches, (3) allow more efficient use of field machines by providing larger areas between ditches, more uniform soil drying, better timing of the operations, and fewer "bog" downs, and (4) optimum yields.

A companion study on a large, very flat Piedmont river bottom soil in Culpeper County indicated that land-forming is equally well suited in that area on surfaces sufficiently irregular to impede surface drainage. Uniform drying in

early spring is a particularly significant advantage. The 3-year average yield of approximately 112 bushels of corn per acre after forming was more than double the long-time average for the field prior to forming.

Forming cost may range from about \$40 to \$100 per acre.



**Upper photo — Land forming large areas means moving several hundred cubic yards of earth per acre, requiring large earth movers for efficient operation.**

**Lower photo — Precise grades are required and the land plane does the final smoothing very effectively.**

### Improved Tobacco Culture

Good soil and water conservation, effective individual row drainage, alternate strip rotation with sod, ease of irrigation, and a layout favorable for mechanization of tobacco production are aided greatly by appropriate land forming. Studies are being made to find the best grading methods to meet the critical seedbed requirements of tobacco and still provide optimum advantages.

Three forming procedures were used: (1) the topsoil was stockpiled, the land graded, and the topsoil respread, (2) the area was graded and topsoil hauled in to provide minimum depth of 0.3 feet, and (3) the area was formed without regard for topsoil position. Average yields in 1962 ranged from 1,875 pounds per acre to almost 2,300 pounds. The highest yield came from the plots formed without regard for topsoil position but with a high moisture level maintained with irrigation. The studies are being continued.

### Microclimate Affects Plant Growth

Most plants used for forage and turf are relatively low-growing and respond to changes in the climate very near the ground (microclimate). Temperatures at 5' above the soil as shown in weather records do not reveal what the temperature near a germinating seed might be. There is even a large difference in temperature at times between the soil surface and the air 4" above the soil.

While microclimate affects plant growth, the plants also alter their own microclimate by their growth. At noon on August 6, 1962, for instance, when seedlings were small, the soil surface temperature was 100°. On August 29, however, the ladino clover and orchardgrass seedlings completely shaded the soil thereby reducing soil surface temperature to 80°. The temperature 4" above the soil was about the same for these two dates. On July 1, 1963, at 4 P.M. soil surface temperatures in a 2-year old orchardgrass sod were as follows: (1) mowed to 1", not irrigated — 128°; (2) mowed to 1", irrigated — 110°; and (3) unmowed, irrigated — 90°. Air temperature 5' above the soil at the same time was 90°.

Controlled environment chambers are being used to study the effect of temperature and light on the growth of forage plants. It appears that orchardgrass seedlings might be better suited to the cool spring and fall temperatures. Orchardgrass tillered more (produced more new shoots) with 60:70° F. night:day temperatures than at higher or lower temperatures.

Microclimate affects the chemical composition of plants in addition to regulating growth. For example, Kentucky 31 contains more water-soluble carbohydrate in the leaves in late fall than in spring or summer. This is thought to be a temperature effect which has also been observed with plants grown at different temperatures in controlled environment chambers.

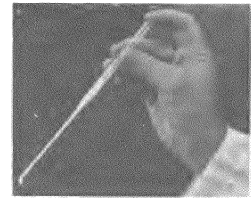
The buildup of soluble carbohydrate in late fall may be associated with a decrease in growth rate as temperatures drop. With slow rates of growth, the demand for energy by the plant decreases; hence, energy trapped by photosynthesis is stored in the leaves and stems as soluble carbohydrate.

There is a meager understanding of the interplay of microclimatic factors on the yield and quality of crops. Higher crop yields may well result from knowledge of the function of microclimate factors. The success of turf seedlings on difficult highway road bank sites depends to a large degree on knowledge of microclimate and how to deal with it. Success or failure of pasture seedings, too, often depends on an understanding of microclimate. Many factors in the microclimate can never be controlled, but an understanding of the function and interplay of such factors will aid in culture and management programs.





# Field Crops and Woodlands



## Fertilize Wisely

In the past few years, much more attention has been directed toward the agronomic-economic production of crops in Virginia. It is no longer a question of applying several hundred pounds per acre of fertilizer and expecting a high yield of a particular crop. Instead, it is a matter of determining the competitive ability of soils for crops and then to maximize profits through wise fertilization.

Experiments were conducted last year, and are still in progress, on Congaree loam to determine the maximum yield of corn that can be produced on this soil and what levels of N, P<sub>2</sub>O<sub>5</sub>, and K<sub>2</sub>O will give the most profitable yield. Last year a maximum of 207 bushels per acre of corn was obtained with 300, 200, 200 lbs. per acre of N, P<sub>2</sub>O<sub>5</sub>, and K<sub>2</sub>O respectively, plus 28 tons per acre of manure. When P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O were each applied at the rate of 200 lbs. per acre, the most profitable rate of N was 197 lbs. per acre.

Experiments have been established this year to determine the economic production potential of the Frederick soils for corn (silage and grain) and alfalfa, and to determine the competitive ability among various soils for different crops. Various levels of N and K<sub>2</sub>O along with an adequate level of P<sub>2</sub>O<sub>5</sub> are being used for the corn. Various levels of P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O are being used for the alfalfa. No data are available as yet.



Corn response to levels of nitrogen (N) on Congaree loam in Orange County in 1926 when phosphorous (P<sub>2</sub>O<sub>5</sub>) and potash (K<sub>2</sub>O) were adequately and uniformly applied. Because of limited rainfall in 1963, irrigation was necessary, but equally good results from fertilizer applications were obtained.

## Corn Without Tillage

One of the first requirements for success in growing corn on an untilled sod is that most of the sod vegetation be killed before the corn is planted. If much live vegetation is left to compete for moisture, the corn is likely to fail. Atrazine 80% at the rate of 5 pounds per acre applied several weeks before corn planting has given effective kill of orchardgrass, fescue, timothy, bluegrass, red clover, as well as many weedy species, when rainfall was plentiful. Plants not killed by this treatment include horse nettle, dewberry, indian hemp, wild sweet potato, and broomsedge.

Studies are underway to find other chemicals, or combinations of chemicals, that will give effective kill of all vegetation encountered. It has been found that combining Atrazine and Paraquat results in a much more rapid kill of the sod and also allows for a reduction in the amount of Atrazine needed. This is important since, in dry weather, sod kill is too slow with Atrazine alone, and because Atrazine at the rates found effective may create a residue problem for succeeding crops. A mixture of Paraquat and Atrazine has given excellent kill of a small grain sod in which corn was to be planted.

Earlier reported results were obtained from hand-planted plots, since no mechanical planters had been adapted to sod planting. Although a number of problems are yet to be solved, several machines for planting in sod are now in use. Research to perfect such planters will continue.

Fertilization studies have indicated that the surface application of fertilizer in the no-tillage procedure is effective. Phosphorus has been found to be absorbed as rapidly when applied in this way as when mixed thoroughly with the soil.

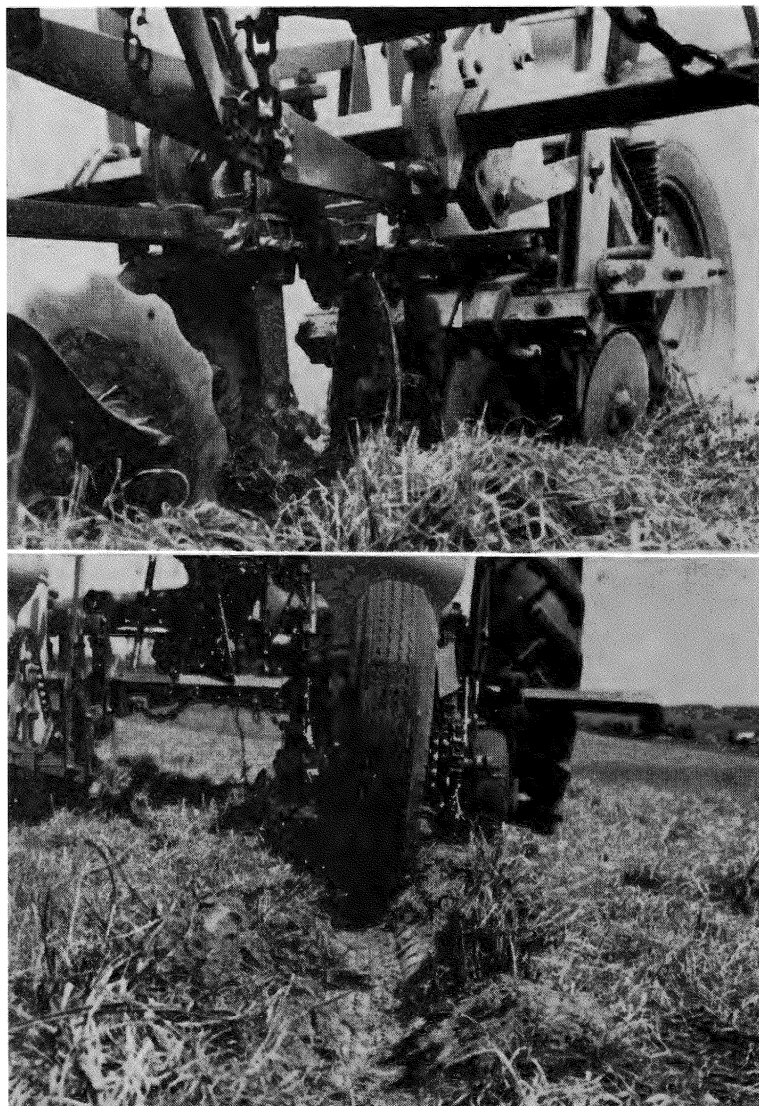
Rotation experiments have been built around no-tillage corn. One of the leading possibilities appears to be no-tillage corn followed by one or two years of grass-

Mechanically planted corn in dead sod. Note almost complete absence of soil disturbance.



legume sod. Another one being studied is no-tillage corn followed in the second year by corn grown with wheel-track-planting, then gress-legume sod for one or more years. Both of these rotations offer the opportunity to intensify corn production and at the same time to minimize the possible harm on succeeding crops of the herbicides used in growing corn. A continuous silage corn experiment in which winter cover crops are used is also under study.

Studies of the time of planting no-tillage corn indicate that soil temperature and moisture are important considerations. The soil under a sod mulch warms up a little more slowly in the spring than does plowed land. It also retains more moisture. In one experiment no-tillage corn planted on May 18 yielded significantly more than corn planted in tilled soil the same day, whereas there was no difference in yield between the two when both were planted May 3. The yield advantage of the later planting was attributed to reduced evaporation of moisture because of the sod mulch. In 1962 the two methods were compared under



Top photo (left to right) shows rolling coulter, narrow chisel (2½" depth) and angled hiller (½" depth) preceding corn opener. Lower photo shows pneumatic-tired press wheel.

supplemental irrigation. Conventionally tilled corn yielded as much as no-tillage corn but it required approximately 3 inches more of irrigation.

## PLANTING EQUIPMENT

Research has shown the importance of air, moisture, temperature, and mechanical treatment relationships of the soil in the immediate vicinity of the seed. Limited cooperative studies to date indicate that mechanical planting requirements may vary somewhat for different soil and cover conditions. However, for uniform planting and optimum seed germination, planter requirements will generally include:

1. Assisting tools in front of a conventional planter corn opener to (a) insure uniform penetration, (b) provide limited subsurface tillage in the immediate seedling environment, and (c) remove enough dead sod from the row surface to allow corn plants to emerge.
2. A seed press wheel to firm the corn grains into the soil and a coverer to completely close the slit opened by the corn opener so as to eliminate air pockets near the seed.
3. A press wheel of appropriate shape and pressure to firm the soil over the seed row.

Controlled laboratory and field experiments are continuing to determine more precisely the minimum soil disturbance around the seed and the proper compaction of the soil over the seed for best germination and plant growth in the no-tillage seedbed environment.

## Other Tillage Research On Corn and Soybeans

*Wheel-track planting* (no discing or harrowing) of corn and soybeans in the past two years has resulted in yields as good as those obtained with conventional soil preparation. The practice is best adapted to the Coastal Plain and to alluvial soils along streams.

*Lister-mulch planting* of corn and soybeans has also shown promise in the Coastal Plain. It affords a fast method of planting soybeans behind small grains, where speed is highly desirable because delays mean reduced yields. The implement used lists the land and plants two rows of soybeans or corn in the furrows between the ridges in a one-trip operation. Yields comparable to those obtained with conventional methods have been made with soybeans following small grain, and with corn on land in soybeans the previous year. Such land is normally relatively free of weeds and planting the corn with only enough row preparation to get the seed covered has given good stands and yields. Corn planted in this manner in 1962 produced a yield of 97 bushels per acre, about the same as yields attained by conventional tillage. Weed control was obtained with a pre-emergence herbicide.

Wheel-track and lister-mulch planting, when properly contoured, afford control of soil and water loss on sloping land.

## Improvement of Varieties Through Breeding and Testing

Research at V.P.I. should lead to additional improved varieties of corn, tobacco, wheat, soybeans, peanuts, oats, alfalfa, trefoil, and orchardgrass for use by Virginia farmers. Much of the research is cooperative among departments. While considerable effort is devoted to varietal development per se, many studies seek fundamental information which will provide a basis for future breeding programs. These studies are designed to evaluate the effectiveness of various breeding procedures, to learn how characters are inherited, and to learn more about the nature of gene action involved in determining yield in various types of crop species.

### Barley

Breeding resistant varieties is a basic procedure in plant-disease control and is the only logical and economical method for the control of some diseases. At V.P.I. the barley breeder and pathologist are cooperating in the breeding of disease-resistant varieties and in studying the inheritance of resistance to leaf rust, powdery mildew, and scald.

In the leaf rust studies, 5 loci for genes controlling resistance have been identified. Studies to determine the linkage relationships with other characters are being made. The relationship of the genes conditioning seedling resistance in 40 barley varieties to race 9 of powdery mildew have been studied. Four of the varieties had two genes for resistance. The data on inheritance of resistance to scald indicate a single gene for resistance in most of the varieties.

### Corn

An experiment is underway to determine whether better inbred lines of corn can be expected from selections based on the performance of first generation selfed progeny or from selections made on the customary basis of test-cross performance. The best plants as determined by each method were selected and the plants within each group were intercrossed to form recombined synthetic varieties. A second cycle of selfing or test-crossing, evaluating, and recombining was then completed. After the two cycles, the recombined synthetic varieties were compared for yield.

	Yields per Acre			
	SELFED PROGENY		TEST-CROSS	
	Cycle 1	Cycle 2	Cycle 1	Cycle 2
Long Ear Synthetic	98.0	109.8	88.1	95.3
Southern Synthetic	103.9	112.1	98.6	109.4

The study will continue, repeating these comparisons at other locations and in other years. Information from these studies should provide a basis for determining the relative merits of first-generation selfed progeny performance versus test-cross performance for early generation evaluation of inbred lines of corn.

### Orchardgrass

A new synthetic variety, Virginia 58-V-1, is being evaluated at six locations in Virginia. This new strain is leafy, has some resistance to leaf diseases, and is about ten days later than commercial orchardgrass. The lateness may make it of value for growing with alfalfa or for spreading out the peak production period of orchardgrass in the spring. Preliminary data also are being obtained on the performance of 22 experimental synthetic varieties which range from early to late in maturity. The inheritance of factors for rust resistance are also under study.



**A — Powdery mildew. B — Barley scald. Research is concentrating on the development of resistant varieties as a means of reducing damage by these diseases.**



**Sudangrass — Millet varietal test at the Piedmont Research Station, Orange.**

## Peanuts

Virginia 61R, a high-yielding Virginia runner type peanut, is being increased and will be recommended to growers in 1964. Selected from farmers' stock peanuts (Atkins runner), this variety is well adapted to varied soil types and conditions in Virginia. In numerous tests at several locations for 6 years, Virginia 61R has outyielded Virginia 56R by approximately 7%. Virginia 61R averaged 72% fancy pods, 27% extra large kernels, and 69% sound, mature kernels as compared with 76% fancy pods, 33% extra large kernels, and 70% sound, mature kernels for Virginia 56R. The thick shell of Virginia 61R makes it suitable for roasting in the shell.

A population of southern corn rootworms resistant to chlorinated hydrocarbon insecticides was first observed in Virginia in 1958. Since then researchers have been evaluating lines and selections of peanuts for resistance to the rootworm and other insect pests. Approximately 2,350 plant introductions have been screened and different degrees of resistance have been observed. Several highly resistant lines have been crossed with high-yielding Virginia type peanuts in an effort to develop high-yielding peanut varieties resistant to the rootworm.

## Flue-Cured Tobacco

Flue-cured tobacco producers are troubled more or less by mild to severe infestations of black shank, root knot, root rot, or mosaic on approximately 70% of Virginia farms. While fairly satisfactory varieties are available to combat black shank and root rot, none has been released carrying multiple resistance to these diseases. Two families of breeding line, one carrying resistance to black shank, root rot, and mosaic, and the other to black shank, root rot, and root knot, have been developed. A promising selection from each group is currently being tested under farm conditions to determine grower and trade acceptability. Second generation material combining the resistance factors of both groups is being grown for further evaluation.

## Trefoil

Several hundred clones of trefoil have been evaluated by the polycross method and one synthetic has been produced and is being tested. Several other synthetics varying in growth type are being constituted. Phenotypic recurrent selection is being conducted with three basic populations — one consisting of erect plants selected at Blacksburg, another of erect plants selected in eastern Virginia, and the third of plants selected with decumbent growth type.

Caged bees are being used to pollinate synthetics in the first and second generations. Since isolation from other clones, as well as good cross-pollination, is difficult under field conditions, this technique of using caged bees appears to have considerable value for constituting synthetics and for certain types of studies.

## Silage Studies

### To Fatten Cattle

Research at the Northern Virginia Pasture Research Station shows that all hays and silages from perennial grass-legume mixtures fed alone are too low in energy (total digestible nutrients) to get maximum gains or milk production. Other work shows that corn silage made from an early maturing hybrid with a high ear-to-stalk ratio is essentially an energy concentrate, as the total digestible nutrients average about 70%. About 20 tons of corn silage per acre, 30% dry matter, is produced per acre. Such high yields of high energy silage are obtained by using good management practices (adapted varieties, liberal fertilization, weed control, early planting, and harvesting when



"Exotic" varieties of corn from Mexico and Central America are crossed with varieties adapted to Virginia to see if improved corn varieties can be developed.



the corn is in an early to medium dent stage). The ears make up more than 50% of the dry matter when harvested for silage.

Research is also underway to improve the palatability and hence the consumption of grass-legume silages. Wilted (low moisture) alfalfa-orchardgrass silages have been found to be about as high in digestibility as non-wilted (high moisture) silages, but cattle eat much more low-moisture silage — why, we do not know. There has been no spoilage when wilting alfalfa-orchardgrass mixtures to 45% moisture before ensiling.

Early cut alfalfa-orchardgrass silages averaged around 60% of TDN on the dry basis compared to 70.6% for corn silage. The composition data show that corn silage is typically low in crude protein and fiber, but high in energy value. Alfalfa-grass silages were much higher in crude protein and crude fiber than the corn silages. The low-moisture silage has been found to be higher in crude protein content than the high-moisture alfalfa-orchardgrass silage.

### RATION TESTS

Various rations high in silage were fed to fattening steers, as shown in the table. Such high-silage rations were used because Virginia does not produce enough cereal grains for livestock and also because silage rations cost less than rations made up of mostly grain. Silages were fed for a period of 140 and 168 days during the last two years, respectively. The data for two years show average daily gains of 2.02 lbs. for steers fed a high-grain fattening ration as compared with 1.87 lb. daily gain with the corn silage-cottonseed ration. The carcass grades were in the top good to low choice category; the fattening ration gave only slightly higher grades. This points out that corn silage is a near-concentrate feed.

Feeding value of high forage rations compared with a fattening ration (2-year average).			
Rations	Daily average per head		Carcass grade**
	Liveweight gain	Dry matter consumed	
1. Fattening ration*	2.02	2.4	12.1
2. Corn silage + 2 lb. CSM	1.87	1.86	11.7
<b>Alfalfa-orchardgrass silage</b>			
3. High moisture alone	0.30	1.39	7.9
4. Low moisture alone	1.09	1.89	9.3
<b>High moisture</b>			
+ 8 lb. EC	1.68	1.89	10.7
<b>Low moisture</b>			
+ 8 lb. EC	1.70	2.16	11.3
<b>Fed 80% corn silage, 1.75 lb. CSM and 20% of alfalfa-grass silage:</b>			
7. High moisture	1.81	1.91	11.9
8. Low moisture	1.82	1.89	11.5
9. As 8, but hay replaced alfalfa-grass silage	1.68	1.68	11.5

\*Full feed ear corn meal, 2 lb. CSM, 3 lb. hay and 15 lb. corn silage daily. Symbols: EC — ground ear corn; CSM — cottonseed meal.

\*\*Grade score: 10 — good; 11 — top good; and 12 — low choice.

When steers were fed alfalfa-orchardgrass silage, the daily liveweight gains from the high-moisture silage were about one-third as good as those fed low-moisture silage. These silages actually had similar feeding value, but the big difference in liveweight gain is attributed to the low consumption for the high-moisture silage. The adding of 8 lb. of ear corn meal improved the gains and grade over either silage fed alone. Adjusting the rations to 80% corn silage and 20% of silage, either high or low moisture alfalfa-grass silage, with 1.75 lb. of cottonseed meal gave gains and consumption values about as good as those for corn silage alone. When alfalfa hay was substituted for alfalfa-orchardgrass silage, the gains were not quite as good as when the forage was all silage.

It may be concluded that corn silage is an excellent forage that is eaten in large amounts and steers may be fattened with it. Alfalfa-grass silages are lower in energy than corn silage and reducing the moisture content before ensiling improves the consumption when the silages are fed. High-forage rations may be used for fattening cattle by lengthening the feeding period.

### For Milk Production

Experiments were conducted during the last two years to evaluate the feeding value of corn silage for milk production when harvested at two stages of maturity: when the grain was in an early milk stage (immature corn silage), and approximately 20 days later, when the grain was medium-dented to well-dented (mature corn silage).

The yield of shelled corn in the silage and tons of silage per acre, based on random sampling in the field, are given in table 1. Immature silage had 1 lb. of shelled corn in every 27 lbs. of silage and mature corn silage 1 lb. of shelled corn in every 8 lbs. of silage. The ears made up

Table 1. — Characteristics of corn silage at different maturities used for milk production studies.

Maturity of grain at harvest	Yield per acre		% dry matter in	
	Grain	Silage	Ears	Stalks
Milk stage	24 lb.	18 T.	25.1%	20.1%
Dent stage	112 lb.	24 T.	51.1%	21.7%

Table 2. — Immature corn silage (grain at milk stage) compared with mature corn silage (grain at dent stage) as forage for dairy cows.

Rations	Dry matter intake		
	Daily 4% fat corrected milk	Corn Silage	Total
Immature corn silage and cottonseed meal	32.4	1.54	1.90
Mature corn silage and cottonseed meal	33.2	2.72	3.04
Immature corn silage, hay, and 16% protein	31.5	1.46	2.58
Mature corn silage, hay, and 16% protein	32.5	2.04	3.11



about 27% of the total weight of the immature silage as compared to 50% in the mature corn silage. The immature silage was higher in crude protein, crude fiber, and ash, and lower in ether extract and nitrogen-free extract, than the mature corn silage. The loss of nitrogen-free extract through the ensiling process was 86% with the immature corn silage as compared to 97% for the mature corn silage.

The four rations fed to milk cows are given in table 2. The daily milk production was about as good when cows were fed immature as mature corn silage, even though the cows ate much more mature silage. Milk production was just as good for the corn silage-cottonseed mixtures as for conventional feeding of corn silage-hay-concentrate mixtures.

In a palatability experiment the cows had access to mature and immature corn silage. They consumed 0.16 lb. of immature silage per 100 lb. liveweight as compared to 2.00 lbs. of the mature corn silage. The mature corn silage was a little higher in digestibility than the immature corn silage.

