AGRICULTURAL ENGINEERING IN VIRGINIA

By

Agricultural Engineering Committee.

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S U M M A R Y

AGRICULTURAL ENGINEERING IN VIRGINIA

The problems in agriculture and rural life that need the cooperation of the engineer for their solution are many and varied, and have to do with almost every aspect of farming and farm life. The improvement of the farm home by a better designed farm house with modern conveniences, such as water supply and bath room fixtures, electric lights, heating and other labor saving devices and life improving accessories, are primarily the problem of the agricultural engineer; the planning, construction, and equipping of farm structures of all kinds, their location and arrangement for convenience and labor saving are important problems, the best solution of which require the services of trained agricultural engineers; the improvement of cultivated land by underdrainage, as well as the reclamation of large areas of wet and over-flow lands by surface drainage and by flood control are important agricultural engineering problems; the reclamation of arid lands by irrigation and more important from the standpoint of Virginia's agriculture the supplying of water to crops in years of drouth or of deficient rainfall by means of surface or overhead irrigation , are problems for the agricultural engineer to solve; the control of soil erosion by terracing, soil saving dams and other means and the clearing of land of stumps and other obstructions by the use of explosives and machinery are also problems for the agricultural engineer; farm machinery in all its manifold relations, along with the use of power to reduce labor and production costs, and more important - to increase the farmers income, are factors which the engineer is constantly working with and constitute one of the most important fields of the agricultural engineer; rural electrification, or the extending of central station electric service to the farms of the nation is one of the later developments in agricultural engineering that is receiving nation wide attention at the present time. Electric power has revolutionized industry and there is every reason to believe that it will do as much for agriculture. However, there are many problems to be solved before rural electrification will be an established fact. While it is the electrical engineer's problem to extend the power lines to the farm, it is essentially the problem of the agricultural engineer to develop new uses and special machinery adaptable to the farm as well as to instruct the farmer in handling this form of power. The agricultural engineering profession has already made some outstanding contributions toward the solution of some of these problems and the progress made to date is a very promising indication that ways and means will be worked out whereby the farmers of the nation will be able to utilize electric power to advantage in their farming operations and enjoy the convenience of electricity in their homes.

The engineer can contribute much to the solution of problems in practically every important type of farming in the state and his cooperation is being solicited by the various agricultural scientists such as the Horticulturist, Agronomist, Dairy and Animal Husbandryman, and Poultry Husbandryman. Indeed most of the problems in agriculture require the cooperation of the engineer for their best solution. Herewith are mentioned a few of the outstanding problems connected with the important types of farming in Virginia where the engineer can be of assistance.

Virginia is an important fruit state and now ranks third of all states in the production of apples. In order that Virginia may compete successfully with other apple growing districts, the growers must lower the cost of producing apples and adopt improved methods of handling their fruit. Lower production costs and improved methods of handling are two of the biggest problems confronting the fruit grower. The proper solution of these problems require the cooperation of the engineer.

Spraying to control disease and insect pests now constitute a big item of expense in fruit production. The engineer can be of assistance in this connection in the design of improved spraying equipment and methods. Improved spray outfits will materially lower the cost of production. For example, the apple growers of the Wenatchee district of the state of Washington are adopting the stationary spray plant and thereby saving one-third to one-half of the time that was formerly required for spraying with a portable rig. In one typical case, in which careful records were kept, the saving was 63 per cent. At least 50% of the 2500 orchardists of the Wenatchee district have installed stationary spray systems. Leading fruit authorities who are familiar with this type of spray system say that the stationary plant will soon replace the portable rig entirely throughout the country. Virginia apple growers can reduce the spraying costs materially by the adoption of this method of spraying. The question of improved methods of handling fruit is largely an engineering problem which calls for properly designed and constructed labor saving grading machinery and packing houses constructed with proper lighting and arrangement to save labor. The problem of orderly marketing of fruit is largely a problem of proper storage so that the fruit may be held until the price is right for marketing. The engineer can be of assistance here in designing practical fruit storage houses and storage house equipment.