### **Insects Affecting Forage**

The alfalfa weevil, most damaging forage crop pest in eastern United States, is now present in every county in Virginia. Heptachlor has been effective in protecting the alfalfa from the weevil for 8 years, but 1962 fall applications of the insecticide were ineffective in many areas. In 5 widely separated areas east of the Appalachians, the weevils were found to be highly resistant to heptachlor. Another reason for the poor control with fall treatments may be that the habits of the alfalfa weevil are changing. The weevils are laying a greater proportion of their eggs in the spring. Consequently, there are greater numbers of larvae in the summer and there are occasional fall outbreaks.

Spring sprays with malathion or methoxychlor are recommended for control of alfalfa weevil larvae. A number of new insecticides show promise for the control of this pest and their use awaits residue clearance. The dispersal of the alfalfa weevil has been studied by trapping and tagging weevils with paint and fluorescent powders. The primary flight periods during 1962 were in June and July, and in early December. These are the periods in which resistant beetles may move into new areas.

### **Weeds in Field Crops**

Interest in the use of herbicides for weed control in field crops is rapidly increasing. The use of herbicides in corn, peanuts, and, to a lesser degree, soybeans, has increased appreciably in the last two years.

### **PEANUTS**

Herbicides that are safe to use as pre-emergence treatments in peanuts have not been as consistent or as long lasting as have the pre-emergence treatments presently used in corn. DNBP, NPA, and falone are materials that are

tolerated by peanuts and these materials are being used for weed control.

Much more consistent weed control in peanuts has been obtained by using a reduced rate of DNBP alone or a combination of DNBP and NPA or falone, applied at the time the peanuts are just beginning to emerge. These treatments have been more consistent than the single materials applied pre-emergence, and the costs have been less. In the several years of testing, peanuts have shown little permanent injury resulting from foliage contact burn. Combinations of some of the longer residual herbicides tolerated by peanuts, along with DNBP, have given longer weed control generally than DNBP alone.

Peanuts have shown enough tolerance to 2, 4-D as a pre- and post-emergence treatment to permit the use of the material for low cost weed control, if adequate FDA clearance is obtained. One of the triazines has shown outstanding pre-emergence weed control possibilities in peanuts.

One group of herbicides has shown a great deal of promise for the control of nutsedge. These materials have been incorporated in the upper 6" of soil prior to planting. Extent of injury to peanuts appears to depend on environmental conditions following application. In tests so far, no reduction in yield has resulted from the apparent injury to the crop.

### **LEGUMES**

Combinations of 4(2,4-DB) and dalapon will effectively control most annual grass and broadleaf weeds in new seedings of alfalfa and birdsfoot trefoil. The clovers (ladino, white, red clover, etc.) are not tolerant to dalapon but are tolerant to 4(2,4-DB).

Pre-planting treatments of thiolcarbamates and trifluralin have shown promise for the control of grasses and weeds in the establishment of new seedings of small seeded legumes. Red clover, ladino clover, lespedeza, birdsfoot trefoil, and alfalfa have shown good tolerance to these materials. Diphenamid has shown good weed control but true clovers have not tolerated rates necessary for control of weeds.

### **TOBACCO**

Certain herbicides applied just prior to or immediately after setting tobacco have given good weed control for 4 to 6 weeks. Diphenamid has proved to be one of the better herbicides to use immediately after setting plants. This chemical should be used at a rate of about 4 pounds per acre overall as a spray or in granular form. Cultivation is usually helpful in loosening the soil after about four weeks.

Certain chemicals like EPTC can be applied as a pre-planting treatment about two weeks ahead of setting plants. This material should be applied at a rate of 4 pounds per acre of active ingredient and incorporated into the soil immediately after application. The soil should be worked

lightly before setting plants in treated areas so as to aid in the breakdown of the chemical.

### SMALL GRAIN

By combining 2,4-D or MCP with Banvel D, the number of species of weeds in small grain that can be controlled has been increased. Banvel D has shown more activity against such species as dog fennel, certain of the wild buckwheats, and some of the difficult-to-control winter annuals. With most of the hormone-type herbicides, the response of fall-seeded small grain is closely related to the rate of physiological activity of the plants at the time of treatment. Varietal differences in response to herbicides have appeared, but whether these differences can be proved significant is not known.

### OTHER RESEARCH

An attempt is being made to study the effect of certain herbicides on the germination pattern of certain weed seeds. Very little is known of the fate of seeds of weed species that came in contact with herbicides applied to the soil, during any phase of their germination process.

Certain weed seeds studied for short periods of their germination have tolerated dosages of herbicides that would destroy the germinating seeds. Low concentrations of some herbicides have increased the rate of germination and also given a higher percentage of germination.

### Harvesting Peanuts

Virginia formers are rapidly adopting the peanut harvesting system of picking from a windrow and artificially drying to a safe moisture content for storage. An estimated 40% of the 1962 Virginia crop was harvested from the windrow, compared to about 10% in 1960. Current research in artificial drying is concerned with drying efficiency and with various quality factors of the peanuts.



A typical farm installation for artificially drying and mechanically handling windrow-harvested peanuts.

## Tobacco Studies

### Black Shank and Stem Rot

Annual observations made since 1954 suggest that the weather in October and November, particularly the date of the first hard freeze, may determine the fate of the black shank pathogen in the soil and hence greatly influence the amount of black shank in the next year's tobacco crop. A method of predicting, for the following year, the relative severity of the disease under Virginia conditions may thus become possible.

In related studies in black shank pathology, greenhouse techniques are being used to investigate the nature of susceptibility or resistance of tobacco to attack by the pathogen, and studies are being conducted in the laboratory on the nutritional requirements of the pathogen, which have been found to vary in relation to the degree of pathogenicity shown by different isolates of the pathogen.

A new project has been undertaken to investigate the causes and control of stem rot and related disorders of newly transplanted tobacco. Cultural or chemical control measures are sought which will require little change in farm practices, such as the use of fungicides in the transplant water.

### Seedbed Covers

Old methods of seeding outdoor beds of tobacco expose the seedlings 11 to 15 weeks to the hazards of weather and diseases.

Tests in the spring of 1962 show that healthy seedlings can be produced under plastic or plastic-cheesecloth covers and be ready for transplanting in 6 weeks. Seeding can therefore be delayed until March 25. Techniques of watering and general management under plastic are currently being studied. The results should be a boon to growers, 30% of whom each year lack good plants for field setting.



Placing covers on seedbeds in plastic cover tests.

## Nitrogen on Burley?

To produce high yields and values of Burley tobacco, growers like to apply liberal applications of nitrogen together with optimum rates of phosphorus and potash. Sometimes rates as high as 500 lbs. of nitrogen per acre (1,500 lbs. of ammonium nitrate containing 33.5% nitrogen) have been used. Close spacing of plants also is often used to increase yields. Under these conditions, a lower quality of tobacco, often not acceptable by the trade, is produced. The question arises if ultimately the grower will not be better off to use moderate fertilization and management practices.

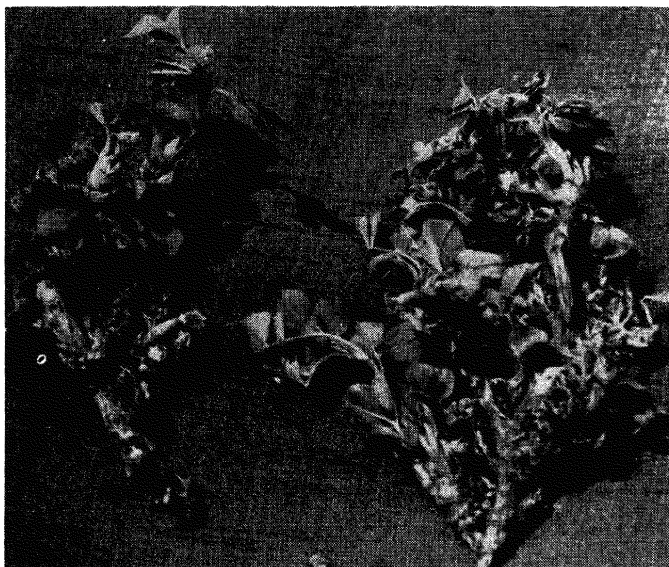
Investigations are conducted to study the effect of rates of nitrogen (100, 200, 300 and 400 lbs. of nitrogen per acre), in conjunction with dates of transplanting (May 20, June 1, and June 10), and spacing in the row (14" and 20") upon acre-yield and value. The results reveal that a poorer quality of tobacco (lower acre-value) is produced with rates of nitrogen exceeding 200 lbs. per acre, in spite of the fact that higher rates often give higher acre-yields. Early planting is favored over late planting and 14" spacing in the row over 20" spacing at all times.

High rates of nitrogen not only lower the quality of tobacco produced but also cause the soil to become more acid, which in turn makes manganese available at such levels that it becomes toxic to the growing tobacco plants.

## Nematode Control

### Alfalfa Stem Nematode

The stem nematode is a major problem in alfalfa production in Virginia. In areas where the disease occurs, stands are depleted rapidly. Crop rotations which offer some degree of control are being studied, but the use of



Stunting and bud distortion of alfalfa by the stem nematode.

resistant varieties is the most satisfactory means of control. Nematode-resistant varieties are available, but these are not suitable for Virginia since they are short-lived, low-yielding, and susceptible to various leafspot diseases occurring in this area. Considerable effort is being made jointly by the Departments of Agronomy and Plant Pathology to incorporate nematode-resistance into a variety adapted to Virginia.

The standard method of inoculating seedlings with a nematode suspension has not been satisfactory. A modification, which includes an additional inoculation of the seed at the time of seeding followed by the inoculation of uninfected seedlings in the cotyledonary stage, has given excellent results. Resistance readings can be made in 10 days to 2 weeks following seedling emergence.

### Nematodes Attacking Peanuts

On farms where the northern, peanut, or sting nematodes limit production, soil fumigation with EDB, D, DD, and DBCP is the best way to check losses. Of the newer materials tested as potential nematocides, penphene and Monsanto's CP17646 show considerable promise. Zinophos is effective in reducing injury to peanut caused by the sting nematode, but it is not as effective as the chemicals currently used by Virginia farmers.

### Soybean Cyst Nematode

To determine whether cysts ingested and excreted by swine would be a factor in spread of the soybean cyst nematode, a total of 18,000 cysts were fed to 6 pigs and 17.8% of the cysts were recovered. Six live larvae emerged from the cysts in laboratory hatching tests, but no reproduction occurred on susceptible Lee soybeans after 2 months in greenhouse tests. Apparently cysts ingested by swine would not be a factor in spread of the nematode, although a few larvae survived passage through the digestive tract.



Lee variety soybeans — on left, damaged by the Virginia strain of the soybean cyst nematode; right — uninfested control.

In greenhouse tests, the top growth of Lee soybeans grown in soil heavily infested with the Virginia strain of the soybean cyst nematode was reduced about 40% and bean yield about 30% compared with control plants grown in non-infested soil.

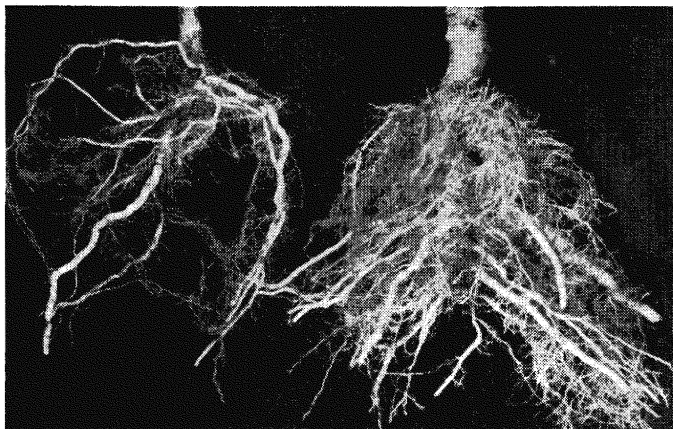
Forty-seven plant species or plant introduction lines were evaluated as hosts of the soybean cyst nematode. Of five new hosts found, common chickweed, mouse-ear chickweed, and common mullein are good hosts, and being common weeds, could be of importance in survival of the nematode. None of the hosts reported above is as favorable for reproduction of the nematode as Lee soybeans.

In cooperative studies, 72 breeding lines or varieties of soybeans were grown in Nansmond County on land infested with the soybean cyst nematode to test them for resistance and/or yield. Many of the lines showed some resistance and one line, designated NC 55, which showed very good resistance in Virginia and in other infested states, was released by the North Carolina Experiment Station for research purposes only. NC 55 has a black seed coat, is not suitable for commercial production.

Land heavily infested with the soybean cyst nematode was fumigated with 200 gallons per acre of D-D (20 to 40 gallons is normally used as a general nematocide). The number of viable cysts was reduced to practically zero, but eradication was not achieved. The value of the soybean crop is not great enough to make fumigation economical.

### New Nematode Pest of Tobacco

A nematode, designated as the Osborne cyst nematode (OCN), was discovered on the roots of stunted tobacco plants in Amelia County in 1961. The infested land in Amelia County has been rented by the Virginia Department of Agriculture in order to study the pathogenic potential of the parasite and to afford the Experiment Station an area for conducting experiments on the control of the new pest.



The tobacco root on the left came from soil infested with OCN; the one on the right, from uninfested soil.

## Woodlands

### Sawfly of Pine

Defoliation by the pine sawfly in the recent Virginia outbreak has declined from 2,000,000 acres to small scattered areas. Seventeen species of primary and hyperparasites were reared from the life stages of the sawfly, accounting for a parasitism of 58.9%. No single factor of natural control, however, was responsible for the decline. The reduction in population densities was the result of a number of contributing factors, the most important of which were insect parasites, insect and rodent predators, diseases, and apparent loss of vigor by the sawfly adults.

### Pine Fertilization

What are the chances that Virginia forests might profitably respond to fertilization? The answer lies somewhere in the future but the prospects are not encouraging so far as loblolly pine is concerned, to judge from preliminary research.

Experiments were started in 1959 on Tatum silt loam and 1962 on Immokalee loamy sand. Tatum silt loam is an upland Piedmont soil and Immokalee occurs in the Coastal Plain. The land use of each is largely forest and both are very low in inherent fertility.

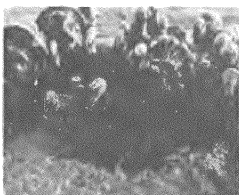
Careful studies of the soil fertility status, needle composition, and plant growth have been made each year since planting. No benefits from treatment have been found on the Tatum soil after 5 years when the trees are approaching 15 feet in height. The trees on the Immokalee soil are much younger and smaller and no conclusions can be drawn as yet.

There appears to be some unexplained differences in the natural growth rate within the experimental area itself and a supplementary study on soil from the site has been started in the greenhouse.

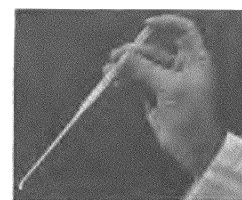


Fireweed, an annual, dwarfs loblolly pine seedlings 6 months after planting. Plot in foreground received no treatment. That in background received lime and phosphate at planting.





# Livestock, Poultry And Their Products



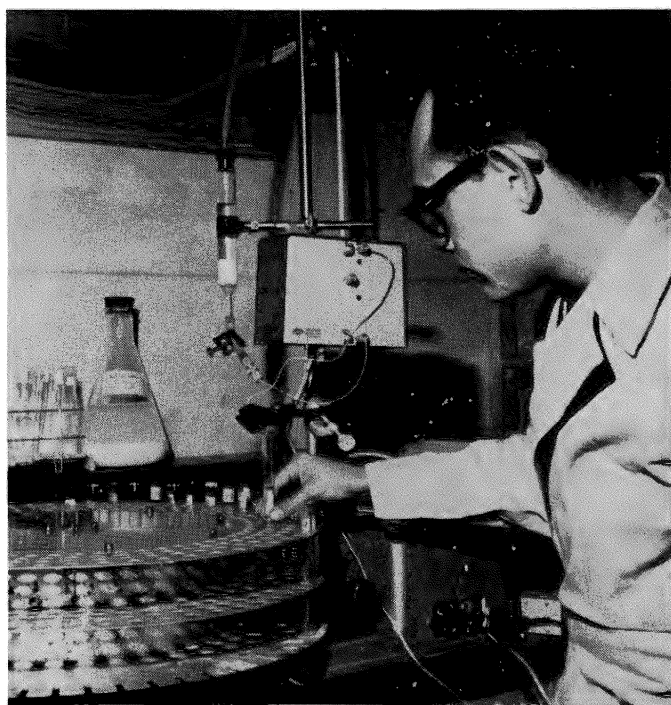
## The Chemistry of Nutrition

### Looking Inside the Cells

The conversion of propionic acid, a major product of rumen fermentation in cattle and sheep, to other fatty acids by enzymes of both the rat and the bovine requires the participation of biotin, a B vitamin. In order to determine how biotin functions in the synthesis of fat, it was necessary to obtain an enzyme preparation deficient in biotin. Since it is difficult to deplete a large animal of biotin, the rat was chosen as the experimental animal.

Our studies have shown that although the rat is able to synthesize the enzyme propionyl carboxylase (this enzyme is required for the first step in the conversion of propionic acid to fat) in the absence of biotin, the enzyme is inactive. Furthermore, the mere addition of biotin to the enzyme does not result in the activation of the propionyl carboxylase. A second enzyme, called activating enzyme, is required to bind biotin to the propionyl carboxylase. The activating enzyme has been shown to bind biotin specifically to several lysine atoms in the propionyl carboxylase molecule.

Studies are now in progress which will attempt to clarify the exact role of biotin in these enzymatic reactions.



An enzyme involved in fat synthesis is purified by adsorption chromatography in a 33° "cold room" in order to minimize thermal inactivation of the enzyme.

Seeking out all the fine details of all the steps involved in moving nutrients from the fermentation processes in the rumen, through the living cells of the animal and finally to the steak on the dinner table seems a long way from the farm. Without knowledge gained in this way, however, there is little chance that we can expect any improvement in animal production in the generation ahead.

### From Crude Fiber to Food

Animals such as sheep and cattle which have a large multiple stomach can use the cellulose in fibrous feeds such as hay as a source of energy. The special place of these ruminants in agriculture is largely a result of their ability to digest cellulose because they can be reared efficiently on crops that are useless as foods to hogs, poultry, and people.

More efficient use of cheap high-fiber feeds could be possible if the process by which cellulose is digested were clearly understood so that it could be controlled. For the past decade the process of cellulose digestion has been studied in detail in many laboratories around the world.

The V.P.I. research group has made three especially significant contributions in the past two years. First was discovery and purification of the enzyme that starts the digestion process off by converting insoluble natural cellulose to sugars that are soluble in water. Second was the first clear-cut proof that the final stages of cellulose digestion are carried out by a complex mixture of enzymes, each of which does a particular part of the job. Third was the unanticipated discovery that cellulose-digesting cells can absorb and oxidize cellulose pieces which are far larger than had been imagined to be possible.



Graduate research team examines model of a cellulose molecule while studying its degradation by enzymes.



## Thyroid Hormones Control Growth

The thyroid gland produces hormones which exert a profound effect on the growth and maturation of all animals. An understanding of how these hormones affect metabolism, and thus growth, would provide information that would enable livestock producers to feed more effectively.

Studies were initiated to determine the effect of thyroxine (one of the thyroid hormones) on the synthesis of protein in the test tube. The addition of thyroxine to protein synthesizing systems was found to effect a remarkable stimulation of protein synthesis. This effect was also seen when thyroxine was injected into laboratory rats. The ability of these rats to synthesize protein increased two to three times.

When experiments were done to determine exactly where and how thyroxine stimulated protein synthesis, it was concluded that thyroxine had no direct effect on the enzymes responsible for protein synthesis. It appeared to exert its effect on some mechanism prior to the assembly of amino acids for protein synthesis. This suggested that thyroxine stimulated the synthesis of ribonucleic acids which are essential in the protein synthesizing process. A comparison of the ribonucleic acid content of tissues from normal and thyroid hormone-deficient rats revealed that a deficient rat contained approximately one-half the amount of ribonucleic acid than did a normal rat. Also, the composition of ribonucleic acid from a deficient rat differed from that of a normal rat.

Studies are now under way to determine exactly where the defect in the synthesis of nucleic acids occurs in animals which are deprived of thyroid hormones. An understanding of this mechanism should enable scientists to control growth and the use of the important amino acids, the building blocks for making proteins.



Rats deficient in thyroid hormone are used in studies of protein synthesis. Both rats are the same age, but the one on the right has ceased to grow because of hormone deficiency.

## Minerals Are Essential, also Toxic

Intelligent use of feed and pasture resources calls for a complete understanding of plant and feed composition. Many minerals in feeds are present in only trace amounts. Some of these are poisonous to animals when present in amounts only slightly higher than the amount needed for healthy livestock. Molybdenum is one such element.

Studies have been under way several years to determine what happens when an experimental animal, the laboratory rat, receives toxic amounts of this element in the diet. Recent findings have uncovered what may be the disturbance in the animals' metabolism that results in the harmful effects of excessive molybdenum. Within a few days after the animal receives molybdenum in his diet in toxic amounts, his growth is depressed. The efficiency with which he uses his feed falls off to where 7 lbs. of feed are required to produce 1 lb. of body weight. With a good diet only 3 to 3½ lbs. of feed are needed to produce 1 lb. of gain.

In balance studies (what goes in and what comes out of the animal), it was found that the nitrogen compounds in urine arising from the metabolism of dietary protein increased greatly when the animal is fed excess molybdenum. Thus, the poor growth resulting from molybdenum in the diet can be explained as molybdenum interfering with the normal metabolism of the protein in the diet. It may also interfere with protein already in the tissue of the animal, particularly proteins that function as enzymes in making more body protein during growth. After several weeks on the molybdenum-containing diet, the rats show further change in urine nitrogen compounds. Instead of being eliminated as urea, the end-product of protein metabolism, amino acids, the building blocks from which the proteins are manufactured, begin to pour out in the urine.

Studies are going forward to isolate cells and cell fractions of the poisoned animals so the exact places in the enzyme factories where molybdenum is doing its damage can be pinpointed. It is through such detailed searches that we will ultimately learn how to manufacture rations for livestock containing exactly the right proportions of the various life-giving constituents.

Surveys have been under way for the past fifteen years in all the major soil belts of Virginia to get an idea of the amount of molybdenum that is present in our feed and forage crops. Occasionally isolated soil areas have been found where this toxic element is present in sufficient amounts to produce crops that may be poisonous to livestock. Detailed search into the damage produced from excess molybdenum should yield the knowledge needed if we have to face outbreaks of poisoning from this element, keeping in mind that we already know that minute amounts of this element are necessary and essential for life, and that amounts only slightly above the required level become toxic.

# Cost and Price Studies

## Forecasting Cattle Prices

Because beef cattle production varies from year to year and between months within years, prices to producers have been unstable, supplies for the market have been uncertain, and consumers have experienced quantity and price changes. One of the primary causes for these uncertainties has been that producers base decisions on present prices rather than prices expected when the product should be ready for market. More accurate price information should make possible more intelligent production decisions.

Studies have sought to develop a reasonably accurate procedure for predicting monthly prices at least one year in advance. Many variables were analyzed for the years 1955-61 in an attempt to show relationships between the data and steer prices. Three seasonally adjusted variables — per capita fed-cattle marketings for slaughter, per capita nonfed-cattle marketings for slaughter, and total personal income per capita — explained about 99% of the variation in seasonally adjusted Good and Choice slaughter steer prices.

Factors were also investigated to explain fed- and nonfed-cattle marketings as well as total personal income, since these must be predicted before they can be used in price forecasting. Relationships explaining 85% or more of the variation in marketings and income were established.

Had the above relationships been available in 1955, they would have permitted remarkably accurate price predictions by month for one year in advance for the 1955-61 period. If the factors affecting beef cattle prices remain approximately the same in future years as they were in 1955-61, the relationships should prove extremely useful in predicting monthly beef cattle prices.

## Milk Assembly Costs

The cost of moving milk from farm to market is being analyzed to determine possible reductions in the light of present conditions. As local milk markets in Virginia have expanded, they have lost their identity as separate and distinct producing-marketing areas. Milk supply areas frequently overlap and cross-hauling occurs. It appears that the movement of milk to markets has not been modified or coordinated in a way to minimize transportation costs.

The present study is designed to determine and outline the least-cost movement pattern of milk from the 40 or more counties supplying the major markets of Eastern Virginia. A well-coordinated system of assembling milk to minimize hauling costs likely will have some implications for the number and size of producer cooperatives and the relationships among them. The study should find potentials for improved efficiency. Attainment of any cost reductions will depend largely on the industry's ability to develop arrangements that will overcome obstacles and limitations.

## Multiple Component Pricing of Milk

Consumers are shifting their emphasis from fat to other nutritional components, particularly protein, in many foods. Since protein is a major constituent of milk, work has been underway at V.P.I. to develop economical methods for testing milk for protein, to determine the variation of protein in milk from different herds, and to develop pricing procedures that will make proper allowance for such variations, much as is done now for fat.

Protein tests on milk from 600 Grade A herds and 600 manufacturing milk herds in Virginia indicate that only about 50% of the protein variation is associated with changes in fat. Milk of the same fat content may differ as much as 0.6% in protein. This amounts to a difference in protein of about 20 lbs. in a 400-gallon tank of milk, or the equivalent of the protein in a quarter of beef from a 1,000-lb. steer.

These variations in protein suggest the possibility for increasing the protein content of milk independently of fat through breeding and selection practices. A movement in this direction would seem to be more in line with consumer demands. One producer group has ordered the necessary equipment for protein testing on an experimental basis.

Pricing procedures that will reflect the relative market values of the various components of milk should be developed, if the industry is to improve the protein content of milk. Price differentials now provided for fat are based largely on the market value of butter. On the basis of increased yields of protein in milk, a price differential of about 5¢ for a 0.1% change in protein in manufacturing milk is indicated. An appropriate differential for milk for fluid use is difficult to establish without a clearer indication than now exists of consumers' valuation of protein in fluid form. Additional work is needed in this area. Furthermore, pricing procedure is needed that will lend emphasis to protein without at the same time providing an incentive for greater fat.

## Egg Delivery Costs

Resources used and unit costs involved in delivering eggs from grading plants to market outlets were studied in 9 plants. Labor required and truck miles traveled to serve 252 outlets on 54 delivery routes of the sample plants were analyzed in terms of plant size, size of delivery, and type of market outlet.

Highly significant differences were found in the size of delivery made to various market outlets. Approximately 2/3 of the variation in total delivery point time and over 3/4 of the variation in unloading time were explained by the volume of delivery made.

Labor costs on delivery routes were found to average approximately \$1.21 per hour. Truck costs based on operating conditions found were 7.9¢ per mile for a 1/2 ton open-body pickup truck and 10.1¢ per mile for a 1 1/2 ton refrigerated truck.

## Animal Diseases and Insect Pests

The estimated average cost of delivering a 24-dozen case of eggs on the sample routes was 14.3¢, of which 9.5¢ was truck cost and a 4.8¢ labor cost. Variation in labor costs among deliveries to various types of market outlets would amount to as much as 3.2¢ per case because of differences in labor requirements at delivery points and the rate of travel to various groups of market outlets.

Effect of size of delivery on egg delivery cost is illustrated by showing that the average cost per case of eggs (24 dozens) would be 10.3¢ for an 80 case delivery compared with 78.8¢ for a 10 case delivery on a hypothetical route. Less frequent deliveries of larger volume to outlets with adequate holding facilities would cut delivery costs. Estimated egg delivery cost of the plants with larger volume was 9.5¢ per case compared with 25.8¢ per case for the smaller volume plants.

A method of estimating the additional cost of making various size deliveries of eggs over specified distances to different types of market outlets was developed, based on average labor and truck-travel requirements. This should help plant management assess the effect of possible adjustments in egg delivery operations.

### Time Factor in Broiler Production

In an endeavor to maximize profits, farmers attempt to allocate resources so that the cost of the last *additional* unit of resource (feed, etc.) is just paid for by the *additional* product produced. This principle applies to all variable resources (feed, fertilizer, labor, gasoline, etc.), but time, as a resource, is often overlooked.

A study of the economics of broiler production suggests that rather than feed birds as long as their gain in body weight is sufficient to cover feed costs, producers should sell their birds at a much lighter weight. While the former approach maximizes returns per batch, ignoring all preceding and following batches, the latter approach maximizes returns to the fixed building, equipment and labor resources available. Time is of paramount importance since the services of these resources are limited for any particular point in time. Thus maximizing profits with respect to time (over all batches), rather than maximizing returns per batch (ignoring time) indicates a 50% increase in net returns to the grower.

Similar studies are planned, or underway, to investigate the economics of turkey and hog production with respect to time *and* space requirements.

### Inefficient Hog Movements

Hog slaughter capacity increased greatly in Virginia from 1954 to 1960 even though hog marketings did not. Slaughterers have therefore become increasingly dependent upon hog producers in other states, and transportation and other procurement costs have become relatively more important.

Costs associated with actual hog movements in 6 south-eastern states were compared with the least-cost movement and found to be higher by from 28% to 56% during the periods studied.

### Vibriosis

Cattle, sheep, goats, swine, pregnant rabbits, and chickens have been shown to be hypersensitive to *Vibrio fetus* toxin. Vibriosis as an infectious disease has been studied since 1909. Research has illuminated these important new facets of this disease: (a) cattle are hypersensitive to whole-cell cultures of *V. fetus* as well as cell-free supernatants, (b) cattle tested were 100% positive to intradermal tests, (c) an insight has been gained into some of the new mechanisms involved in the pathogenesis of the disease, (d) new knowledge of the nutritive requirements of *V. fetus*, and (e) a new membrane filter technique has been successfully used for the isolation of vibrios.

### HYPERSENSITIVITY

Calves enter into a profound state of anaphylactoid shock in 10 to 12 minutes, and often die within an hour, following intravenous inoculation of *V. fetus*. Whole-cell culture or the cell-free supernatant is toxic. One ml. per 100 lbs. body weight was lethal to calves weighing 200 to 300 lbs.

Newborn calves and mature or aged cattle were shown to be hypersensitive. Reaction to the *V. fetus* supernatant was progressively greater in calves as they develop toward puberty and probably reaches a maximum at puberty or soon thereafter. Cows in different stages of gestation experience a severe anaphylactoid shock reaction following a single intravenous inoculation of either *V. fetus* cells or cell-free supernatant. Vibrionic-allergic type abortion may ensue and the clinical sequelae following inoculation were severe or fatal. The toxin immobilizes bull sperm after one hour of test tube contact.

The intradermal skin test applied in the lateral cervical region is positive in sensitive animals in one to two hours. The antigen may be either *V. fetus* cells or cell-free supernatant. Cattle tested were 100% positive.

### GROWTH REQUIREMENTS

A chemically defined medium has been developed which appears to satisfy the nutritive requirements for good growth of *V. fetus*. Eighty-seven strains representing isolates from the bovine, ovine, porcine, avian, and man were studied. Important characteristics common to all the strains included: (1) magnesium and ferrous ions represent their major mineral needs, (2) niacin was the only vitamin required, (3) amines were not required, (4) they used amino acids as their sole source of carbon and nitrogen, (5) their amino acid requirements varied; some strains required one or two amino acids while other strains required many more, (6) their optimum temperature for growth was 35-37° C. and, (7) their optimum pH for growth was 6.8-7.2.

## MECHANISMS OF PATHOGENESIS

It is believed that the bovine vibrionic hypersensitive state is a major facet of the vibrionic abortion syndrome. The bovine probably becomes hypersensitive either passively during prenatal development or by contact during the early post-natal period with vibrios or other micro-organisms with antigens common to the vibrios. Abortions would then relate directly or indirectly to the hypersensitive state of the bovine and reaction to antigens of *V. fetus*.



Anaphylactoid shock in the bovine following intravenous inoculation of *V. fetus* cell-free supernatant is pictured above. Below, pulmonary edema — both intra-alveolar and interlobular were constant lesions seen in calves after shock.

*V. fetus* has been isolated from more than 27 human patients showing a variety of clinical symptoms ranging from abortion to septic arthritis, and thus may become a major allergic and infectious disease problem of man.

## DIAGNOSTIC METHODS IMPROVED

Cellulose acetate membrane filters with a specific pore size have been found to be very useful for the isolation of *V. fetus* from larger bacteria. The filter technique coupled with the selective antibiotic media facilitates the isolation from different sources.

## Infectious Bronchitis

Infectious bronchitis causes serious economic losses in young chickens through deaths and delays in growth, and in adult chickens by causing a drop in egg production down to 5% or less. Within the last 20 years, research in the U. S. has taken two approaches in fighting bronchitis. One has been to produce a killed virus vaccine, but current indications are that such a vaccine is neither efficient nor economical. The other has been to produce a live virus vaccine, the virus being weakened — or modified — by propagation in chicken embryos. If the virus is only slightly weakened, the vaccine induces a sound immunity, but unfortunately the vaccine reaction often initiates or “triggers” secondary bacterial infections which cause more damage than the original disease. If the virus is weakened enough to decrease the vaccine reaction, the immunity the vaccine imparts is low in degree and of short duration. A really satisfactory live virus vaccine has not yet been developed.

Researchers at V.P.I. are attempting a third approach — modification of the virus by growing it in embryos other than those of the chicken. Although bronchitis virus apparently will not infect turkeys, it has been adapted to propagation in developing embryos of turkey eggs. During the first two years of this work, the virus frequently seemed to die out or “disappear,” but by repeated trials it was finally grown in 17 serial transfers from turkey embryo to turkey embryo. The newly adapted strain now shows much less tendency to die out. At present it induces excellent immunity in chickens but still causes an objectionable vaccine reaction.

Plans are to continue adaptation in the atypical host embryo through at least 50 turkey embryo passages. Attempts are also being made to adapt the virus to embryos of other bird species and to tissue cultures.

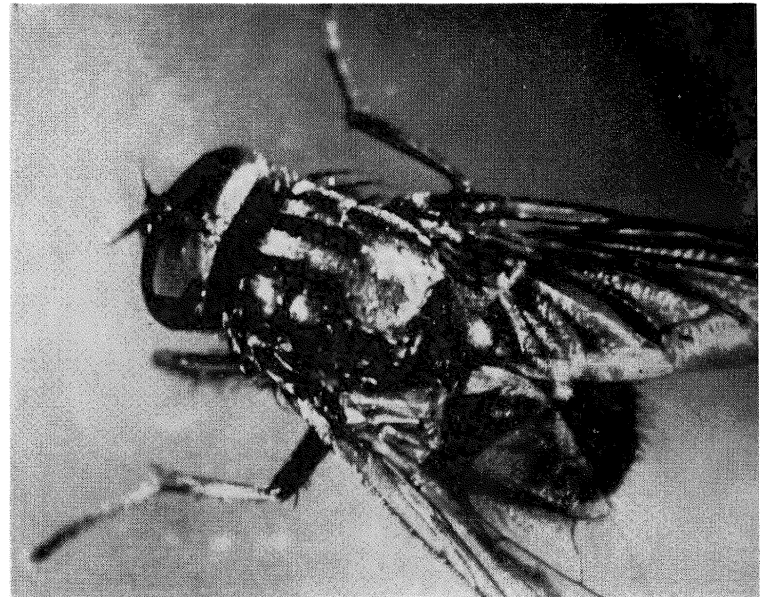
Potential benefits of work on adapting infectious bronchitis virus to unusual hosts or tissues lie in two fields. First, during adaptation the virus may become modified so that it retains its ability to induce excellent immunity in chickens but no longer causes objectionable vaccine reaction. Such a vaccine strain of the virus could be of great economic importance to the poultryman and the consumer. Second, any change induced in fundamental characteristics of the virus should provide valuable information to those doing basic research on virus diseases.

## Insects Affecting Livestock

Research on the biology and control of Virginia's most important livestock pest, the *face fly*, has been continued using both laboratory and field facilities. Although many insecticides have been tried, those sprayed or dusted directly onto animals have not given effective control where reinfestation by adult flies is heavy. Large-scale experiments with treating manure by free-choice ingestion of Ronnel and mineral salt caused only slight reduction of adult flies on treated animals, although good control of larvae in the manure was attained. This poor control is believed due to the tendency of the adult flies to disperse widely over pasture areas.

Using 5% malathion dust in self-applicating devices hung near mineral salt boxes shows promising results. Such a device appears to be both practical and economical.

In the control of *cattle grubs* on beef animals, systemic insecticides such as Ruelene, Famophos, and Co-Ral applied as a "pour-on" treatment have been found to be highly effective.



An adult face fly, about 10 times actual size.

# Beef Production

## Factors Influencing Feed Consumption

Factors which influence the intake and efficient use of feed in beef cattle are not clearly understood. In 1962-63, a feeding trial was conducted with individually-fed heifers to determine the effect of frequency of feeding and different hay-to-concentrate ratios on feed consumption and feedlot performance. Twenty heifers were fed either a high (67%) concentrate ration or a high hay ration (containing 62% grass hay). One-half of the heifers within each ration group were allowed to eat all they would consume during two 1-hour feeding periods daily; the other half were allowed to eat for six 20-minute periods daily.

Heifers fed the high concentrate ration consumed more feed, gained faster, and used less feed per pound of gain than heifers receiving the high hay ration. The low energy ration, however, was most efficient in terms of total digestible nutrients (TDN) required per pound of gain. Heifers fed six times daily gained somewhat faster and were more efficient in use of feed and TDN than those fed twice daily. When feed and TDN intake were expressed on the basis of pounds per 100 lbs. of body weight, consumption was slightly greater for the heifers fed the high concentrate ration but no consistent differences in consumption were noted with frequency of feeding.

Limited studies have been conducted on the effect of metabolite injections on appetite and eating patterns of cattle. In two studies, intravenous injection of 1 liter of a 15% solution of acetic, propionic, or butyric acid, or a mixture of the three, were administered to beef heifers with physiological saline used as a control.

Injections of propionic or butyric acids appeared to influence eating patterns of heifers more markedly than like amounts of acetic acid or a mixture of acetic, propionic,

and butyric acids. Heifers receiving saline began eating almost immediately after injection of the solution. Those receiving acetic acid or the mixture began eating an average of 19 to 22 minutes after injection, while heifers receiving propionic or butyric acid solutions did not eat for an average of 100 to 130 minutes, respectively, after injection. Feed consumption of heifers was decreased 29% by propionate or butyrate injections as compared to those injected with saline.

## Age of Dam and Calf Performance

This study sought to determine the effect of the age of the cow at time of calving on the performance of her calf, when other influences are held as constant as possible. Data included 8,985 records by 2,051 cows in 59 Angus herds and 5,216 records by 1,240 cows in 37 Hereford herds. No herd was used with less than four years' records and no cow was included unless she had remained in the herd until reaching the age of 6 years and had at least 3 calf records available. Calf gains from 120 to 299 days of age were used.

Average daily gain of the calf increased as the age of the cow increased from 2 to 7 years. There was no significant difference from 7 through 11 years, and a gradual decrease thereafter. These conditions held for both the Angus and Hereford breeds. The greatest difference was between 2- and 3-year-old dams.

The following adjustments are recommended: increase 2-year-old dam records by 10%, 3-year-old dam records by 5%, 4-year-old dam records by 3%, 5-year-old dam records by 2%, and 13-year-old and older dam records by 3%. These adjustments will make their records comparable to those of mature dams (7-11 years).



## Condition vs. Grade of Beef Calves

A recent study of 4,994 Angus and Hereford calves, ranging in age from 90 to 450 days, showed that condition has a highly significant influence on grade of both Angus and Hereford calves. For each increase of one point in condition, there was a corresponding increase of approximately  $\frac{3}{4}$  point in grade. Conformation scores or grades of beef cattle should be adjusted for differences in flesh condition. A rule of thumb for a quick approximate adjustment for differences in flesh condition is as follows: Add one point to the grade if the animal is below average (thin) in flesh condition and subtract one point if above average (good) in flesh condition. If an animal is extremely thin or very fat, 2 grade points would be the appropriate value to add or subtract.

## Relation of Weight and Grade to Performance

Because of the ever-increasing emphasis on weight for age and the trend of many breeders to select for extremely large mature cattle, this study was undertaken to estimate the relationship of mature weight and grade of parents to the performance of their offspring.

In the sire-offspring comparisons, the weight-ADG relationship was estimated as 22% among the Angus and 30% among the Herefords. For each 100 lbs. increase in adjusted mature body weight of the sire, there was a corresponding increase in adjusted ADG of their calves of .028 lb. among the Angus and .041 lb. among the Herefords.

The dam-daughter estimates were within sire, herd, management practices, and year. The estimated weight-ADG relationships were 23% for the Angus and 20% for the Herefords. For each 100 lbs. increase in adjusted mature weight of the dams, there was a corresponding increase in adjusted ADG of the calves of .061 lb. among the Angus and .052 lb. among the Herefords.

Although these relationships are fairly low, they are positive and statistically significant and indicate that some progress would be made in growth rate of the calves by paying attention to the mature weight of the parents.

Estimates of the relationship between adjusted mature grade of parent and the weaning grade of the offspring were positive but quite low, indicating that the mature grade of the dam has little influence on the offspring's grade at weaning. The correlations were only 9% and 12% among the Angus and Herefords, respectively. Corresponding values for the sire-offspring relationships were 23% for each breed.

## Selecting for the Dwarf Gene

A study of the growth patterns of homozygous dwarfs, heterozygous and homozygous normal cattle at various ages from birth to maturity has shown that the heterozygotes (carriers of the dwarf gene) have a different growth pattern from either true dwarfs or normal animals. In general, known carriers and offspring of carrier and suspect

parents are lower in height, about the same in chest circumference, but have a larger height/chest ratio when age and/or weight are held constant, and the males develop significantly faster in masculinity than normal cattle. The growth pattern of the three genotypes is in agreement with the growth hormone deficiency found in the dwarf calf. The growth pattern of the heterozygous animals indicates a similar but less extreme deficiency in growth hormone.

With the preference for smaller cattle with shorter legs and shorter bodies, larger chest to height ratio, and extreme masculinity in bulls, particularly at a young age, cattle judges and breeders apparently unknowingly favored the heterozygote in their selections during the 15- to 25-year period prior to the mid-50's. All of these factors came nearer to the ideal conformation being selected for during that period.

## Breed Crossing

In the spring of 1956, a beef cattle crossbreeding project was initiated at the Shenandoah Valley Station.

Phase I of this two-phase project has been completed. It was designed to compare crossbred and straightbred progeny with respect to size of calf crop, pre- and post-weaning growth rate, weaning and slaughter grades, and various carcass data. Matings were made in such a manner that each year approximately equal numbers of straightbred, two-breed, three-breed, and back-cross calves were produced.

Results suggest that the most significant advantage of crossbreds over straightbreds is the percentage of calves born alive and weaned. Cows bred to bulls of different breeds to produce crossbred calves had 90% calves born alive and 87% weaned, compared to 82% and 76%, respectively, for cows in the straightbred groups. Birth weights of crossbred calves were consistently greater (in both sexes) than those of the straightbred calves.

Less dramatic are the differences between crossbreds and straightbreds in weight at weaning and slaughter. Crossbred steers and heifers averaged 424 lbs. and 391 lbs. These differences were more than maintained in the slaughter weights. Average slaughter weights for the steers (approximately 22 months of age) and heifers (approximately 14 months of age) in the crossbred groups were 1096 lbs. and 785 lbs., respectively, while straightbreds averaged 1054 lbs. and 757 lbs.

Female calves born to these two groups of cows had essentially the same average birth weights, while the male calves produced by the crossbred heifers averaged 2.5 lbs. heavier than those produced by the straightbred heifers.

## Inbreeding vs. Mass Selection

A genetic study has been underway at the Beef Cattle Research Station, Front Royal, using two breeding schemes: inbreeding and mass selection. Calves from the two schemes are descendants of foundation sets of paternal half-sisters. Changes in beef conformation and growth rate resulting

from mass selection are compared with changes observed among cattle from crosses of inbred lines.

Calves' growth and conformation from birth to weaning were heavily affected by these non-genetic factors: year, sex, age of dam, age of calf, and inbreeding. Differences between sexes in both type and growth were large at midsummer and at weaning, with heifers having higher type scores at weaning, but bulls growing about .20 lb. per day more than heifers.

Average daily gains of calves from dams less than 5 or over 10 years old gained from .21 to .30 lb. per day less than calves from mature dams (aged 5 to 10). This was more important at midsummer than at weaning.

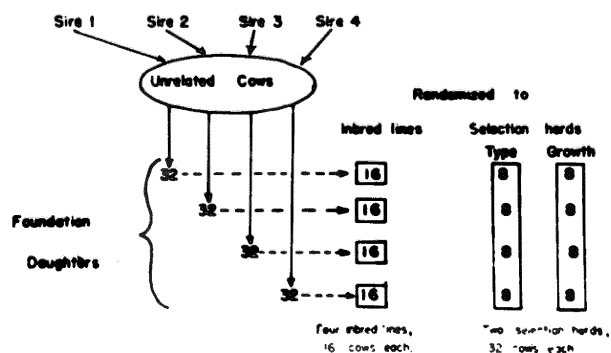
Inbreeding has been more detrimental to Angus calf performance than to Shorthorns. Differences between type and growth selection herds are in the desired directions, being .07 lb. per day for growth rate in both breeds, and .4 and .3 unit on type score in Angus and Shorthorn.

Kind of herd	Birth Data			Weaning Data		
	No. born (alive and dead)	Inbreeding		Birth weight, lbs.	Average Daily Gain	Conformation score <sup>b</sup>
		Dam	Calf			
<b>ANGUS</b>						
Foundation	335	.02	.01	62.0	1.72	11.4
Inbred	176	.03	.25	58.8	1.57	10.7
Type selection	106	0	.04	58.6	1.69	11.9
Growth selection	107	.01	.02	64.2	1.76	11.5
Test	278	.01	0	59.9	1.72	11.5
All Angus	1002	.01	.06	60.7	1.69	11.4
<b>SHORTHORN</b>						
Foundation	275	.08	.03	66.9	1.51	11.0
Inbred	154	.04	.23	66.5	1.46	10.8
Type selection	137	.06	.04	68.7	1.48	10.9
Growth selection	164	.05	.05	70.4	1.55	10.6
Test	230	.08	.05	69.0	1.52	10.8
All Shorthorns	1076	.07	.08	68.4	1.50	10.8

<sup>a</sup>Results from calves with complete data through weaning; 785 Angus, and 853 Shorthorns.

<sup>b</sup>According to a scale in which 6, 7, 8 equals medium; 9, 10, 11 equals good; 12, 13, 14 equals choice; and, 15, 16, 17 equals fancy.

#### FOUNDATION SIREs — chosen after individual and/or progeny testing



## Cooperative Bull Testing

Work was started in 1961 in cooperation with the State's Department of Welfare and Institutions to obtain field progeny tests on bulls of different lines of breeding produced at the Beef Cattle Research Station. At present 16 bulls are under test in several herds totaling more than 260 cows. The bulls are furnished to the cooperating herd management in return for information on progeny — a complete growth record and index on each individual offspring. Progress to date has been very satisfactory and there is a possibility of going to multiple sire herds for line testing as opposed to individual sire testing.

## Fattening Steers

### GRAIN ON PASTURE

Yearling cattle on pasture usually need some supplemental grain during the season if they are to yield desirable carcasses at the end of the grazing season. The question arises, "How much grain should be fed and when should it be fed?"

An experiment was completed to study dry matter intake and digestibility at intervals during the grazing season by yearling steers grazing native pastures. The indicators chromogens and chromic oxide were used. Results showed that percent dry matter digested and pounds digestible dry matter intake per 100 lbs. bodyweight decreased rather sharply after the early spring grazing. Also, it appeared that some supplementation, even early in the spring, probably would be needed to obtain a uniformly high rate of gain during the entire grazing season.

In one trial, rate of gain was increased with each increase in amount of grain fed up to about a 60% full feed. Carcass grades tended to follow amount of supplement fed. The trial is being repeated and conclusions cannot be drawn at this time.

### PROTEIN AND ENERGY LEVELS

An experiment was completed on the effect of widely different protein levels in steer-fattening rations of constant energy concentration. Maximum rate and efficiency of gain was obtained in fattening steer calves finished as short yearlings when the ration contained 12.5% protein. This ration also gave maximum nitrogen retention.

In a feeding trial using different protein and energy levels in rations of fattening steer calves, maximum gain was obtained when the ration contained 12.7% protein. Energy level of the ration influenced rate and efficiency of gain. When the TDN level was raised from about 62% to 67%, rate of gain was increased 14% and feed efficiency 8%. Increasing the energy level to 72% TDN resulted in a decrease of 0.19 lb. in daily gain and a small depression in feed efficiency compared to 67% TDN.

### FEEDING POULTRY LITTER

A large tonnage of poultry litter is produced yearly in Virginia and several other states. The material has been used mostly as fertilizer. Since litter contains a high crude

protein content, it may be of value as a source of protein supplement and roughage in livestock rations.

A feeding trial was conducted to determine the relative value of poultry litter containing peanut hulls or wood shavings for fattening steers. Three lots of 10 heavy steers were full-fed ground mixtures.

There was little difference in gain between steers fed a normal or control ration and those fed a ration containing 25% peanut-hull poultry-litter. Steers fed a ration containing 25% wood-shaving litter gained a little less. The lot fed the peanut-hull-litter ration required 9% less feed per pound gain than the control lot. Feed efficiency for the wood-shaving-litter lot was intermediate.

Carcass grades tended to follow rate of gain. Dressing percent was slightly lower for steers fed the peanut-hull litter. A taste test showed no discrimination against meat from steers fed poultry litter.

### STILBESTROL IMPLANTS

Two trials were conducted to determine the optimum level of stilbestrol to implant in steers going into the feedlot to be fattened, some of which had received an implant at the beginning of the previous grazing season, and some had not. The levels tested were 0, 12, 24 and 36 mg. It was found that implanting 24 mg. stilbestrol in steers going into the feedlot resulted in maximum increase in rate of gain and did not markedly alter slaughter or carcass grade, regardless of whether the steers had received a previous spring implant.

### Rations Affect Veal Quality and Composition

The cooking and eating characteristics and the composition of the meat of 24 male Holstein calves fed whole milk rations with added hay or lactose were studied. Average daily gains were 1.24 for hay, 1.15 for no lactose added, 1.36 for 5% lactose, and 1.51 for 15% lactose. Differences in cooking were small and inconsistent. Increasing lactose increases tenderness, as evidenced by taste panel and Warner-Bratzler Shear evaluation, decreased moisture, and increased fat. Little difference between treatments was noted in juiciness of veal.

### Sonograms in Carcass Studies

Animal scientists at the Virginia Station have been using a sonoray (high frequency sound wave) machine as a possible aid in selecting those animals possessing the most desirable carcasses, to be used as breeders. To check the value of sonograms they studied live experimental animals just prior to slaughter and compared results with direct carcass evaluation.

The scientists have found that lack of sharpness and definition in general in the sonograms can lead to major errors. The principle appears to be good in theory and, they believe, with some improvement in equipment, sonograms may become a useful tool in selecting breeding stock.

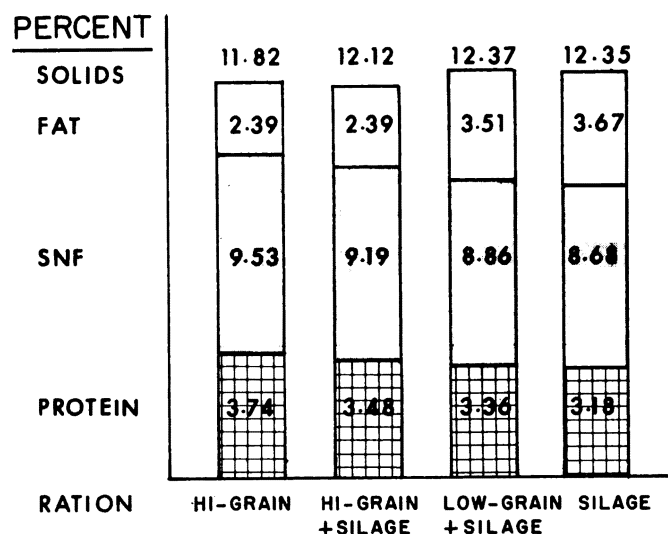
# Milk Production

## Effect of Feeding on Milk Composition

Studies have shown that feeding high levels of grain (about 26 lbs. per day) and no supplemental forage to lactating cows on pasture caused a marked depression in the fat content of the milk — from 3.4% to 2.3% in six weeks. This was accompanied by a substantial increase in the solids-non-fat (SNF), principally the protein fraction. Cows fed the same amount of grain plus about 24 lbs. of corn silage per day did not exhibit as great a decrease in milk fat, while milk protein was higher than for cows fed normal levels of grain.

The feeding of lesser amounts of grain and liberal quantities of corn silage resulted in milk of normal fat content. Milk protein and SNF were lowest when grain was not included in the ration. The accompanying figure illustrates the effects of the different rations on the major constituents of milk.

## EFFECT OF VARIOUS FEEDS ON MILK COMPOSITION



To investigate the cause of the changes in milk composition, rumen fluid was sampled and the proportions of volatile fatty acids (VFA) present were determined. Results showed that the rumen fluid from cows on the high-grain and low-forage ration was lower in acetic and butyric and higher in propionic acids than that from cows on more normal type rations.

Grazing cows fed high levels of grain gave 38.1 lbs. of milk daily; cows receiving less grain and liberal amounts of corn silage gave 36.5 lbs. However, the extra milk produced did not pay for the additional cost of the grain, especially in light of the reduced fat test of milk from the high-grain cows.

In another study cows were fed all of the corn silage they could eat plus grain or a protein supplement. The composition of their milk remained normal even though hay was not fed. Tests for fat, protein, and SNF from 36 cows on such rations averaged 3.93%, 3.17%, and 8.79% respectively. It was further demonstrated that the stage of maturity at which corn silage was cut did not affect the composition of milk.

(See also "Multiple Component Pricing of Milk," page 18, and "Silage for Milk Production," page 11.)

### Large-Scale Testing for PLM

Production testing for PLM (protein-lactose-mineral fraction of milk), originally a research project alone, became widely available to Virginia dairymen in 1962. Earlier trials showed the procedures to be practical for field use. Approximately 4,000 cows in 70 herds were on test for PLM as of April 1963, and the number steadily increases.

A dye absorption method is being used to analyze milk samples, taken from each cow one day a month, for total protein content. The monthly yield of protein is calculated for each cow, and lactation records are being accumulated.

Analysis of the data thus far indicates that percentages of protein and percentages of fat in the milk of individual cows are not too highly correlated. In other words, we cannot do a good job of predicting one from the other.



The amido black procedure is used for determining protein content of milk.

### Herd Environment Is Important

An examination of 29,089 milk and fat records obtained from dairy herds in 23 states, showed that the cows themselves accounted for 57.4% to 61.0% of the total variation in milk yields and 51.4% to 54.9% of the total variation in fat. Similar values for years (within herds) were 0.02 — 4.7% and 0.9 — 5.3%; for herds, 32.1 — 34.6% and

34.6 — 35.5%; and for states, 3.3 — 7.6% and 6.2 — 10.0%.

These results have at least two applications. First, in selecting cows on the basis of milk and fat yields, much attention should be paid to the herd environments in which the milk and fat yields were measured, and substantially less attention to years and to geographic areas such as states. Second, when a sire is evaluated by the yields of his daughters in several states, a few more daughters, perhaps 10% more, should be included in the summary than if the daughters had been in one state or smaller area. This second application is of special importance for sires used in artificial breeding.

## Poultry

### Feeding Arsenicals to Chickens

Two organic arsenicals have been widely used as feed additives in poultry rations for the past 15 years; but so far the mechanism, physiological or biochemical, as to how arsenicals stimulate growth has eluded clarification.

Studies toward the understanding of how arsanilic acid benefits chick growth have been in progress at this station for the past six years. At no time, however, has growth response been normal. Until three years ago a growth stimulation was obtained; but three times the recommended stimulatory level of 90 grams per ton of feed, or 270 grams, of arsanilic acid was required, and the response was further predicated upon the presence of fish solubles in the diet. During the past three years even this response has disappeared.

The arsanilic research has since been reoriented to study the effects and action of toxic levels of the additive. Seven times the recommended 90-gram level, or 630 grams per ton of arsanilic acid, has been shown to be required before growth is depressed. Levels as high as 2,300 grams served only to further depress growth and have not caused mortality or symptoms of toxicity.

The highest level, when administered in the drinking water as the sodium salt, however, did produce thiamine-like deficiency symptoms including the characteristic head retraction. The thiamine-like deficiency syndrome suggested that the arsanilic acid was interfering with the enzyme systems involving pyruvic acid oxidation. That the possible interference did not involve thiamine or phosphate was demonstrated when increased dietary levels of thiamine and/or phosphate failed to alleviate arsanilic acid toxicity.

There still remains lipoic acid and perhaps other metabolites involved in pyruvic acid utilization to investigate. Studies elsewhere have shown that arsanilic acid is not degraded by the animal body, so a possible effect of the arsenic ion or inorganic arsenic on metabolism seems remote.



It is generally believed that improved growth rates from feeding arsanilic acid are brought about by certain changes in the intestinal microflora. If we learn how the additive alters metabolism in the host chick, the same action should apply to microorganisms in the intestine where similar enzyme systems are at work.

### **Vitamin B<sub>12</sub> and Methionine in Egg Production**

Four all-mash diets were fed to commercial strain-cross S. C. White Leghorn pullets. All diets contained soybean oil meal as the only protein concentrate. Diet 1 was calculated to contain 3 micrograms of vitamin B<sub>12</sub> per pound and 0.34% methionine. Diet 2 had 3 micrograms vitamin B<sub>12</sub> per pound and 0.53% methionine. Diet 3 contained 5.3 micrograms vitamin B<sub>12</sub> per pound and 0.34% methionine. Diet 4 had 7.4 micrograms vitamin B<sub>12</sub> per pound and 0.34% methionine. The calculated cystine content of each of the diets was 0.25%. The calculated protein, fat, fiber, energy, and other nutrients were practically identical in all 4 diets.

Egg production was significantly better for pullets fed diet 4 — 7.4 micrograms vitamin B<sub>12</sub> per pound and 0.34% methionine. The next highest egg production was obtained from the birds fed 3 micrograms vitamin B<sub>12</sub> per pound and 0.53% methionine. No significant differences were shown in feed efficiency, egg weight, or body weight gains. Satisfactory egg weights, body weight gains, feed efficiencies, and egg production rates were obtained on all four diets. Mortality was comparable and from causes seemingly not influenced by diet.

### **Feed Additives and Egg Production**

Six feed additives, Arsanilic acid, Furazolidone, Reserpine, Ninhydrone, Amprolium, and Aureomycin-10 were fed to layers to determine their effects on egg production, egg weight, feed conversion, and certain functional properties of the eggs.

Layers fed Arsanilic acid laid approximately 19% more eggs classified as jumbos, extra large, and large size than those on the control ration. Those fed Aureomycin-10 laid 16% more eggs in these three weight classifications than the controls.

Layers fed Furazolidone, Aureomycin, and Amprolium increased in rate of production faster during the early part of the laying period than the controls. During the seven 28-day feeding periods, egg production was highest (76.5%) in the pen fed Aureomycin-10 at 10 gms per ton of feed.

Layers fed Amprolium averaged 74.8% production while those on the control ration averaged 67.7%. They laid the greatest number of pounds of eggs of any pen and had a feed conversion of 2.52 pounds of feed per pound of eggs.

Specific gravity, pH of foam, and angel-cake-volume for eggs from each pen were comparable but a highly significant difference for these characteristics was noted between

feeding periods. The difference for foam stability and tensile strength of angel food cakes was significant between treatments and highly significant between feeding periods.

### **Broiler Lighting**

How long a daily period of light and what intensity of light should broilers be subjected to for best growth? Limited experimental evidence has produced no one good recommendation for a broiler lighting program.

Several broiler experiments conducted at V.P.I. were designed to study the effect of various lighting regimes on body growth and feed conversion to 9 weeks of age. Different broiler crosses were compared in each of these experiments to determine if different stock responded differently to lighting treatments. The only source of light was from incandescent bulbs controlled by time clocks.

The lighting treatments, with a light intensity of 2 to 3 foot candles, used in the first 3 trials were as follows: (1) continuous light, (2) one hour of light and 2 hours of darkness — a total of 8 hours of light during each 24-hour period, and (3) 8 hours of light and 16 hours of darkness. In a fourth trial, using 1 foot candle light intensity, a lighting schedule of 23 hours on and 1 hour off was compared to a 13-hour period of light plus three 1-hour periods of light with 2 hours of complete darkness between each period of light. An additional experiment using a light intensity of approximately 1 foot candle to compare continuous light with an 8-hour light day was also conducted.

The greatest growth response was made by those groups receiving continuous light, or nearly so, compared to those under shorter light regimes. Both males and females made similar response. Some of the stocks tested responded more favorably than others, but in no case was the use of the extended light period found to be detrimental to body growth.

In general, for those groups receiving 8 hours of light per day, a slight growth advantage was observed when this was given in 8 one-hour periods evenly spaced through the 24-hour day rather than in one 8-hour period.

The use of low intensity light, from the standpoint of body growth and economy of electrical use, appears to be desirable.

### **Light for Egg-Producers**

The influence of daily light periods on the growth and productivity of two different stocks of commercial laying chickens was studied over a three-year period.

Pullets restricted to 6 hours of daily light during the growth period attained greater body weights at 8 weeks of age than those given 14 hours per day. By 20 weeks of age, however, birds under restricted light weighed less than those grown in a 14-hour day. Age at first egg was also retarded by about 11 days under light-restriction.

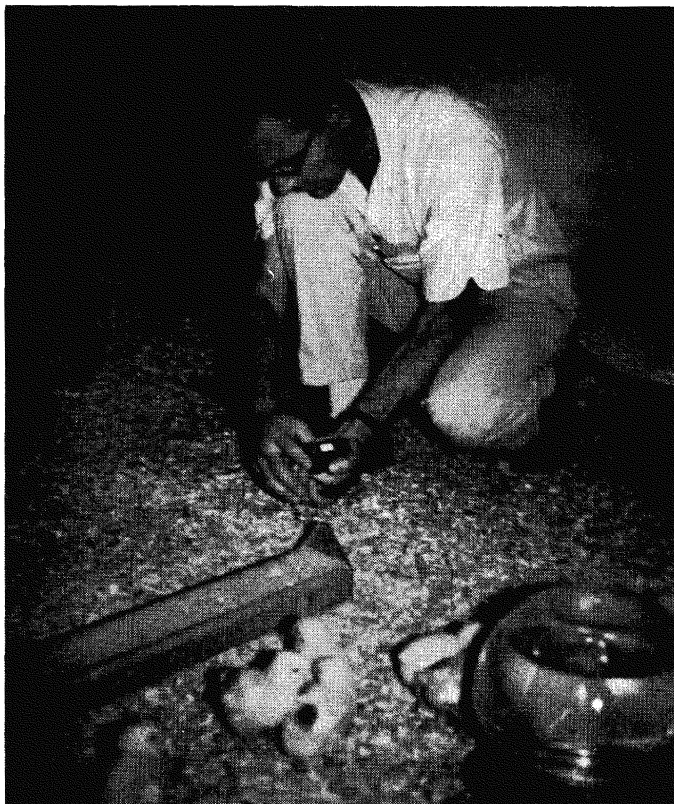
If these birds were given 36 hours of continuous light at 14 weeks of age, then returned to the 6-hour schedule, there was essentially no difference in age at maturity or body weight. Thus it was apparent that the lower body weights associated with short daylength were due to retarded maturation of ovarian tissue.

The light-restricted birds used  $1\frac{1}{4}$  pounds less feed to reach 20 weeks of age than those receiving 14 hours of light, suggesting an economic advantage for this form of light management for growing stock, also, there was less mortality.

At 20 weeks of age, pullets grown in 6 hours of light were given a 3% increase in daily light each week. Those grown on the 14-hour schedule were maintained on that schedule until 50 weeks, which was when the 6-hour-3% groups reached 14 hours per day, and then placed on a 3% increment system concurrent with the others.

Differences between lighting groups in annual egg production were not significant, although the patterns of production differed. The 14-hour-3% groups laid at a higher rate during the first and last quarters of the laying year, while the 6-hour-3% groups were higher during the middle two quarters.

With the exception of the first month, birds on the 6-hour-3% schedule required less feed per dozen eggs. There were probably two reasons for this: (1) Birds were smaller in size and (2) egg size was reduced. When feed required to produce a given weight of eggs was calculated, it was found that there was little difference between groups.



Light intensities were measured with a sensitive photometer during the growing and laying periods.

Economic efficiency may depend on the method in which the eggs are marketed, however.

Restriction of daily light during the early laying period resulted in reduced body size, which was not recovered even after the birds were permitted longer periods of light. Because of their smaller size, these birds used less feed but also laid smaller eggs.

Viability was essentially the same for both lighting treatments during the laying period.

### Temperature and Storage Time of Undiluted Turkey Semen

Although artificial insemination has become widely accepted by breeders seeking to improve reproduction in heavy broad-breasted strains of turkeys, fertility by this technique, though higher than that obtained with natural matings, is still lower than it should be.

Of many factors that influence fertility in an artificial insemination program, two of the most basic yet least understood are temperature and storage time in handling undiluted turkey semen. Research is being conducted to determine the optimum combination of these two factors. Semen was stored at seven different temperatures between  $32^{\circ}$  to  $104^{\circ}$  F. for periods of 15, 45, and 75 minutes, and then used to inseminate 252 hens.

Results indicate that turkey semen should be held between  $68^{\circ}$  and  $80^{\circ}$  F. and stored for no longer than 15 minutes after collection for maximum expression of fertility. Neither storage temperature nor storage time had any significant effect on hatchability of fertile eggs within the range of temperature and storage time used in this study.

Semen samples were also analyzed for physiological characteristics and results substantiated those obtained by the tests.



Research personnel made microscopic examination of the properties of semen and placed it in containers that maintained the desired temperature.

# Sheep

## Breeding Research

### RAPID GROWTH OF LAMBS

A comparison of breeding methods to improve the transmitting ability of Hampshire rams to sire fast-growing lambs from commercial grade ewes has been underway since 1956. Each year 15 ram lambs produced from a flock of 60 to 75 purebred Hampshire ewes, are progeny-tested by breeding each of them to 10 Hampshire X Rambouillet ewes. The three rams whose progeny have the fastest average daily gain from birth to market weight are selected to be used as stud rams in the purebred flock the following season, replacing the rams used the year before. This breeding system is known as *Recurrent Selection*.

Another flock of purebred Hampshires is used as a *Genetic Control*. Rams produced in this flock are also progeny tested in the test flock to provide a measure of progress made in the Recurrent Selection flock. To date only a few of these rams have been progeny tested, but their lambs appear to have somewhat slower growth rate than those sired by Recurrent Selection rams.

### PERFORMANCE TESTING OF PUREBRED RAMS

A uniform feeding test to evaluate gain and potential breeding of rams was initiated in 1962. Fifty-six yearling rams were selected from purebred flocks throughout the State of Virginia and were supplemented by 13 rams from the Experiment Station flock. All of the 69 rams used were consigned from flocks where production records were kept, and only rams whose daily gain to weaning was above the average of its particular flock were accepted.

They were placed on a 9-day feeding trial, being self-fed a ground hay and grain ration. Then they were sheared, thoroughly examined by a veterinarian, checked for fertility, and graded for type and quality. All rams meeting health, gain, and grade requirements were sold in a Performance Tested Ram Sale.

The trial and sale were repeated in 1963 with 87 rams of five breeds tested. The practice of selling unfitted, closely shorn rams that have been graded rather than evaluated in the show ring has proved popular and the management procedure is sound, as evidenced by the performance of these rams in commercial flocks.

Ram Feeding Trial - Performance by Breeds

	Average Daily Gain		Feed per Lb. of Gain	
	1962	1963	1962	1963
Cheviot		.52		9.33
Dorset	.53	.52	10.82	10.67
Hampshire	.60	.60	10.95	10.46
Southdown	.48	.47	10.44	10.36
Suffolk	.74	.75	9.50	8.99

Each year a number of the rams produced in the Recurrent Selection project described above have also been entered in this test to compare their performance with rams produced by breeders. The growth rates and weights of the station-bred rams have compared very favorably with those entered by private breeders.

### EFFECTS OF ENVIRONMENT

A comparison of the response of sheep of different breeding to different environmental conditions was started in 1960. Groups of ewes of two rather widely different genetic backgrounds and origins are kept at the Southwest Virginia Station, Glade Spring, and at the Central Experimental Farm, Ottawa, Ontario. The two kinds of ewes are  $\frac{3}{4}$  Hampshire -  $\frac{1}{4}$  Rambouillet, produced in Virginia, and North Country Cheviot x Border Leicester crosses produced in Northern Quebec.

The ewes are bred to three Suffolk rams which are replaced each season. Due to difference in breeding dates (August 1 to October 1 in Virginia; November 1 to December 15 in Ontario) the same rams are used in both flocks in the same year. The greatest difference in response to environmental effects has been in percentage of ewes bred and average lambing dates. A higher percentage of the Hampshire ewes were bred in Virginia and they lambed about 3 weeks earlier than the Cheviot-Leicester crossbreds. In Ontario there was little difference in percentage of ewes bred but the Hampshire ewes lambed 5 days later.

Lambs from the Hampshire ewes grew faster, were heavier at 120 days, graded higher in the carcass, were fatter, and yielded a higher percentage of dressed carcasses in Virginia than did the Cheviot-Leicester ewes. In Ontario the differences in these traits were small but reversed as compared to Virginia.

### Intensive Production of Lambs

Research on methods by which sheep numbers can be greatly increased on the average Virginia farm has been carried out for several years at the Blacksburg and Glade Spring stations. Concentration of sheep numbers on pasture usually results in increased losses from parasites and disease but particularly with internal parasites. Mature sheep develop resistance but lambs, being much more susceptible, grazed with their mothers in fairly high concentration, become heavily parasitized. Some method of management that will prevent lambs from becoming infected seems necessary. Several possibilities have been tried and are briefly described below.

### EARLY WEANING OF LAMBS

At Blacksburg lambs have been weaned at the beginning of the pasture season (about April 20) for the past 4 years and finished on bluegrass or ladino clover pastures with supplemental grain, as well as in dry lot. The lambs grown to market weight in dry lot on pelleted complete rations did

extremely well, averaging 0.7 lb. gain per day and grading top choice to low prime. Those alone on pasture gained 0.5 lb. per day and averaged choice. Lambs on pasture with their mothers averaged about 0.45 lb. gain per day and graded low choice. Lambs grazed on ladino clover pastures did better than those on bluegrass.



**Lambs weaned at 30 days of age and raised on slatted floors.**

#### SEPARATE GRAZING FOR LAMBS

Lambs have been grazed on separate pastures from ewes at the Glade Spring Station for the past 4 years. These lambs were not weaned but were put in barns with their mothers for about 8 hours during the day. The rest of the time they were grazed on separate pastures. A control group of lambs and ewes were grazed together for comparison.

Lambs grazed by themselves have gained faster and graded higher than those grazed with their mothers. The average difference has been about 0.1 lb. gain per day and 1/3 of a grade. Lambs grazed on ladino clover did somewhat better than those on bluegrass.

Although 8 to 12 lambs were grazed per acre of pasture, it was necessary to mow frequently or to use cattle to graze the surplus growth. Very little time or labor was needed to separate the lambs from the ewes after a week.

#### VERY EARLY WEANING OF LAMBS AND REBREEDING OF EWES

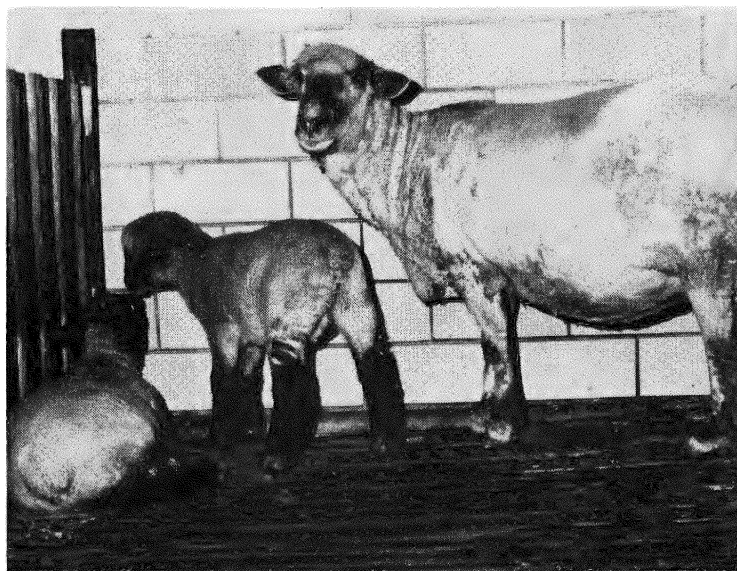
The method described in previous reports in which ewes were prepared before lambing by being shorn all over or around the udder and genitalia, washed and then placed on slatted floors to lamb has been continued. (Goats were added to the project to be used in both parasitic and bacteriologic investigations.) Leaving the ewe and lamb together for 30 days and then weaning is the key to having the ewes rebred to give two lamb crops per year.

In the past two years additional, appropriately designed facilities have been provided and various types of slatted floors are being evaluated. These include not only wood, but also concrete slats, steel slats, and various types of wire mesh, expanded metal floors. Additional work is being done on management practices and development of hay-feeding and grain-feeding facilities which will minimize or eliminate wastage of hay or grain.

Methods of using vasectomized or other forms of teaser rams to detect ewes in heat are being investigated. Use of hormones both by injection and in forms that can be fed in the grain are being investigated. Methods that will be easily performed to identify pregnancy in the ewe are also being investigated.

Indications to date are that this method has great potential insofar as commercial application is concerned. Average days between lambing was 203.5, and average lambs marketed per ewe bred averaged 1.4.

Lambs have made very good gains, averaging close to 0.7 lb. per day from birth to weaning. Practically all of them graded prime. They were self-fed a complete pelleted ration, 35% ground alfalfa and 65% concentrates, and were fed long alfalfa hay in addition. Feed conversion has been very satisfactory, ranging from 3.5 to 3.8 lbs. per pound of gain.



**This ewe was shorn and washed before she lambbed on slatted floor.**

#### Influence of Ewe's Nutrition on Lamb Performance

Rations containing 60%, 100%, and 140% of the energy level recommended by the National Research Council were fed to three groups of ewes during the last 8-12 weeks of pregnancy, in each of the last 4 years, to determine the effect on lamb birth weights, growth rate, and survival to 56 days of age.



There has been no marked effect on birth weights by either the high- or low-level of energy. Average daily gains of the lambs in each group were also quite similar. The lamb survival rate to 56 days also indicated little effect from the treatments.

There has been some indication that feeding the 140% level resulted in excessive fattening of the ewes and created lambing troubles and some delay in milk flow.

The condition of the ewe prior to the start of the experimental period had a marked influence on the results. The ewes went into the feeding period in good flesh each year and this tended to mask or minimize the treatment effect in the lower energy level group and possibly aggravate the excessive fattening situation in the 140% group.

The data indicate that ewes in good condition can be fed 60% of the recommended level of energy during late gestation without impairing lamb birth weights, vitality, and subsequent growth rates.

### Fattening Lambs

#### CALCIUM LEVEL AND ZINC SUPPLEMENTATION

A feeding trial was conducted to study the effect of calcium level of lamb-fattening rations, and the interrelationship of zinc supplementation and calcium level. Eight lots of 10 lambs each were fed completely pelleted rations with approximate calcium to phosphorus ratios of 1:1, 2:1, 4:1, and 8:1, with and without 100 parts per million zinc (5.65 grams zinc oxide per 100 lbs. feed).

In lots not fed supplemental zinc, rate of gain and feed efficiency were lower at the two higher calcium levels. No depressions in rate and efficiency of gain were observed at high calcium levels in the lots fed supplemental zinc. Liver iron levels generally decreased as calcium level of the ration increased, whether the ration was supplemented with zinc or not. Liver copper levels also decreased with increases in calcium level in the lots not fed supplemental zinc, but not in the zinc supplemented lots. At slaughter no stones were detected in the bladders of any of the lambs.

#### PHYSICAL FORM OF RATIONS

Four feeding trials were conducted to study the relative value of coarse grinding, fine grinding, and fine grinding and pelleting the entire ration, when the hay is of low or high quality; and the value of feeding a small amount of long hay to lambs fed completely pelleted rations. The roughages consisted of pasture-clipping hay and high-quality alfalfa hay.

The highest daily gains were for the lots fed pelleted rations with or without a small amount of long hay. When alfalfa hay was used as a source of roughage, the highest feed efficiency was for the lambs fed the completely pelleted ration. When pasture-clipping hay was the roughage source, the lowest feed efficiency was for the lambs fed coarsely ground feed; and there was not much difference among the other lots.

## IMPLANTS

An experiment was completed on the effect of implanting 3 mg. stilbestrol or "Synovex" (25 mg. progesterone and 2.5 mg. estradiol benzoate) in grazing and feedlot-fed fattening feeder lambs, and time of implanting these. The implants were administered at the beginning of the trial, at mid-period, and at both times.

Implanting 3 mg. stilbestrol or "Synovex" to grazing or feedlot-fed feeder lambs at the beginning of the period or at mid-period generally resulted in an increase in rate of gain. The response was generally more marked and was more consistent when these implants were made at the beginning and again at the mid-point of the period than when used at only one of these times. The implants did not markedly alter carcass grade.

## Swine

### Confinement and Carcass Quality

Does confinement affect pork carcass quality? The rapidly growing interest in more efficient methods of swine production, emphasizes this question. Concern has been expressed that hogs fed in close confinement on concrete do not yield the highest quality pork.

Two trials using 210 pigs compared carcass quality of pigs reared in an air conditioned house, half-shelter over concrete, with those in a dirt-lot colony-type house. Carcass quality as measured by U.S.D.A. grade, marbling, overflow, and feathering was not materially affected by type of house or amount of floor space per pig.

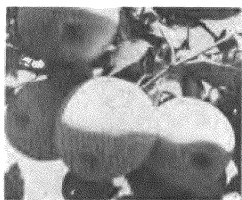
Future work on this project will be to study the effect of confinement on pork processing characteristics.

### Indicators of Carcass Composition

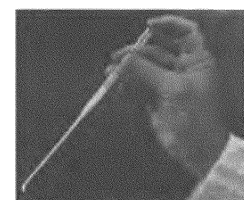
Since carcass length, backfat measurements, loin eye area at the 10th rib and lean cut yield are generally accepted as good estimators of carcass composition in swine, a study was made of these conventional estimators and also other objective indicators of carcass composition.

Fifty-six carcasses from pigs weighing 50, 100, 150, and 200 lbs. live were measured and cut. The rough loin was divided into 4 sections and the lean and fat of the cut surface areas were determined. The ham was also divided and the cross section areas of lean and fat were determined. The cuts were physically separated into lean, fat, and bone, and chemical composition was determined on lean and fat. A close relationship between separable lean and fat, and percent protein and fat of the side was noted.

Carcass measurements of length, backfat, loin eye area, and lean and fat areas of the ham cross section were not found to be reliable estimators of composition. The 10th rib to mid-loin section and the total loin were found to be better indicators of physical and chemical composition of the side than the other primal cuts. Lean cut yield and *Longissimus dorsi* weights were not found to be good indicators of composition.



# Fruits, Vegetables And Ornamentals



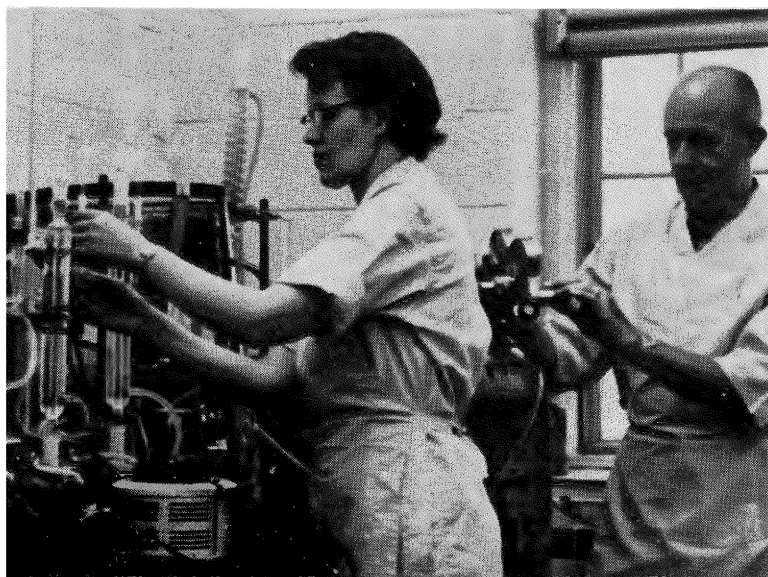
## Chemical Residues

The use of new organic chemicals, which generally are more effective than the older inorganic materials for protecting cultivated plants and domestic animals from harmful pests, has required new methods for the detection of these pesticides in foodstuffs and to assure that safe levels are not exceeded. Many difficulties encountered in the past for the quantitative determinations of pesticides are being overcome by improvements in instrumentation and micro-techniques, including both chemical analysis and bio-assay.

Studies to obtain the necessary data for the correct use of chemicals in the control of pests have been underway for several years in Virginia. We are determining the time required for residues to disappear and are establishing persistence curves for each vegetable of commercial importance in the State. Research is being conducted in both the low-lying coastal areas and higher inland mountain regions.

Studies are underway to improve the methods of analysis including extraction of the residues from foodstuffs; the removal from the extracts of pigments, waxes, fats, and other foreign materials which interfere with the analysis of the residue; and the use of new instruments to increase the sensitivity and productiveness of the laboratory.

Modifications were made in the analysis of sevin to give a more sensitive detection of the residue in milk and vegetables. It was determined that the hornfly could be controlled on cows without contamination of the milk if the sevin was applied immediately after milking.



Special apparatus is used to determine organic residues in plants.

## Insects of Apples and Peaches

Research on apple insects must deal with many factors and in several areas; for example, insect biology, development of resistance, control programs, evaluation of current and new insecticides and acaricides, modes of application, and compatibility of the various components of the spray mixtures.

The arthropod pests of apples include codling moth, red-banded leaf roller, phytophagus mites, aphids, scale insects, leaf miners, curculio and others. Many of these must be controlled each season.

Many valuable pesticides have lost their effectiveness in control programs because the pests have developed resistance. Some examples are DDT resistance in codling moth, TDE resistance in red-banded leaf roller, and generalized resistance in phytophagus mites to a number of organic phosphates.

Control of codling moth and red-banded leaf roller is now being designed to destroy the moths before the eggs are deposited. Previous control was chiefly by destroying the larvae. Guthion and Sevin are the main insecticides in use for these two pests; however, parathion and malathion are widely used.

Several experimental insecticides of the carbamate group appear to hold promise for future use. A number of the organic phosphate group are also being evaluated. New or novel ways of controlling arthropod pests are also investigated. Research is carried out on the use of biological agents in the control of apple pests.

Many insects attack the peach tree and its fruit. Of those attacking the tree, the peach tree borer, the lesser peach tree borer, and scale insects are most important; and of the fruit, the plum curculio and the tarnished plant bug are annual problems.

Of many new insecticides tested, a combination of dieldrin and parathion gave outstanding control of the plum curculio and scale insects, and this combination spray is currently recommended in four early season applications.

The tarnished plant bug is difficult to control since it appears often at bloom period when insecticides cannot be applied because of toxicity to bees. Several repellent materials were tested in combination with the insecticides during bloom but none gave the desired results.

Of the many insecticides tested for control of the lesser peach tree borer and the peach tree borer, thiodan was most effective. Endrin and parathion were moderately effective in controlling both species but DDT was effective only for control of the peach tree borer.

## Orchard Mouse Control

Reinfestation of orchards by pine mice following their elimination by ground-spraying with endrin was studied in two locations. During the summer and fall, the invaders spread rapidly over the orchards at a minimum rate of 500 to 1,000 feet per month. Reinfestation stopped during the winter since mouse movement and rate of reproduction were much less.

Well-established mouse colonies along the edge of an orchard serve as effective barriers against invasion by migrating mice. If large numbers of mice are in the invasion groups, they may overwhelm established colonies and move on into the orchard.

Endrin ground spraying of a 4' to 6' strip along the tree row is effective in killing all pine mice in apple and peach orchards. Cultivation between the tree rows forces the mice to live in the sodded area along the row. This area should be considered as a mouse pasture containing desirable food plants and the most suitable area for periodically eliminating the population by spraying.

## Apple Breeding

Many years of apple breeding work are finally beginning to show results. The thousands of seedlings produced to date have borne fruit and a few superior seedlings have been selected for further testing. Of these V.P.I. 2, 4, and 5 appear most promising.

V.P.I. 2 is a seedling of Winesap crossed with Opalescent. The fruits ripen at Blacksburg about September 15 or ten days before Delicious and have attractive skin color and above average size. The flesh is extremely firm and of sprightly to tart flavor.

V.P.I. 4 is a seedling of Red Rome crossed with Schoharie. The fruits ripen about September 18 or shortly before Delicious. They are highly colored with fine finish. The flesh is firm and of mild subacid flavor somewhat like Northern Spy (Schoharie is a seedling of Northern Spy).

V.P.I. 5 is a seedling of Macoun crossed with Arkansas Black. Its fruits ripen about October 2 at Blacksburg or shortly before Golden Delicious. The fruits have solid dark-red color and superior finish. The fine grained white flesh is crisp and juicy with flavor that suggests its Macoun parentage.

Several years of additional testing may be necessary before these selections are named and released.

## Chemical Thinning of Apples

Five ammonium ( $\text{NH}_4^+$ ) salts of four highly ionized acids were found to act as adjuvants to increase absorption of the sodium salt of naphthaleneacetic acid (NaNAA). The effect cannot be assigned to the  $=\text{N}=\text{}$  moiety of the molecule alone; the activity appears to be a synergism between the  $\text{NH}_4^+$  cation and the anion from a strongly ionized precursor acid.

Guthion,  $(\text{NH}_4)_2 \text{SO}_4$ , and  $\text{NH}_4 \text{HSO}_4$  were significantly effective as adjuvants to induce NaNAA absorption whether applied in the same tank mixture with NaNAA or 24 hours prior to NaNAA application. Applications of Guthion 24 hours after NaNAA were without significant adjuvant effect.  $(\text{NH}_4)_2 \text{SO}_4$  in soft water sprays significantly enhanced NaNAA thinner action whether applied in the same tank with NaNAA or prior to NaNAA.

"Days after full bloom" is a questionable method of timing fruit-thinner sprays. Several climatic factors may cause the desirable spray date to vary considerably from year to year. Blooming of the wild dewberry seems to coincide with the most desirable date for thinning York apples with NaNAA, suggesting that vegetation other than apples may provide a suitable index.

A spray of Sevin at concentrations of 2 lbs. of 50% wettable powder per 100 gallons gave satisfactory thinning of Rome and Winesap, but was inadequate on York and Golden Delicious. Adding NaNAA at 10 ppm to the Sevin gave satisfactory thinning of Golden Delicious. During a season when Rome was not adequately thinned with NaNAA, it was suitably thinned with 50% wettable Sevin at 1.25, 2.0 and 2.5 lbs. per 100 gallons.

## Peach and Nectarine Breeding

The most recent peach introduction is V.P.I. 54, to be named Madison and released August 1, 1963. It is a seedling of Ideal x Redhaven. It was selected in 1955 when it bore a full crop of attractive fruit in a season when most of Virginia's peach crop was destroyed by frosts. The fruits ripen seven days before Elberta, filling a period in the ripening season for which no superior variety is available. They are highly colored and attractive, with exceptionally firm yellow flesh and resembling Redhaven in texture, flavor, and quality. The fruit buds were tolerant to frost in 1957 and 1959 as well as in 1955.

V.P.I. 58, which ripens 12 days after Elberta, is being propagated for possible introduction after a few more years of testing. This is a seedling of Rio Oso Gem x an unnamed V.P.I. selection. The fruit is superior in size and color and its yellow flesh has flavor and texture superior to Rio Oso Gem. Its blossom buds appear to have considerable tolerance to frost.

New nectarine selections may lead to eventual introduction. V.P.I. 52N is a most attractive white-fleshed nectarine that has performed outstandingly in tests in France and Italy and has attracted the attention of horticultural research worker there as well as in the United States. V.P.I. 57N is a very early ripening, yellow-fleshed nectarine of superior fruit size, attractive skin color combined with above-average quality, and frost tolerance. V.P.I. 59N ripens its yellow-fleshed fruits a few days after V.P.I. 57N. The fruits have fine size and exceptional color and finish. The flesh is less stringy than that of most nectarines, and it has a mild, rich flavor, and a quality well above other nectarines.

### **Peach Fruit Spacing**

Tests have been run to determine the effect of the time of thinning and spacing of fruits on some of the early maturing peach varieties. Fruits on separate trees of each variety were thinned at bloom, and at 2, 4, and 8 weeks after bloom. At each thinning spacings of 4", 6", and 8" apart were used. Additional trees of each variety were thinned to only one fruit per growing point regardless of its length.

Total yield of all fruits was not affected by the time of thinning and was reduced only when the spacing exceeded 8". Time of thinning had more influence on the size of the fruit than did the spacing.

For earlier ripening, maximum size, and highest yield of marketable fruit, thinning should be completed as soon as possible after bloom and the fruits spaced not less than 6" and not more than 8" apart.

### **Weed Control in Young Peach and Apple Orchards**

The control of weeds during the first two or three years in young orchards aids rapid growth of the trees. Chemical control has been found to be fairly economical.

A spray containing a mixture of Amizine and 2,4-D has proved successful in young peach and apple orchards. Another mixture containing duron and Amitrole is also safe to use on the young trees. A new herbicide, Shell 7961, also appears to give excellent control without injury to the trees.

The spray should be carefully directed around the base of the trees, so as to prevent getting any of the mixture on the trunks or stems. It should be applied as a flat low-pressure spray in the spring before leaf buds begin to swell.

### **Plastic Mulch for Young Plantings**

Peach trees grown 2 years with 4' squares of black plastic mulch around them increased 25% more in trunk diameter than check trees and 10% more than trees hand-weeded. Trunk measurements at the end of the fourth growing season indicated that mulched trees had maintained their relative growth advantage.

Advantages of the black plastic mulch include: control of all vegetation, relative low cost compared with hand weeding, and freedom from possible mechanical or chemical injury to foliage, root, or trunk.

Some disadvantages are these: time and care required for correct application; care needed to cultivate around edges of material; possible harboring place for mice; possible moisture shortage during long periods of scant rainfall.

### **Plastic Mulch for Grapes**

Black plastic mulch used around Concord grape vines at planting time and maintained during the first summer

greatly increased vine growth. This effect persisted to the second and third years and mulched vines bore fruit one year earlier than unmulched vines. Conservation of soil moisture under the mulch during the critical early stages of vine growth appeared to be an important factor.



**Above, a 3-year-old unmulched Concord grape vine. Below, a vine of the same age mulched with black polyethylene film during its first season.**

## **Vegetables**

### **New Cultural Practices for Broccoli**

Broccoli plantings irrigated to keep moisture levels high have yielded about twice as much edible plant material as plants not irrigated. In some years, irrigation tripled the yield of lateral inflorescence, and the broccoli produced on the high moisture plots was of higher quality and more succulent.

One-foot spacing between plants in rows 3 feet apart significantly increased the yield of central and lateral inflorescences, leaves, and total edible material over that obtained from a 1½' spacing. The chemical composition of the plants was not significantly influenced by the spacings tested.

Using 10 leaves per plant increased the yield of edible material by 39% over the usual practice of harvesting only



the inflorescence. Yields of inflorescences were slightly reduced by pruning. Leaves are equal to inflorescence in vitamin C and 4 times as high in vitamin A.

Although yield and quality of broccoli varied from year to year, broccoli plant parts high in crude fiber and dry matter always tended to be low in ascorbic acid and carotene.



The effect of high and low soil moisture levels on the size of broccoli plants.

### Xenia Effects in Sweet Corn

The xenia effects in sweet corn have been observed for weight, composition, and quality of kernels of self-pollinated corn compared to outcrossed  $F_2$  hybrids. Outcrossing of certain hybrids reduced kernel size, embryo size, and pericarp content, but increased quality; for others, quality was decreased and the other factors increased.

Since pollen influences quality, sweet corn grown for quality evaluation should be hand-pollinated. Furthermore, sweet corn should never be planted close to field corn which may tassel at the same time. Controlled pollination is also necessary in studies of the influence of soil type and other factors affecting sweet corn quality; conversely, careful selection of uniform soil is necessary for studying xenia effects and evaluating varieties.

### Consumer Acceptance for Sweet Potatoes

Research indicates that much of the decay caused by *Rhizopus* soft rot and black rot of sweet potatoes can be eliminated by treating the tubers with sodium-orthophenylphenate (SOPP) before shipping. The use of this fungicide treatment and 3-pound bags provides the consumer with higher quality, more attractive sweet potatoes. Packaged sweet potatoes outsold sweet potatoes displayed in bulk. An attractive, ventilated package, easy to handle and open seems to be the key to more successful marketing of Virginia sweet potatoes.

### Consumer Acceptance for Potatoes

When 10-pound bags of Virginia-produced potatoes were priced the same in a large serve-yourself store, mesh bags outsold paper bags. When prices reflected the cost of packaging, with paper bags 2 cents per bag less than the mesh, the paper bags sold best.

Brown and white paper bags sold equally well. Red plastic mesh was much more popular than brown. The package most suitable for Virginia potatoes should be ventilated, to overcome high moisture and chance of decay, and the potatoes should be mature when dug, if Virginia producers are to maintain their market position.

### Weed Control in Vegetables

When peppers, tomatoes, cabbage, and broccoli are transplanted, an application of granular herbicides greatly reduces weed competition without injury to the plants. Research shows that control without harm is obtained with Diphenamid at 6 lbs./A., trifluralin at 2 lbs./A, and tillam at 4 lbs./A. The latter two chemicals should be worked into the soil by cultivation immediately after application.



Weed control in cabbage, broccoli, and tomatoes with diphenamid at six pounds per acre at transplanting.

### Pricing of Processing Tomatoes

Agricultural economists are examining the pricing of processing tomatoes in an attempt to develop a more realistic basis and one that will give producers incentives to deliver tomatoes more suited for canning.

Experimental lots of Campbell 146 variety tomatoes were selected subjectively in 3 quality classifications, in 3 size classes, for 3 color intensities. Objective measurements of each of these factors were made, expressing final quality characteristics in terms of: (1) size, count of tomatoes per 100 pounds; (2) defects, percent core and trim waste; and (3) color, colorimeter reading of the blended juice of each lot.

# Ornamentals

## Weed Control in Nursery Crops

Amizine, a herbicidal mixture consisting of 45% simazine and 15% amitrol, controls winter and summer annuals, both broadleaf and grassy weeds, for 6 to 8 months when applied between October and January. It must be applied as a directed spray and when the weeds are relatively small. The amount of hoe time required for maintaining weed control during one year following treatment was reduced more than 50% from one application.

Simazine alone gave excellent residual control of annual weeds but must be used pre-emergence to the weeds. The added amitrol gave the extra punch to control existing winter annual weeds. This has the advantage of leaving a dead sod to prevent winter erosion of the soil. Winter erosion can be a serious problem following simazine treatments.



**Weed control from January application of amizine showing dead sod which helps prevent erosion.**

## Winter Injury Research

A winterized lath house has been designed and tested for preventing winter injury to plants in landscape and nursery. The house is an "A" frame built of 2" x 4" lumber 12' long. The base is 17' and the height 8'.

The frame is covered with lath strips or snow fence, and this shade layer is covered with 4-mil polyethylene film held down by wires. A film 24' wide will cover the entire structure.

No heat is needed, as the purpose is to keep plants dormant. On December 12, 1962, at Blacksburg the outside temperature was  $-6^{\circ}$ . Inside the lath house it was  $20^{\circ}$ . Twenty species of borderline plants came through the severe winter with little or no discoloration, while plants in conventional mulch or lath houses were severely damaged. When the plastic is removed about April 1, the structure serves as a shade house.

These factors were studied in relation to time required to trim 100 pounds of the raw product, yield of prepared product, and quality score and grade of the product canned from each lot.

Preliminary analysis shows that color, size, and defects are all related to the time required to peel, core, and remove defects from the raw product. The pounds of tomatoes that could be trimmed per hour increased at a uniform rate as colorimeter readings increased. As the number of tomatoes per 100 pounds increased (size decreased), the pounds of tomatoes that could be prepared per hour decreased. As trim waste increased up to the 20% level, the pounds of tomatoes that could be prepared per hour decreased. Above the 20% level, an increase in trim waste was associated with higher rates of preparation.

Yield of prepared tomatoes was influenced by both the size of tomatoes and defect trim waste, but was not significantly affected by colorimeter readings. As either count of tomatoes per 100 pounds or defect trim waste increased, the yield of prepared tomatoes declined. The exact nature of these relationships is not determined but the rate of decline is probably not uniform.

Colorimeter reading was, by far, the most important factor affecting quality of the canned tomatoes. The higher the readings, the higher were quality scores and grade. Percent trim waste was inversely related to grade points but size showed no significant association with quality.

Calcium salt substituted for a portion of the sodium salt, as seasoning, resulted in marked increases in grade score and final grade, as it consistently led to higher scores for wholeness in the canned product.

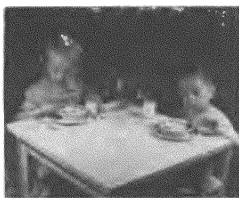
The above relationships, supplemented by variable costs per case of tomatoes packed, labor costs per shift, and overhead plant costs, can be used to arrive at prices that can be paid for tomatoes with varying quality characteristics resulting in break-even costs for canned tomatoes.

Additional work is needed to confirm these relationships under varying variety and plant conditions, and to work out the details of inspection procedure and reporting of quality characteristics to meet the needs of the industry.

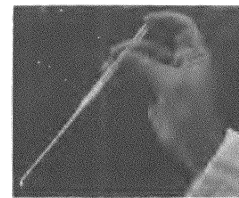
## Vegetable Variety Trials

Many new vegetable varieties are released each year. Although time and facilities for testing are limited, effort is made to test those varieties that appear more likely to be of value to Virginia producers. It would be very difficult for a grower to test even a few varieties scientifically because he would lack the time and facilities, and possibly the training.

Researchers conduct trials of tomato varieties at Warsaw and Blacksburg, and sweet potatoes are tested on Eastern Shore in cooperation with the Virginia Truck Experiment Station. Results are published each year.



# Human Nutrition And Food Technology



## Nutrition Studies with Children

Twelve preadolescent girls, 7 to 9 years of age, served as subjects for a nutrition experiment during the summer of 1962. They were housed, fed, and cared for in one of the women's residences on the V.P.I. campus for 6½ weeks. They consumed a weighed diet and collected all excreta. Biological materials collected were sent to the Agricultural Experiment Station in each of 6 states and to the Human Nutrition Research Department of the U.S.D.A. Data from this study will provide information on relationships between protein utilization and the metabolism of several different vitamins and minerals.

## CALORIE NEEDS OF CHILDREN

A five-year study of the energy children use has been initiated. Calorie needs for basal metabolism and for selected activities will be determined. Information from this study should add to our knowledge of caloric requirements of children and of differences between individuals in calories used for the same activity. It should also indicate which calorie needs for basal metabolism, and for activities, vary or remain constant in the same child during growth from preadolescence through adolescence.



Measuring air expired during walking, to determine energy expenditure of children under study.

## Factors Influencing Meat Preference

Many questions have been raised regarding the ability of present U.S.D.A. grade standards to reflect the qualities in beef most desired by the consumer. If this is true, the consumer has inadequate means of selecting beef cuts and reflecting his desires through actions in the market. In turn, the producer cannot know precisely what is wanted by the consumer. More objective standards would improve the efficiency of the marketing system.

Research at V.P.I. seeks to correlate consumer preference with beef characteristics in an effort to determine more meaningful grades. Characteristics studied were protein, fat, moisture, and ash. Top round muscles from 12 cattle were used for analysis and taste panel work.

When there was a large difference in fat content between two samples, the taste panel preferred the high fat sample by 3 to 1. When the difference between fat content of samples was small there was a 3 to 1 preference for the samples with the least fat. The taste panel expressed a preference for round steaks nearest the anterior end of the muscle.

## SCORING MEAT MECHANICALLY

Studies at V.P.I. show that the number of "chews" a taste panel member records for a piece of meat is quite closely related to the tenderness score of the meat. Since chewing is a mechanical action, it should be possible to devise a machine which will duplicate the chewing action of a person.

The machine now being developed has been used to measure tenderness of lamb, veal, pork, and beef. As yet, the machine has not been able to measure the tenderness of meat as well as a trained taste panel but recent modifications of it have been giving promising results.

## Bitter Flavor in Cottage Cheese

About one-third of the cheese produced in the United States (excluding process cheese) is Cottage. One problem associated with marketing this perishable product is a bitter flavor that often develops at refrigeration temperatures. Causes of this defect are presently unknown.

To permit studying the compounds associated with bitterness, a method was developed for quantitatively extracting the bitter flavor materials, based on differences in solubility. To make the separation, the Cottage cheese was dissolved with a tissue grinder in a slightly alkaline solution (pH 9.0). Then the solution was acidified (pH 4.2) with dilute hydrochloric acid and subsequently made slightly more alkaline (pH 4.5) with dilute sodium hydroxide. At this hydrogen-ion concentration the bitter components were soluble and the cheese proteins were precipitated.

Results so far indicate that development of bitter flavor in Cottage cheese is due to (a) residual microbiological enzymes, (b) enzymes associated with the growth of microorganisms in Cottage cheese, or (c) combinations of these factors. Further research should demonstrate more clearly the influence of microorganisms on bitter flavor and indicate means of control.



Tissue grinders of 40 ml capacity, lower left, and a Metrion hydrogen ion meter, in front of operation, were used in separating bitter-tasting materials from Cottage cheese.

### Canning Characteristics of Peach Varieties

Peach growers need to have good peach processing varieties that yield well and mature over a period of several weeks. The quality of the clingstone pack in Virginia is acceptable while that of the freestone is unsatisfactory. It is felt that a pack of greater uniformity in quality can be had by using selected varieties having similar canning characteristics, refrigerated storage, and certain cultural practices.

The peaches used in this research were produced in Montgomery County and were harvested when the majority of peaches of each variety were in the eating-ripe stage. The harvested fruit was separated subjectively by firmness and ground color into groups of immature, mature, and over-mature classes.

After they were stored for 5 months at 60° F., the canned peaches were evaluated by a technical panel for color, smoothness of the outer surface, lack of raggedness, absence of discoloration, flavor, and texture.

The study showed that a clingstone pack of fair uniformity can be obtained by starting the season with Babygold 8 and follow it with W2-7-30, W2-7-22, and Babygold 7. Babygold 6 and Babygold 5 can be used until W2-7-30 and W2-7-22 become available.

To provide freestone varieties that would produce a uniform quality pack, the pack season should start with V.P.I. 50 followed by Redglobe, Madison, Redskin, and Jefferson. Until V.P.I. 50 becomes available, Richaven or Sunhigh could be used with a fair degree of success.

### Apples after Harvest

Research on keeping apples after harvest is resulting in longer availability, greater after-storage life, and longer maintenance of high apple quality. To accomplish these ends, some apple disorders are being reduced and better keeping practices are being adopted. These are results of research studies in Virginia and other states.

The dark skin disorder of apples called apple scald is being controlled commercially by the use of a scald-inhibiting material, such as diphenylamine (DPA) or etoxyquin.

Over-ripeness, mealiness, and internal breakdown are being avoided by marketing fruit while it is still in a firm condition. Apple pressure testers are used to determine fruit firmness and the storage limit for each lot of fruit.

Improved cold storage practices, such as prompt storage, rapid cooling, and controlled atmosphere (CA), are being followed. In CA storage the carbon dioxide and oxygen gas concentrations are controlled to provide longer storage life and after-storage shelf-life than under regular cold storage conditions.

### DPA CONTENT OF APPLES

Since diphenylamine has been found effective in controlling scald in apples, it is important to know the factors that affect the DPA content of treated apples and the amount of DPA present in different apple products. Determinations of those factors have been made.

All the apple products tested were prepared in the laboratory, but the conditions used were as close as possible to commercial conditions. Results are summarized as follows:

Fruit treated by immersion in 2,000 ppm DPA suspension was found after 5 months storage at 32°F. to contain 0.50 ppm DPA. This is considered a very low residue level.

DPA residue in apple products made from peeled fruit was found to be relatively very low. In products made from unpeeled fruit the residue was twice as high, or higher.

Processed products prepared under the conditions used in this work had a low DPA content — in all instances lower than one-tenth the established U. S. Food and Drug Administration tolerance of 10 ppm in or on fresh fruit.



## TRIM WASTE OF APPLES FOR PROCESSING

Packers of fresh fruit have improved their handling techniques, raising the quality of the table sorts. A study was made to see if today's table sorts are as suitable for processing as tree-run apples.

No significant difference was found between the amount of waste trimmed from table-sort apples and that trimmed from tree-run apples, except in one packing house where more trim waste was removed from table-sort apples. This increase was due primarily to excess rough handling.

Trim waste increased as the length of storage increased but more slowly in cold than in common storage. Table-sort apples did not deteriorate in storage any faster than the tree-run apples did.

Table-sort apples obtained from selected packing houses had the same value for processing as tree-run apples did.

## CORROSION IN APPLESAUCE CANS

Canned applesauce frequently exhibits internal can corrosion, marked often by discoloration of the product and mild to severe detinning of the container.

The following and possibly other factors that may have a bearing upon corrosion were studied: air content, particle size, consistency, pH, total acidity, soluble solids, corrosion accelerators and inhibitors, and apple variety.

During preparation and canning of applesauce, certain of its physical and chemical characteristics were changed in order to study systematically the factors mentioned above.

Degree of corrosion was ascertained by visual observations of the tin plate and by quantitative polarographic tin determinations in canned applesauce stored for different periods of time. Hydrogen, oxygen, carbon dioxide, and nitrogen content of can headspace gases were quantitatively analysed by gas chromatography procedures. Throughout the work, only standard cans of known tin plate composition and made from identical tin plate were used.

The results obtained are as follows:

- 1) A correlation was observed between consistency of canned applesauce and rate of corrosion, the higher consistency product being less corrosive.
- 2) A minimum rate of corrosion was noted in applesauce of pH between 3.5 and 3.7. Rate of corrosion was higher in applesauce of pH between 2.5 and 3.5, and between 3.7 and 4.7.
- 3) Time of packing during the processing season was found to be a factor when storage temperature is above 70°F or when storage periods are longer than 12 to 18 months at 70°F or above, a higher rate of corrosion being observed during the earlier periods of the season.
- 4) A higher rate of corrosion was observed in 303 x 406 cans than in 603 x 700 cans.

## CONCENTRATING APPLE JUICE

Sargeant Electronic Concentration Process is a new method for producing high-density fruit-juice concentrates. It replaces conventional conduction heating with dielectric heating. High frequency energy at 20,000 cycles per second is used to evaporate water under vacuum. Concentration occurs at about 60°F so heat damage to the product is eliminated. A 7-fold orange juice concentrate is being produced commercially by this process.

A research program has undertaken to determine the suitability of the process for apple juice concentrates. Results obtained to date can be summarized as follows:

- (a) No important technical difficulties were experienced while concentrating 12% soluble solids apple juice to 75.4% soluble solids.
- (b) The concentrate reconstituted easily with 7 parts water to produce a 12% soluble solids juice.
- (c) The following chemical and physical characteristics of apple juice were unchanged by the process: pH, specific gravity, viscosity, color; and the amount of tannin, total acidity, ascorbic acid, reducing sugars, total sugars, and sucrose.
- (d) The only change by concentration was a loss of apple aroma; however, taste panel studies showed that the reconstituted juice still retained enough apple flavor that its overall quality compared quite favorably with that of the original juice.
- (e) Concentrate stored at 35°F remained physically stable for 8 weeks and then began to darken in color. Increasing storage temperature to 75°F increased the rate of darkening. Darkening is accompanied by flavor deterioration. Concentrate stored at -10°F did not darken.

## *Vegetable Processing*

### SNAP BEAN END DARKENING

Mechanical harvesting of snap beans has given processors a serious problem: the color on the ends of green beans changes to a dark brown or black. Investigation shows the problem to be serious all over the United States.

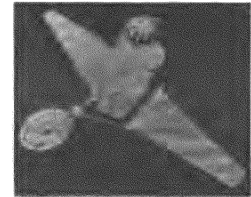
A season of work in bean fields, processing plants, and the laboratory has produced an understanding of many of the factors influencing the darkening. Washing or submerging the beans in water or limiting oxygen accessibility by any means, such as enclosing in a polyethylene bag or glass container, reduced or eliminated the problem. Treatment of beans with solutions of sodium bisulfite or ascorbic acid delayed onset of color change by 24 hours.

### ULTRASONIC SOUND FOR CLEANING

Present methods of washing vegetables may change in the near future. Research at V.P.I. indicates that "sonic energy" helps greatly to remove spray residues, radio-active fallout, insects and insect parts, and sand and grit from vegetable crops. The process is based on the principle that sonic energy, setting the water in motion, creates an excellent scrubbing action.



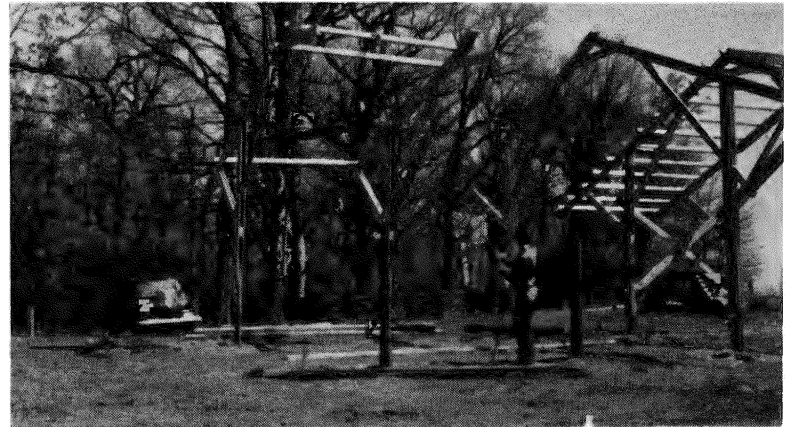
# Buildings and Equipment



Better buildings for less cost continue to result from the structures research at V.P.I. New and improved design information is obtained which can be used by architects and engineers anywhere, and specific building designs for Virginia and similar areas are developed and made available to the general public.

## Tilt-Up Construction

The labor-saving concept of tilt-up construction can be applied in many ways. In the picture immediately below, a double carport is being framed. The frame can be tilted from side to side to provide easy access for sheathing, roofing — even prime painting and hanging gutters.



The finished carport. The only construction that could not be done before the frame was finished and secured in place was building the storage at the back and finishing the columns.

Tilt-up construction has proved to be advantageous with this and other small structures. In the upper picture, two half-frames are tilted into place by a truck as one step in erecting the type structure shown in the lower view of a building erected on one of the V.P.I. farms at a cost of 39¢ a square foot, less than half the usual cost. Labor rates were \$1.35 and \$1.65 per hour. This and another shed just like it will store 8,750 bales of hay and shelter 133 brood cows while they feed.

## Farm Building Panels

A prefabricated, insulated, curtain-wall panel has been developed that is reasonable in cost, weight, expected life, insulating value, surface finish, and flexibility. The concrete stressed-skin sandwich panel, 2' wide and 8' long, is composed of 2" expanded polystyrene insulation encased between two faces of 1/2" mortar that is reinforced with prestretched 14-gauge mild steel wire placed 1" on center. One surface of the panel is cast against polyethylene which affords a slick, sanitary finish.

Tests for bending, shear, and resistance to impact have shown that the panels are adequately strong for any ordinary wall construction. Plain butt joints between erected

panels resist water penetration as well as any joints tested. Calking compound in the joints gave better results than mortar.

These panels exhibit very desirable characteristics for farm construction, but they are better adapted to manufacturing in a plant similar to a concrete block plant than to home manufacturing. The costs of materials for the panels amount to about 30¢ per square foot at present retail rates. It is believed that the panels are a potentially marketable building component.

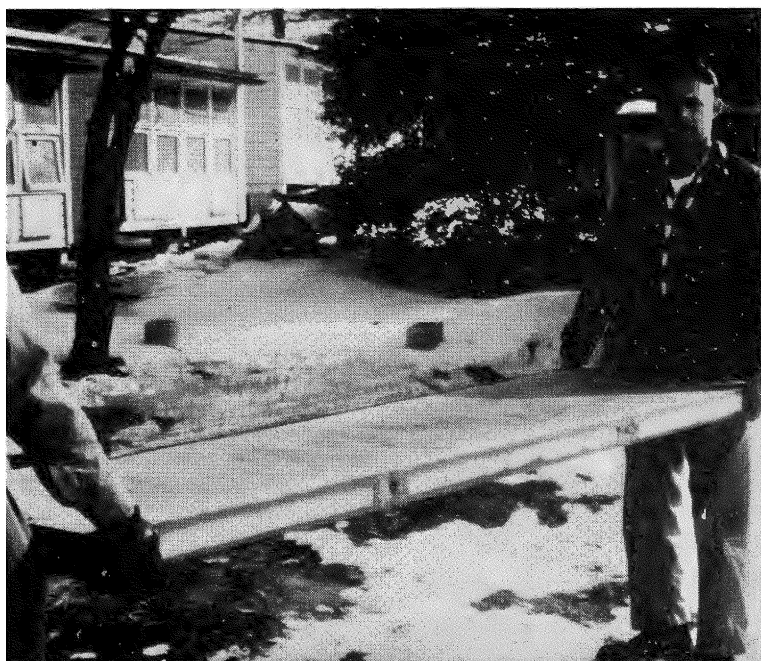
### Plastic Greenhouses

Plastic greenhouses have become popular as practical, economical, plant-growing structures because of their low

cost and ease of construction. The gothic-shaped house resulting from research at V.P.I. has these principle features: pleasing appearance, low cost, easy to build, structural strength, clear span, and covering easy to apply.

Natural testing conditions have proved that the gothic greenhouse will withstand snow accumulation, hail and sleet, and winds exceeding 70 miles-per-hour. The 4-mil ultra violet inhibited polyethylene film covering easily lasts from one fall season on into the summer months of the next year.

The 21'-wide greenhouse can be built any desired length, in multiples of 4', up to a maximum of 100'. The framework consists of built-up rib-type curved rafters, constructed in a jig, and the planted posts to which they are attached. The bracing and framed ends complete the structure. After film has been applied, securing with wooden lath strips at only the end rafters, the ridge, and the bottom



Two men can handle an insulated panel, which weighs about 200 pounds; consequently, no special, on-site erecting equipment is required. Prefabricated, 2'x8', insulated panels were used for the side walls of the building in the lower picture. Rectangular posts formed the structural frame. Windows were cast in the panels before erection.



The large plastic film sheet is first attached to the ridge of the greenhouse, then brought down over the curved rafters. It is fastened at the ridge, at both end rafters, and along the bottom edge only.



edge has proved sufficient, since the curved shape of the structure tends to maintain the film in a snug fit. This minimum amount of fastening saves time and materials in the recovering operation necessary each year.

Research at V.P.I. to evaluate plastic and glass greenhouses as growing structures for vegetables and flowers, has shown no significant differences between horticultural crops grown in such houses under similar conditions of heat and ventilation. Since plastic greenhouses cost from 1/10 to 1/5 as much as glass greenhouses of comparable size, they should be more widely used in horticultural crop production.

### Temperature-Controlled Swine Housing

Swine production is an important enterprise in south-east Virginia and expansion throughout the state as a whole would seem practical and justifiable. Slaughtering and processing plants in Virginia handle three times as many shipped-in hogs as are marketed within the state.

Confinement of swine enables a grower to use automated feeding systems and efficient waste-removal methods. Calorimeter studies have indicated that animals grew faster and required fewer pounds of feed to produce a pound of meat when in a controlled environment. Such studies usually involved only one or two animals for short periods of time.

To determine if commercial-size lots of hogs grew faster and gained more weight per pound of feed consumed, environment (temperature) controlled facilities for 45 to 60 animals at Tidewater Research Station were constructed and are being used. Identical animal lots are also grown in a conventional 1/2-open swine house with the same floor and pen arrangement. The records for two trials have indicated only slightly higher feed efficiency and growth rates in the temperature-controlled house. Additional data

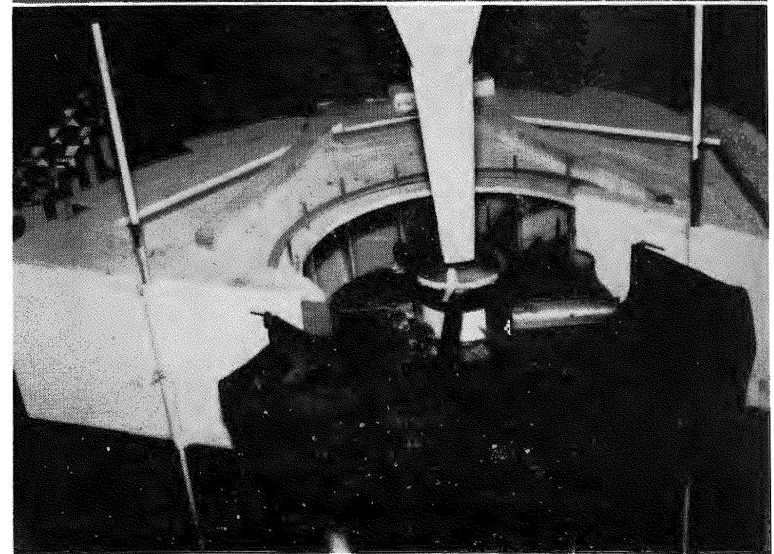
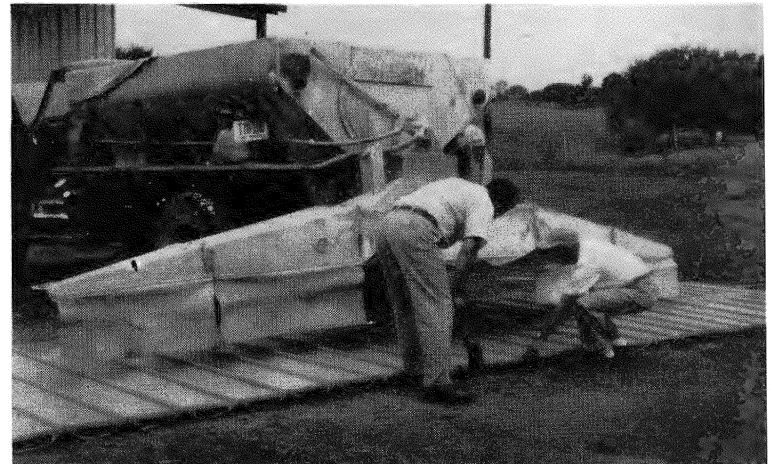
is needed to substantiate the trend noted even though it is insignificant.

### Bulk Fertilizer Spreaders

Research directed toward improving the performance of bulk spreaders was initiated in 1961. Commercial spreaders were tested early in the investigation to develop procedures for more accurate calibration and adjustment. The procedures were published along with information concerning selection of new equipment.

In 1962, basic laboratory studies of both boom and fan-type distributors were conducted. Results with fan-type distributors showed the influence of blade design, feeder design and other factors on performance. This work led to designs which give more of the necessary uniform distribution.

Development of principles and improved controls for boom-type distributors is in progress. This type has greater potential as a satisfactory distributor for fertilizer-pesticide mixtures which tend to separate.

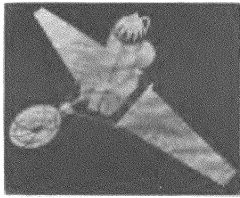


Special apparatus was developed to test commercial bulk spreaders (upper picture), and laboratory studies (lower picture) provided basic information for improving distributor design.

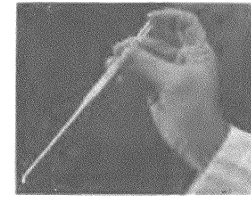


The environment control facility at Holland for studying swine in confinement production: (1) Feed storage bins, grinder, and mixer. (2) Half-open conventional swine house. (3) Environment (temperature) controlled house.





## Other Research



### Sensory Pathways in Birds

The avian brain differs strikingly from that of mammals in possessing little or no cerebral cortex. At the same time birds display a rich variety of stereotyped behaviors and remarkable responsiveness to environmental factors such as day-length. As a start toward understanding the mechanisms of this varied behavior, V.P.I. scientists have been tracing sensory pathways to the midbrain and forebrain of chickens by recording changes in the electrical activity of the brain evoked by loud clicks or by brief flashes of light. Visual stimuli cause large and widespread changes in brain activity, a result expected from the extensive development of the eye and associated anatomy; whereas sounds have much more restricted effects. It is hoped that this work will eventually increase our understanding of the mechanisms by which day-length and behavioral factors affect growth and reproduction in both birds and mammals.

### Resistance to Insecticides

In man's efforts to control insects with poisons, he finds that some pests develop strains which cannot be killed by chemicals that originally were quite effective. For the past 15 years a program of research, designed to obtain basic and applied information on this problem, has been in progress. Most of the work has centered around the German cockroach, because of its suitability as a test organism and the lack of work in other laboratories of the world on this important insect species. Some of the objectives are to study the inheritance of resistance to insecticides, to detect reliable genetic markers, to determine whether or not resistance can be induced in the laboratory by selection, to study cross-resistance and the stability of resistance, to check for resistance in field populations, to test promising new chemicals for activity in killing normal and resistant cockroaches, and to study the effects of ionizing radiation on various strains. The research program has been very fruitful in providing answers to practical problems in insect control where resistant strains have developed, and it has contributed information fundamental to our understanding of the world-wide problem of insect resistance to insecticides.

### Radiant Energy for Insects

Will hornworm moths be attracted better by some lights than others? What kind of light attracts them best? Can enough of them be caught to make trapping practical for tobacco growers? These are some of the questions being studied by agricultural engineers and other scientists. They use a device to break light up into its various colors. The moths are subjected to these special segments of light.

Their reactions are studied with the aim of pinpointing that part of the light to which they are most responsive. When we have determined which part of the light they respond to best, the next step will be to develop traps which use this particular light.



As hornworm moths are subjected to various types of light they are observed through an infrared telescope. Light, humidity, and temperature are controlled by the researcher.

### Turfgrass Research

More knowledge is being sought on the improvement of turf for lawns, athletic fields, parks, playgrounds, highways, golf courses, cemeteries, and other uses. The research is cooperative among departments at V.P.I. and with the Virginia Department of Highways, the Virginia Truck Crop Experiment Station, and golf courses in Richmond and Newport News. Basic and applied ecological principles, such as climatic, biological, and soil factors and their inter-relationships to turf growth and quality, are being studied.

#### MULCHES FOR TURF ESTABLISHMENT

Mulches improve the microclimate for seed germination, seedling establishment, and growth. Fibrous, nonconducting organic materials such as straw, woodfiber cellulose, and sawdust moderate the temperatures and improve moisture conditions. Temperature extremes are somewhat less with straw than with other materials, but straw often carries weed seeds and cereal grains. Woodfiber cellulose also moderates temperatures, increases water infiltration and retention, is not easily washed away, and undesirable seeds

are not brought in. Sawdust washes off easily. Black or green elastic-plastic type mulches have proved satisfactory. Obtaining grass stands without mulches from either spring or late fall seedings has been difficult.

### LIME AND FERTILIZER

Turfgrass species generally grow best when the soil pH is between 6 and 7. The highly soluble aluminum and low calcium-phosphate complex of acid soils is very harmful to most of the turfgrass species.

On limed soils, phosphorus and nitrogen deficiencies limit seedling growth in most situations. Many soils are low in potassium; liberal potassium fertilization is especially necessary where clippings are removed. Preliminary work indicates that certain plant diseases are more serious with low than with liberal potassium fertilization. Phosphorus applied liberally year after year accumulates in soils; on golf course greens where clippings are removed, the soil is often very high in phosphorus and potassium is critically low.

Judicious use of nitrogen is very important. Soluble or quickly available sources of nitrogen must be applied frequently but at light doses to avoid burning or overstimulation. Organic sources of nitrogen need to be applied at bi-monthly intervals and the urea-formaldehyde materials may be applied once or twice annually for good turf growth.

New slowly available nitrogen materials are being studied. Excess growth because of nitrogen appears harmful to cool-season species during the summer because food reserves are depleted due to high rates of respiration. Work is underway to diagnose causes of fertilizer injury to seedlings and to make fertilizer adjustments to reduce it.

Legumes that have slow seedling growth, such as crown vetch and *Lespedeza sericea* are reduced in stand and growth rate for highway turf if liberal nitrogen fertilization and high rates of grass seeding are used. Legume stands were very satisfactory when slowly available urea-formaldehyde nitrogen was used. Non-aggressive grass sods are necessary to control erosion while legumes get established.

### DEGENERATED SODS ALONG ROADSIDES

Grasses degenerate because of insufficient fertilizer for maintenance. Sparse highway slopes may be renovated by seeding a slurry of fertilizer, seed, and woodfiber mulch. The application can be increased where old growth is very sparse. Straw mulch was not suitable for such renovation.

An experimental golf green is being established to study compaction, aeration, and water requirements with various amounts of sand and Weblite in soil-organic matter mixtures. Two kinds of gravel are also being evaluated for drainage.

Excellent stands of bent and bermudagrass are obtainable when a water slurry of stolons and woodfiber mulch

are applied simultaneously. The mulch is also useful for establishing pennecross bent with seed.

### DOLLARSPOT DISEASE

Dollarspot disease causes considerable damage to bentgrass putting greens and bluegrass lawns in western Virginia. Researchers are studying the influence of nitrogen, phosphorous, and potassium on disease development and the effectiveness of fungicides for control. Results show that when urea-formaldehyde is used as the source of base nitrogen, it should be supplemented with a more readily available form for the first year and a half. Comparison of 6- and 12-lb. rates of each of the nitrogen sources showed there was less disease at the higher rates. The relationships of phosphorous and potassium to disease development and the interrelationship with nitrogen are being investigated but have not been determined to date. The broad spectrum fungicides Actidione-Thiram and Dyrene have consistently given the best chemical control of the disease.

### WEED CONTROL

Dicamba is a new herbicide for weed control in turf. Research at various locations in Virginia indicates good control of white clover, knotweed, curl dock, chickweed, and chicory without injury to bluegrasses, Kentucky 31 fescue, or bermuda turf.

Betasan is a new herbicide for crabgrass control in bluegrass, putting green bent, and bermuda turf. It is applied pre-emergence to the crabgrass in established turf.

### Farm Adjustment Studies

When adjustments, changes, or modifications in their farm organization and operation should farmers in various parts of Virginia make in order to improve the net income of their businesses? This question has always been pertinent to farm business managers in a dynamic economy, but today the increasingly rapid tempo of economic and social changes and of technological innovations affecting farming makes rapid adjustment to these changes essential for survival of a healthy agriculture.

A study of the situation in Southside Virginia indicated that the amount of available capital was an important resource restriction limiting net farm income. The study indicated that on these farms additional capital could be used profitably for additional enterprises, depending upon the supply of other resources available.

For small farms with less than 150 acres of open land, additional capital would most profitably be used to add hogs, laying flocks or contract broilers, and a small number of steers. For farms with over 150 acres of open land, additional capital could most profitably be used to add a Grade-A milk enterprise. The next most profitable enterprise for the large farms would be to add the steer enterprise. For small farms, it would be economical to rent in more crop land if it could be obtained at an annual cost less than \$30 per acre.

A study of farm adjustment opportunities in Southwest Virginia indicated that many beef cow-and-calf farmers

have low incomes because of low efficiency of resource use. Good alternative enterprises appear to be steers, market hogs, and laying hens, under various conditions. Corn silage is one of the most profitable crops for the typical farm, and the purchase of additional feed to permit expansion of livestock production would add to profits.

In nine counties of Northeastern Virginia, cash-grain crops supply a large portion of farm income. Preliminary results of studies indicate that fattening cattle and hogs may be profitable enterprises for expansion, and that an increase in corn silage should probably accompany any expansion of the beef enterprise. Lack of natural pastures inhibits expansion of the beef cow-and-calf enterprise.

A fourth farm adjustment study has been begun in the peanut-producing area of Southeastern Virginia. The acreage-control program for peanuts limits the size of this enterprise, and contributes to high land values for those acreages with peanut allotments. This study has not yet progressed to the point of identifying adjustments which would most significantly enhance net farm incomes. The effect of the peanut acreage allotment program on land values and the estimated marginal value of an acre of peanut allotment are also being investigated.

### A Financial Analysis of Virginia's Retail Farm Equipment Industry

Competition among retail farm equipment dealers has intensified in recent years as the number of farms has decreased and size of farm and farmer mobility increased. As a result, the number of retail farm equipment businesses has decreased. To survive, dealers will have to make more efficient use of resources employed.

Research was undertaken to obtain an over-all description of the financial structure of the industry; to establish financial guideposts for managers to use in adjusting resources; to estimate the effects of selected factors on profits; and to provide a guide to further research.

The analysis of financial statements by sales groups revealed that net profits tended to increase with size but varied widely among and within sales groups; e.g., in the \$200,000 to \$300,000 sales group, net profit ranged from \$33,404 to a loss of \$16,503. Although volume is important, management ability has a considerable effect on profits.

Operating margins varied considerably among and within sales groups. They also varied between departments; e.g., margins for new equipment sales were generally the largest, while used equipment often operated at a loss.

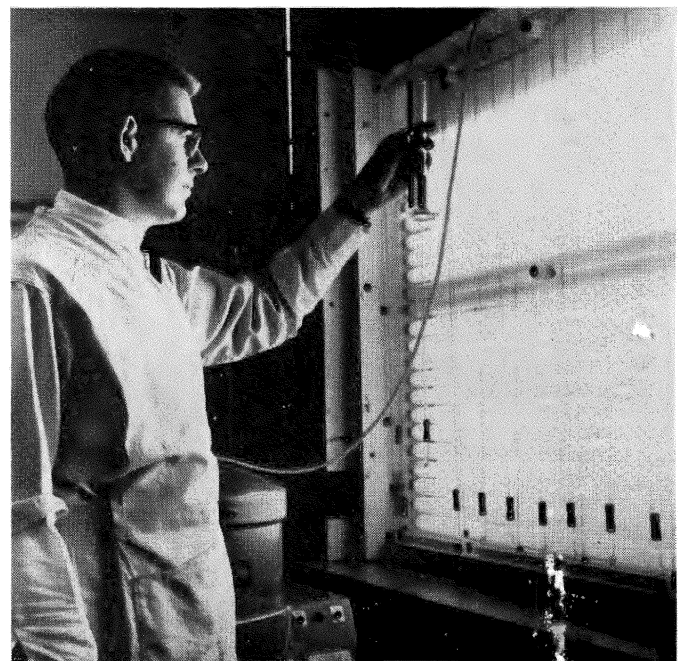
Some firms in all but the largest sales volume group showed substantial losses. The primary causes were low operating margins on sales, high operating expenses per unit of sales, and a large inventory.

Research is currently underway to determine the variation and the causes of variation in profits and costs of the shop department.

### New Approach in Study of Plant Growth

Plant growth at the cellular level can be conveniently divided into two phases: (1) cellular division, and (2) cellular differentiation. These two processes control the growth and maturation of the entire plant. Because cellular division precedes cellular differentiation in plant growth and may be the rate-limiting step in the growth of the entire plant, studies have been initiated to investigate the chemical reactions which control the time, sequence, and rate of cellular division in plant cells.

Because the tissues of higher plants contain cells in all stages of cellular division as well as cells undergoing differentiation, it is impossible to study the detailed biochemical sequences which accompany only cellular division. To circumvent this difficulty, a unicellular green alga, *Chlorella pyrenoidosa*, was selected for these studies. Its sole purpose in life is to reproduce by cell division, but it has been found to be very similar in metabolism to that of higher plant cells. Using this organism makes it possible to separate cellular division from differentiation; however, in ordinary cultures of this alga there were still cells present in all stages of division. To surmount this problem, a new technique was developed by which the growth cycles of billions of single cells within a culture could be synchronized. These cells once synchronized develop through all phases of their growth cycles at nearly the same rate and divide at nearly the same time. In essence, a population of synchronized cells behaves biochemically and physiologically as a single cell. Thus, the synchronous culture technique effectively separates the chemical events associated with growth from those associated only with division, as well as separating the individual steps of division from each other.



Apparatus for the mass culture of synchronized unicellular algae for use in basic studies of plant growth at the cellular level.

It has been possible to follow the changes in chemical composition and enzymatic capacity as a function of the growth cycles of these plant cells, and it is hoped that a chemical basis for the control of plant growth might be achieved.

### **Decomposition of Cellulose by Soil Microorganisms**

In recent studies on the microbial decomposition of cellulose, researchers at V.P.I. have isolated a number of actinomycetes from cellulose-enriched soil. These organisms are being tested for cellulase activity. The scientists have also isolated several anaerobic cellulose-decomposing bacteria from soil and are testing them also.

These two groups of microorganisms are well known as important agents of cellulose decomposition in nature, but in recent years they have received scant attention from soil microbiologists. These studies should produce new evidence regarding the role of these organisms in nature. Since cellulose comprises a large percentage of many agricultural and industrial wastes, it would be of great practical significance if useful biochemical products could be obtained as end products of waste fermentations. Future work will be directed toward this goal.

### **Folic Acid Utilization by Bacteria**

Organisms which synthesize coenzyme F via p-aminobenzoic acid use a biosynthetic pathway that does not involve folic acid, but which does involve di- and tetrahydrofolic acids as intermediates. Other organisms synthesize coenzyme F by directly reducing folic acid to di- and tetrahydrofolic acids, and are not concerned with p-aminobenzoic acid. The literature indicates that organisms use one or the other mechanism, but not both.

Present investigation finds that *Escherichia coli* uses the p-aminobenzoic acid pathway, but not the folic acid reduction pathway, as indicated by the failure of folic acid to reverse sulfonamide inhibition of growth. Furthermore, cell-free extracts of *E. coli* did not possess the ability to hydrogenate folic acid, under the conditions employed. Folic acid *per se* was found to be incapable of reversing sulfonamide inhibition of *Pasteurella multocida*. However, *Clostridium sporogenes* was found capable of using both pathways for the biosynthesis of coenzyme F, since it was sulfonamide-sensitive in the absence of folic acid, but sulfonamide-insensitive in its presence. Also, resting cell suspensions were shown to be capable of the hydrogenation of folic acid.

This is the first time such a dual organism has been reported. In addition to these results, an interesting microbial association was found, in which *Staphylococcus epidermidis* excretes a growth factor for *Pasteurella multocida*, allowing the otherwise impossible growth of the pasteurilla. A dialysis technique of demonstrating the stimulatory effect was developed.

### **Decay and Decomposition of Submerged Organic Debris**

There is contained within the form-family Moniliaceae of the Fungi Imperfecti an unusual group of aquatic fungi that grow within the submerged skeletonized vascular tissues of angiospermous debris. These so-called "aquatic Hyphomycetes" complete their entire life-cycles beneath the surface of the water. It is believed that these fungi play an important role in the degradation of plant debris.

It is the purpose of this study to elucidate the biology of these fungi. Emphasis is being placed on the occurrence and distribution of the aquatic Hyphomycetes including those forms found in marine and brackish waters.

### **Development of Larval Flukes**

Nine new species of larval flukes have been discovered in fresh water snails. These organisms have been described and figured with special emphasis on the development of the excretory systems. The life cycle of these new larvae are under investigation. One life cycle has been elucidated, an intestinal parasite in ducks, and elements of five other life cycles have been experimentally produced in the laboratory.

The areas under investigation are the New River, Mountain Lake, and the pond on the V.P.I. campus.

### **Systematic Studies**

#### **FAMILY BRANCHIOBDELLIDAE**

Branchiobdellids are oligochaete worms epizoid on freshwater crustaceans. The work of describing new genera and species, the study of the zoogeography and evolution of the group continues. Since the last biennial report, an expedition to Mexico has completed the collecting phase of the work. This expedition, local collecting in Virginia, and gifts have increased the number of collections approximately 300 to a total of 1700.

The description of a new species from a cave isopod is in press. Papers on a new genus and the branchiobdellids of the Mountain Lake, Virginia, area are in preparation, and will be finished in 1963. The major work consists, as in the past, of an overall study leading, it is hoped, to a monograph of the Branchiobdellidae of North America.

#### **ARACHNIDA**

Three major studies are included: One, a study of the internal anatomy of the female copulatory apparatus of spiders of the genus *Dolomedes* is nearing completion and the studies of these spiders will be continued with a revision of the pisaurid spiders of the Nearctic. Another study of the Pseudoscorpionida of the Southern Appalachians is under way, and approximately 400 collections of pseudoscorpions from this area have been acquired. A study of the spiders of the genus *Tetragnatha* is under way and about 200 collections of these animals are at hand.



## Ecology and Behavior of Aquatic and Semi-aquatic Diptera

The roles of many aquatic insects in the lentic ecosystem are poorly understood, because the life history and behavior of relatively few species are well known. Using certain dipterous larvae of the Scatomyzinae and Chloropidae, the interrelationships between phytophagous, saprophagous, and predacious species are being examined under laboratory and field conditions. Better understanding of the trophic aspects of these species should lead to more precise generalizations concerning the structure of the lentic habitat.

Since the immature stages of most of the species in this investigation are unknown, descriptions and illustrations of these stages are being prepared.

## Fungus Diseases of Fish

Fish mycopathology is a relatively new field of research and many phases of it have been little investigated. It is well known that whenever fresh-water fish are handled or even slightly bruised, fungus infections and a high mortality rate are likely to follow. There are also fungus infections among fish populations in which no recognizable stress conditions are detectable. In addition, under both hatchery and natural conditions, almost all fish eggs are susceptible to fungus attacks.

It has been incorrectly assumed by most fishery biologists that all fungus infections of fish are caused by *Saprolegnia parasitica* Coker. Studies at V.P.I. indicate that several different fungi are associated with diseased fish and fish eggs. A total of more than 200 infected specimens have been received from federal, state, and private hatcheries from throughout the United States and Canada. Fourteen distinct species representing six genera and three different families of aquatic fungi were isolated and proved to be capable of infecting experimental host fish.

## Nematology Research

Experiments conducted in the greenhouse have shown that the *knotweed cyst nematode*, which commonly attacks smartweed in the United States, also infects and causes reduced yields of buckwheat. This is the first report of the knotweed cyst nematode attacking any economic crop. It is not known, however, whether buckwheat in Virginia or any place in the United States is grown in soil infested with knotweed cyst nematodes. This basic work was initiated in order to determine the complete host range of the knotweed cyst nematode as it morphologically resembles and occurs in the same fields with the soybean cyst nematode.

An unidentified species of the *sting nematode* is a very important pest of peanut, cotton, corn, and soybean in the lighter soils of eastern Virginia. It has been determined that although the strains of this nematode are frequently morphologically distinguishable from farm to farm in Virginia, they resemble each other more closely than they do

the currently described species. Morphological studies of the Virginia population of the sting nematode were initiated in order to make it possible for nematode taxonomists to give it a species title when the over-all study of the sting nematode group is completed.

The never-ending problem of nematode taxonomists is whether to group together populations into different species which show even a minor but constant morphological variation. Not only are these studies of academic interest, but they are also of great importance from an applied standpoint. Unless it can be established that populations of the sting nematode in geographically different areas are the same species, it may be necessary to repeat many costly experiments to determine whether they may be controlled in a similar manner.

## New Host for *Verticillium albo-atrum*

A wilted *Osmanthus ilicifolius* (Holly Osmanthus) plant on the campus of V.P.I. was examined in August 1962. The xylem exhibited extensive discoloration and *Verticillium albo-atrum* was isolated from the discolored tissue.

Greenhouse studies established the pathogenicity of the *Verticillium* isolate. After six weeks plants inoculated with the isolate began losing the lower leaves and at the end of ten weeks the plants were dead. *V. albo-atrum* was reisolated from the sapwood of the inoculated plants.

Although *V. albo-atrum* is prevalent in Virginia as a parasite on a number of species of ornamental plants, this is the first report of it as a parasite on *O. ilicifolius* in Virginia and is believed to be the first report on this host in the United States.

## A Pesky Weed - *Artemisia vulgaris*

*Artemisia vulgaris* (mugwort) is a member of the wormwood family and has Chrysanthemum-like leaves. It grows to a height of about three feet and produces tiny flowers late in the summer. This weed was used in ancient times as a medicine. The Chinese used the oil from the leaves as a remedy for hemorrhage and diarrhea.

*Artemisia* is a vigorous weed and has been rapidly spreading over many areas of Eastern Virginia. It has few natural enemies and can take over an entire area if

***Artemisia vulgaris* (mugwort) plant showing the vigorous root system and rhizomes. The plant when mowed will send up 12 or more new ones.**



given the opportunity. It is resistant to most commonly used herbicides and apparently is resistant to all known plant diseases and insects. No other weed seems to grow where it is established.

The weed apparently releases a toxic substance to the soil, which inhibits growth of other plant species. The inhibitor is present in both green and dry plant material and can be extracted from either leaves, roots, stems, or flowers. Crude extracts inhibit the growth of algae and several crop plants, such as mustard, eggplant, beans, corn, and peas.

Chromatographic analysis has revealed the presence of salicylic acid and several other substances inhibiting germination and growth, factors which may be of considerable economic importance to agriculture.

### **Brush Control**

Low-volume sprays have been developed for the control of most woody species in pastures and rights-of-way. They are more effective on black locust, sumac, and sassafras than are conventional high-volume sprays. Low-volume applications have been made possible by the use of inverted emulsions and other thickening materials. These materials can be applied by centrifugal discs or hand guns. Volumes of 12 to 24 gallons per acre are sufficient for control of brush. These thick mixtures have an added advantage in that they do not drift as much as conventional sprays and for that reason are safer to use near crop plants.

The most common chemicals used in these low-volume sprays are 2,4-D and 2,4,5-T, applied at a rate of 6 to 12 lbs. per acre.

### **Control of Undesirable Trees**

The objective of woodland owners throughout the State is to grow large, high quality timber. Economical methods that will aid in converting poor hardwood growth into fast-growing pine are much in demand.

A temporary soil sterilant called fenuron applied in pellet form at the base of undesirable hardwood trees has been effective in killing most species. As little as 4 grams per tree is needed. Treatments applied in the spring were more effective than in the summer and winter. Associated, untreated white pines under 6 feet tall were uninjured, and the survival of white pine seedlings planted a year after the soil was treated with fenuron was almost 100%.

Fenuron has had little influence on trees growing in swampy, organic soils or on very dry sites; so a study is being made on the influence of different soil types throughout the State.

## **Statistical Research**

### **Services**

The Department of Statistics and the Statistical Laboratory provide both basic and applied research and promote the efficient use of statistical methods in research. The department also is a consultant for the Experiment Station, other State agencies, and the college as a whole. It furnishes computational services for many projects of the Agricultural Experiment Station. Much of the research, performed under grants and contracts, is basic and has wide application for both agriculture and industry.

Frequently, problems under study are not solvable by existing statistical methods, necessitating research resulting in technical papers in various journals.

A listing follows of some of the major pieces of research done in the last two years. Available published results are given in the listing of Experiment Station publications on page 54.

*Order Statistics and the Design of Experiments*, under a grant from the U. S. Army Research Office (Durham).

Research under the Biometry Training Grant, supported by the National Institutes of Health.

Research under a grant from the Department of Health, Education, and Welfare.

*Development of a Statistical Method for Correcting for Inter-element Effects in the X-Ray Fluorescence Analyses of Pyrotechnic Compositions*, under a grant from the U. S. Army.

*Relationship Between Educational Experience of Children and Accidents*, supported by the National Education Association.

*Relationship of Physical Conditions and Accidents*, supported by the Public Health Service.

*Stochastic Processes and Theoretical Genetics*.

### **Computing Center**

The IBM 650 was replaced in May 1962 by an IBM 1620 with a 60,000 digit memory. This machine has been used an average of more than 17 hours per day since installation. October 1962 an IBM 1620 with a 20,000 digit memory was added to the Center. This second machine is now being used an average of more than 10 hours per day. Projects from the Agricultural Experiment Station account for 30% of the total machine usage. In addition, 10% of the use is devoted to teaching students to use the system.

Projects include such widely varied subjects as the simulation of a nuclear reactor, developing and tabling statistical functions, recording watershed drainage, programming of optimum farm enterprises, and analyzing data for a household survey on consumption habits, corn variety trials, economic production functions, agricultural field experiments, and experimentation on livestock and poultry production. The center has aided in developing a procedure

for the record-keeping of the Virginia Beef Cattle Improvement Association and in setting up a mail-in accounting procedure for farmers.

## *Wildlife Research*

### **Deer Browse Production**

The mature forests of precolonial and colonial times in North America did not supply large quantities of food for the White-tailed Deer, as these animals are dependent on shrubby plants for their principal winter food. Browse, or woody twigs and stems of the previous year's growth up to a height of 5', is the staple winter food of the White-tailed Deer and each animal requires from 2 to 5 lbs. of browse per day, with an average of 3 lbs. (dry weight) per day in winter, for adequate nutrition.

A closed canopy of mature forest growth does not permit adequate light to reach the forest floor to sustain browse production in large quantities. Openings created by cutting make larger quantities of browse available. As the age of the forest increases after cutting, browse production again is inhibited as the light is reduced; therefore, the food available to deer is directly related to the age of the forest.

A study was made for the response in browse production as influenced by cutting intensity and time since the cut was made, on the Broad Run Research Area in Craig County. Work was limited to a 40- to 60-year-old mixed oak and pine forest cover which had a comparatively closed canopy.

The browse produced on areas on which no logging had been carried out and on tracts which had been cut was measured. An inference from this study is that a 40- to 50-year-old, closed-canopy forest of oak-pine produces only about 10 lbs. of browse per acre. However, if the stand is heavily cut, browse production may increase 22-fold or to about 220 lbs. per acre, within 4 years following the cut. Therefore, a continuous timber-harvesting program is the most practical method of producing a sustained yield of browse for optimum deer production.

### **Wild Turkey Ranges**

This investigation, third segment of a 10-year appraisal of forest and wildlife management practices, sought to measure the influences of forest-wildlife management practices on the distribution and abundance of wild turkeys by recording seasonal habitat preferences. The study was conducted in the Broad Run Research Area on three compartments, each representing a management treatment, or combination of treatments. A fourth compartment served as a control. The study area is representative of many areas in southwestern Virginia.

In addition to the standard turkey censusing techniques of sight observations, gobbling counts, trapping and banding, and hunter and resident interview, two new techniques were tested: self-operated cameras and aerial census. The standard census techniques provided the bulk of the data; however, the self-operated cameras and aerial census showed

promise of providing more accurate information, once perfected.

Adult male turkeys began gobbling in late April 1962, and ceased calling in early June. Seven calling males established an estimated mating territory of approximately 90 acres.

Summer distribution patterns increased with the age of poults, culminating in an estimated average late-summer range of 500 acres.

Most fall in mid-September interrupted the summer distribution patterns, and the early fall ranges became narrow and elliptical, extending from the lower to the higher elevations. The occupied winter habitat for birds on the study area, based on snow track counts, included approximately one square mile.

The annual range of the four family flocks on the Broad Run Management Area encompassed approximately 1,700 acres in 1962. Estimated population densities varied from one bird per 400 acres to one bird per 100 acres. Total estimated population of the research area averaged one bird per 170 acres.

Records of bait line attendance indicated that turkeys fed primarily from dawn to mid-morning and secondarily from mid-afternoon to dusk. Adult males frequented bait lines regularly in the spring and family flocks in the summer. The movements of family flocks increased as the summer passed; the birds shifted in the autumn and began frequenting the higher elevations as the season progressed. Flocks wintering on the study area restricted their movements to the lower elevations.



**Wild Turkey hen taking her own photo. Note nylon thread over back of this hen; this thread was attached to a mouse-trap trigger that operated the camera. The sign in the back records the date and location.**

## *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.
- Unit Costs and Operating Efficiency in Apple Product Processing.
- An Economic Appraisal of Farming Adjustment Opportunities in Selected Areas of Virginia 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 North-eastern Virginia.
- Tenure Adjustments in Farm Consolidation.
- The Optimum Allocation of Farm Resources in South-eastern 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.\*

#### 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.

### **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.\*

#### 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.
- Design Improvement and Evaluation of Plastic Greenhouses as Plant Growing Structures.

### **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.
- Adaptation 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.
- Phosphate Fertilization Methods for Alfalfa.
- 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.

\*Contributing to a Regional Project.



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 Population 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.

Crop Utilization of Nitrogen from Applied Fertilizers and from Fixed Ammonium in the Soil.

Economic Production of Corn in Virginia.

## **Animal Husbandry 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.\*

### **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.

\*Contributing to a Regional Project.

## **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.

Standardization and Adaptation of Pesticide Residue Chemical Assay Methods for Plant and Animal Products.\*

### **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.

## **Biology Department**

### **FEDERAL FUNDS**

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

### **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 Ephydriidae 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.

## Dairy Science Department

### FEDERAL FUNDS

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

The Evaluation of Forages with Dairy Cattle.

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

### STATE FUNDS

A—Effectiveness of Sires Used in Artificial 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

Susceptibility of Codling Moth to DDT and to a New Nematode Disease.

Wettable Powder Formulations of Insecticides in Relation to Performance Against Orchard Insects, with Special Reference to the Codling Moth and the Red-Banded Leaf Roller.

Control of Insects Affecting the Production of Flue-Cured Tobacco

Bionomics and Control of Insect Pests of Alfalfa, with Special Reference to the Alfalfa Weevil, the Meadow Spittlebug, and Potato Leafhopper.\*

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

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

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

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

The Bionomics and Control of Insect Pests of Grain Sorgums 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.

### 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.

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

Insecticidal Residues in Milk Following Ingestion of Alfalfa Hay Containing Residues of Heptachlor and Heptachlor Epoxide.

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

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

\*Contributing to a Regional Project.

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

### 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.

## Home Economics Department

### FEDERAL FUNDS

The Decision-Making Factors Involved in Consumers' Selection of Different Types of Fluid Milk and Dairy Products.\*

The Fortification of Foods with Non-Fat Dried Milk Solids. Nutrient Balance in Preadolescent Children.\*

### STATE FUNDS

The Utilization of Energy in Certain Preadolescent Children and the Fatty Acid Composition of a Diet of Plant Foods. Educational and Vocational Goals of Rural Youth in Virginia.

## 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.

### 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.

Vegetable Variety Evaluation.  
 Powdery Mildew Resistance in Winter-Type Muskmelons.  
 Sweet Corn Quality.  
 Land Cress Culture, Weed and Pest Control.  
 Design Improvement and Evaluation of Plastic Greenhouses as Plant Growing Structures.  
 Cleaning Vegetables Prior to Marketing.  
 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.  
 Factors Affecting Tin Plate Corrosion in Canned Apple-sauce.  
 Miscellaneous Problems in Food Technology.  
 Blending Soft and Firm Apple Varieties for Sauce.

### 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.  
 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.\*  
 The Relationship of Nematodes to Plant Diseases in Virginia.\*

#### STATE FUNDS

Fruit Diseases.  
 Bean Diseases.  
 Tomato Diseases.  
 Weed Control in Small Fruits.  
 Weed Control in Tree Fruits and Vegetables.  
 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.  
 Soybean Cyst Nematode Investigations.  
 Causes and Control of Injuries to Newly Transplanted Tobacco Seedlings.

\*Contributing to a Regional Project.

### 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.

#### 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 Selection 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 Poultry 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.

### Veterinary Science

#### FEDERAL FUNDS

Control of Respiratory Diseases of Fowls Other than Newcastle Disease.  
 Control of Respiratory Diseases of Poultry.\*  
 Vibriosis of Cattle and Sheep.\*  
 Cause and Control of an Avian Hepatitis-Synovitis Syndrome.  
 The Pathologic Physiology of Enterotoxemias in Domestic Animals.  
 A Study of Effect of Environmental Factors on Parasites of Sheep and Cattle in Virginia.  
 A Study of Sodium and Water Flux in the Alimentary Canal of Ruminants.  
 The Flora of the Animal Intestinal Tract in Disease and in Health.

#### STATE FUNDS

Factors in the Cause and Control of Infectious Sinusitis of Turkeys.  
 Bovine Leptospirosis.

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### **Bulletins**

- 530—Protein Supplements for Beef Calves. C. M. Kincaid, J. S. Copenhaver, J. A. Gaines, and G. W. Litton. August, 1961.
- 531—Producing Yearling Slaughter Steers from Pasture. F. S. McClaugherty and R. C. Carter. February, 1962.
- 532—Marketing Eggs Through Retail Food Stores in Lynchburg, Virginia. April, 1962.
- 533—Palatability and Digestibility of Coastal Bermudagrass and Alfalfa Hays. R. C. Hammes, Jr., R. E. Blaser, H. T. Bryant, and R. W. Engel. March, 1962.
- 534—The Value of Alfalfa-Orchardgrass Silage With and Without Sodium Meta-bisulfite for Milk Production. H. T. Bryant, R. E. Blaser, and R. C. Hammes, Jr. March, 1962.
- 535—Opportunities in Nutritional Sciences. R. D. Michael, Editor. February, 1962.
- 536—Proceedings of the Seventh Annual Staff Conference of the Virginia Agricultural Experiment Station. R. D. Michael, Editor. February, 1962.
- 537—Weights and Grades of Beef Cattle and their Relation to Performance. T. J. Marlowe. May, 1962.
- 538—Soil Survey for Urban Planning and Other Uses. S. S. Obenshain, H. C. Porter, and R. E. Devereux. October, 1962.
- 539—Labor and Capital Requirements in Herringbone and Other Elevated-Stall Milking Parlors. R. Lee Chambliss, Jr. July, 1962.
- 540—Genesis and Morphology of Virginia Soils. R. E. Devereux, G. H. Robinson, S. S. Obenshain. April, 1962.
- 541—Analysis of Financial Statements of Virginia's Retail Farm Equipment Businesses. Max R. Glass and A. J. Ortego. July, 1962.
- 542—Labor Efficiency and Selected Costs among Virginia Meat Packing Firms. R. T. Crowder and M. E. Juillerat. September, 1962.
- 543—The Influence of Fertilization and Irrigation on the Quality of Pasture Herbage. J. A. Lutz, Jr., S. S. Obenshain, and J. H. Lillard. November, 1962.
- 544—Egg Quality in Retail Food Stores. J. T. Buck. January, 1963.
- 545—A Study of Dwarfism in Beef Cattle. T. J. Marlowe. December, 1962.
- 546—Proceedings of the Eighth Annual Staff Conference of the Virginia Agricultural Experiment Station. R. D. Michael, Editor. March, 1963.
- 158—Effect of the pH on the Black Shank Disease of Tobacco. J. L. Troutman and J. L. LaPrade. May, 1962.
- 159—Lime Effects on Soil Reaction and Base Content of Eleven Soil Types in Virginia. W. W. Moschler and others. December, 1962.
- 160—Structurally Balanced Roof Frames. H. T. Hurst and J. P. Mason, Jr. February, 1963.
- 161—Records and Distribution Problems of the Fishes of the North, Middle, and South Forks of the Holston River, Virginia. R. D. Ross and J. E. Carico. April, 1963.
- 162—Some Factors Affecting Insecticidal Efficiency. W. S. Hough and C. H. Hill. June, 1963.
- 163—Reducing Cost on Selected Grade-A Dairy Farms. J. A. Reynolds and R. G. Kline. June, 1963.

### **Research Reports**

- 54—The Influence of Two Light Management Systems on the Growth and Production of Commercial Layers. H. S. Siegel, W. L. Beane, and C. E. Howes. September, 1961.
- 55—Fungicide Research for Preventing Decay on Nema-gold Sweet Potatoes. Daniel Badger. September, 1961.
- 56—Consumer Acceptance for Prepackaged and Bulk Sweet Potatoes. Daniel Badger. October, 1961.
- 57—Agricultural Progress. A Report of Research by the Virginia Agricultural Experiment Station, for the period July 1, 1959 to June 30, 1961. R. D. Michael, Editor. December, 1961.
- 58—A System for Intensive Production of Lambs. Douglas F. Watson. February, 1962.
- 59—Effect of Soluble Salts on Phosphate. J. A. Lutz, Jr. and C. I. Rich. December, 1961.
- 60—Results of Barley, Oat, and Wheat Varietal Tests Conducted in Virginia, 1961. J. L. Tramel, T. M. Starling, and C. W. Roane. December, 1961.
- 61—1961 Variety Trials, Tomato and Sweet Potato. F. H. Scott and C. D. Wood. March, 1962.
- 62—Corn Performance Bulletin for 1961. E. Shulkcum. March, 1962.
- 63—Plastic Greenhouses. P. H. Massey, Jr., McNeil Marshall, and R. W. Gray. June, 1962.
- 64—Investigating Beef Cattle Prices for Short Time Periods. W. D. Anderson and M. E. Juillerat. September, 1962.
- 65—Virginia Tidal Riverbank Erosion Survey. E. W. Mundie, R. E. Blaser, J. H. Lillard, W. L. Gibson. November, 1962.
- 66—Results of Barley, Oat, and Wheat Varietal Tests Conducted in Virginia in 1962. T. M. Starling, J. L. Tramel, and C. W. Roane. November, 1962.
- 67—1962 Variety Trials—Tomato, Sweet Potato. F. H. Scott and C. B. Wood. January, 1963.
- 68—Corn Performance Tests, 1962. E. Shulkcum and C. F. Genter. February, 1963.
- 69—Performance of Experimental Corn Hybrids in Virginia, 1962. C. F. Genter. March, 1963.
- 70—Results of Sudangrass and Pearl Millet Performance Tests in Virginia, 1958-1962. P. T. Gish, T. J. Smith, and A. S. Williams. April, 1963.
- 71—Performance of Tobacco Varieties and Breeding Lines Tested in Virginia in 1960, 1961, and 1962. J. W. Crews and others. June, 1963.
- 72—Demand and Price Relation Between Peanuts and Cashews. D. Upton Livermore. June, 1963.

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- 152—Tardigrada of Southwest Virginia: With the Addition of Description of a New Marine Species from Florida. G. T. Riffin, Jr. March, 1962.
- 153—The Spotted Alfalfa Aphid in Virginia. J. L. Bishop and Davy Crockett. October, 1961.
- 154—Microbial Degradation of Cellulose. K. W. King. December, 1961.
- 155—Virginia Flora. A. B. Massey. February, 1962.
- 156—The Marginal Value of Flue-Cured Tobacco Allotments. W. L. Gibson, Jr., C. J. Arnold, and F. D. Aigner. March, 1962.
- 157—Persistency of Malathion, Parathion, Perthane, and Sevin on Selected Vegetable Crops. J. F. Eheart, P. H. Massey, Jr., and Jean Dickerson. March, 1962.



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### Articles in Popular Publications

Staff members of the Station have also written nearly 150 articles reporting on research and appearing in less technical magazines, such as *Crops & Soils*, *Southern Planter*, *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 department which have been widely used in farm magazines and newspapers.

## STATEMENT OF INCOME & EXPENDITURES

July 1, 1962 — June 30, 1963

### Income

#### CURRENT FUNDS:

Federal Government Appropriation .....	\$ 900,522.46
State Government Appropriation .....	2,008,680.00
Other Non-Educational and General .....	2,170.48
Resident Facilities .....	11,790.26
Sale of Dairy and Farm Products .....	267,526.12
<b>Total</b> .....	<b>\$3,190,689.32</b>

#### RESTRICTED FUNDS:

Commercial Research Grant Balance from Previous Year .....	\$ 199,119.82
Commercial Research Grant .....	408,991.67
Research on Nematodes Affecting Peanuts and Soybeans .....	.00
Investigation of Tobacco Diseases .....	.00
Investigation of Diseases and Pests Harmful to Shade Trees and Other Landscape Plantings .....	.00
<b>Total</b> .....	<b>\$ 608,111.49</b>

### Expenditures

#### CURRENT FUNDS:

General Administration .....	\$ 67,661.43
Organized Research .....	2,820,655.15
Library .....	10,888.32
Maintenance of Physical Plant .....	110,935.15
<b>Total</b> .....	<b>\$3,010,140.05</b>

#### RESTRICTED FUNDS:

Commercial Research Grant .....	\$ 463,932.27
Research on Nematodes Affecting Peanuts and Soybeans .....	.00
Investigation of Tobacco Diseases .....	.00
Investigation of Diseases and Pests Harmful to Shade Trees and Other Landscape Plantings .....	.00
<b>Total</b> .....	<b>\$ 463,932.27</b>

### PLANT FUND ACCOUNTS

	Amount of Appropriation	Spent
Office Equipment .....	\$ 1,335.00	1,324.17
Medical and Laboratory Equipment .....	34,715.00	28,818.33
Farm Equipment .....	5,200.00	4,653.10
Livestock .....	5,000.00	4,910.50
Other Equipment .....	3,050.00	2,158.49
Beef Cattle Research Units and Equipment .....	30,950.05	30,950.05
Experimental Silos at Middleburg .....	9,700.00	5,449.48
Drying, Curing, and Seed Storage at Holland .....	2,000.00	.00
Tobacco Grading Room and Equipment .....	10,261.61	10,245.09
Temporary Greenhouse at Holland .....	7,641.75	7,505.81
Utility Building at Charlotte Courthouse .....	11,000.00	15.90
Surplus Property Disposal Fund .....	2,550.00	2,290.00
<b>Total</b> .....	<b>\$123,403.41</b>	<b>98,320.92</b>

## *Station Organization*

### **Board of Visitors Virginia Polytechnic Institute**

#### **OFFICERS**

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Mrs. Elva DeLaBarre Redding, *Clerk*

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Mrs. Henderson Graham, Marion  
E. H. Lane, Altavista  
W. Thomas Rice, Richmond  
P. D. Sanders, Richmond  
Mrs. English Showalter, Roanoke  
Mrs. Donald Wilhelm, Arlington  
Erwin H. Will, Richmond  
Wyatt A. Williams, Orange  
Harry C. Wyatt, Roanoke  
Mrs. E. Floyd Yates, Powhatan County

#### **EX-OFFICIO MEMBERS**

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Instruction, Richmond*  
R. H. Cowherd, *President of the Board of Agriculture  
and Immigration, Gordonsville*

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William J. Erwin                      E. H. Lane                      Erwin H. Will

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Agriculture  
Laura Jane Harper, B.S., M.S., Ph.D., Dean of Home  
Economics  
Harold Newell Young, B.S., Ph.D., Director  
Chester Hugh Duncan, Assistant to the Director  
Blannie Green Runchey, Executive Clerk  
James Frederick Boone, B.S., Treasurer

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Harry Morgan Love, B.S., M.S., Ph.D., Professor (Head)  
John Thomas Buck, B.S., M.S., Ph.D., Professor  
Maynard Calvin Conner, B.S., M.S., Ph.D., Professor  
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Daniel Delano Badger, B.S., M.S., Ph.D., Assistant Professor  
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Monte Everett Juillerat, B.S., M.S., Ph.D., Assistant  
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Albert Joseph Ortego, Jr., B.S., M.S., Assistant Professor

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\*As of June 30, 1963.



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Leonard Roy Shenton, B.S., Ph.D., Professor  
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Whitney Larsen Johnson, B.S., M.S., Associate Professor  
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Raymond Harold Myers, B.S., M.S., Assistant Professor  
Frederic Charles Barnett, B.S. M.S., Instructor

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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  
John Clark Osborne, B.S., M.S., D.V.M., Professor  
Gordon Allen MacInnes, B.S., D.V.M., Associate Professor  
Walter E. C. Moore, B.S., M.S., Ph.D., Associate Professor

\*Department jointly employed by Experiment Station and the Agricultural Extension Service.

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Charles Henry Domermuth, Jr., B.S., M.S., Ph.D., Assistant Professor  
Herbert Lamarr Klewer, B.A., M.S., Instructor

### 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 Husbandry

#### 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., Assistant Professor of Animal Husbandry

#### Southside Virginia Research Station, Charlotte Court House

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

#### Southwest Virginia Research Station, Glade Spring

Frank Shannon McClagherty, B.S., M.S., Assistant Professor of Animal Husbandry

#### 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 Mallory Boush, B.S., M.S., Ph.D., Associate Professor of Entomology  
George B. Duke, B.S., Associate Professor of Agricultural Engineering (USDA-ARS)  
Daniel LeRoy Hallock, B.S., Ph.D., Associate Professor of Agronomy  
Grover Cleveland Smart, Jr., B.A., M.A., Ph.D., Assistant Professor of Plant Pathology and Physiology  
Horace Randolph Thomas, B.S., M.S., Associate Professor of Animal Husbandry  
Morris Wilburn Alexander, B.S., M.S., Assistant Professor of Agronomy

#### Tobacco Disease Research Station, Chatham

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

### DECEASED

Russell Franklin Miller, associate professor in the department of biochemistry and nutrition, died February 24, 1963. He joined the department in August 1955 following completion of his studies for the Ph.D. degree at the University of Wisconsin, from which he had obtained a master's degree in 1953. He was a native of Monroe, Wisconsin. He was especially noted for his basic research in trace mineral nutrition and toxicology and his interest in the welfare of his students.

### RETIRED

**Leroy Cagle** retired January 11, 1963 ending a service as assistant entomologist which began in 1926. He was then 70 years old. Because of illness, Mr. Cagle asked to be placed on a part-time basis in 1955. He specialized in the biology and ecology of plant-feeding mites. A native of Coble, Tennessee, he obtained a B.S.A. degree in entomology from the University of Tennessee in 1923 and was employed by the Virginia Crop Pest Commission before joining the Experiment Station.

**James Frank Eheart** retired December 31, 1961 as associate professor of biochemistry and nutrition. He was born in Roanoke County, Virginia, August 29, 1897 and obtained degrees at V.P.I. in agriculture (1919), and plant pathology (1921), and an M.A. degree in chemistry from Columbia University in 1929. Meanwhile, he had joined the department of agricultural chemistry of the Experiment Station in 1926. Mr. Eheart did exacting research on the content in plant materials of trace elements and vitamins.

**Walter Seneff Hough** retired March 31, 1963, following more than 40 years with the Experiment Station doing entomological research on fruit pests at the Winchester laboratory. He authored his first bulletin for the Station in February 1925 and has contributed steadily and notably ever since to the solution of insect-control problems in fruit production and to other entomological studies. A native of Ruffsdale, Pennsylvania, he specialized in entomology at Stanford University and at Ohio State University, obtaining both an M.A. and a Ph.D. degree from the latter in 1921 and 1925 respectively. Before coming to Virginia, he was employed by the Federal Horticultural Board.

**Robert Harry Hurt**, associate professor of plant pathology at the Piedmont Fruit Research Laboratory, Charlottesville, retired November 6, 1961, at the age of 70. He was first a graduate pharmacist and later earned degrees in plant pathology and biology at V.P.I., a B.S. in 1923 and an M.S. in 1932. He joined the Experiment Station in 1923 and contributed steadily to the solution of disease problems in apple and peach production for nearly 40 years.