Trucking is one of the most important of the agricultural industries of the state. In 1927 the total acreage in all truck crops was 120,530 and the value was estimated to be $28,055,000. Virginia ranked third in truck crop shipments during 1927, and was only exceeded by California and Florida in the number of cars moved. The engineer can be of assistance to the trucking industry in such vital problems as land drainage, improved irrigation systems, cold storage plants for perishable vegetables, common storage for potatoes, and improved transportation methods, etc.

Dairying is growing in importance in Virginia and is fast becoming one of our most important agricultural industries. The value of dairy products in 1927 was $24,487,000. The matter of proper buildings and equipment on the dairy farm is of major importance and constitutes one of the biggest items of investment on a dairy farm. The design of the dairy buildings and equipment for economical production is primarily an engineering problem. The engineer can and is giving valuable assistance to the dairy industry along these lines. Refrigeration equipment is becoming a very important problem in dairying and the engineer can contribute much in improving refrigerating equipment. The design, construction, and equipping of dairy manufacturing plants is also a problem of major importance that calls for the cooperation of the engineer.

The poultry industry is growing rapidly in the state. The estimated value of eggs and chickens produced in 1927 was $27,304,000. The engineer can be of assistance in this industry in the design of better farm poultry houses, incubators, brooders, and other poultry equipment.

The livestock industry is also an important farming enterprise in the state. The total value of livestock sold or slaughtered in 1927 is estimated to be $28,250,000. Improved labor saving equipment, better designed barns and feed grinding and handling machinery are important problems in this industry where the engineer can be of assistance.

Tobacco growing is also an important agricultural industry in the state. This crop is raised in about one-third of the state. The average annual acreage and value for the years 1921 to 1927 being 182,428 acres and $26,369,286. This is a crop that requires a tremendous amount of hand labor in its production, more than for any other crop raised in the state. The big problem, therefore, in tobacco production is the reduction of labor costs by the use of machinery. This is a difficult problem, more difficult than for any other crop. Better designed and larger tobacco barns is one way the engineer can help. He can also be of assistance in designing new machines adaptable to this crop. On many tobacco farms in the state a considerable part of the cultivated areas is rolling and subject to erosion. The terracing of these fields, which is an engineering problem, would aid in conserving fertility, and should increase yields of the crops grown.

In addition to the specialized types of farming referred to in the preceding paragraphs there is the big field of general farming that constitutes the great bulk of the farming enterprises in the state. The ten principal crops raised in Virginia from 1921 to 1927 in order of their value were corn, tobacco, hay, wheat, peanuts, cotton, oats, rye, buckwheat, and barley. The average total acreage and value for these crops during this period was 4,131,734 acres and $109,729,126.

Power and labor, (factors which the engineer is constantly working with), constitute over one-half of the total cost of producing these crops. These two items of power and labor are directly subject to the control of the farmers. The farmer needs the aid of the engineer in designing new machines and advising on proper machines to use under certain conditions so that he can materially reduce his production costs and thereby receive a greater income for his labors.

DEPARTMENT OF AGRICULTURAL ENGINEERING

The Virginia Polytechnic Institute recognizes the importance of engineering as applied to agriculture and for several years has been developing this work at the college. Extension work in agricultural engineering was started in 1914 with the employment of an engineer to instruct the farmers of the state in land drainage. In 1920 a department of agricultural engineering was established at the college to develop resident instruction work in agricultural engineering. Two years later a four year course in agricultural engineering was inaugurated and provision made through the experiment station to start research work in a small way. The three major divisions of the department, therefore, are residnet instruction, research, and extension.

RESIDENT INSTRUCTION

The resident instruction work of the department is primarily concerned in teaching service courses such as farm surveying and drainage, farm power and machinery, farm buildings and agricultural drawing to all students of agriculture. Short course work in such subjects as gas engines and tractors, sewing machine work, home equipment, etc. is also to be handled by the resident staff. Beginning this year each member of the resident staff will carry on some line of investigation connected with his speciality. Such studies, however, will be entirely separate from the experiment station work.

The resident staff is also responsible for the handling of all classes in the professional four year curriculum in agricultural engineering. Thirty-five men have been graduated since 1922, with the degree of Bachelor of Science in agricultural engineering, and approximately thirty men are now registered in this curriculum. Only ten colleges are offering this type of professional training, and V. P. I. is the only college east of the Mississippi offering a four year course in agricultural engineering. The supply of agricultural engineers is much less than the demand and the V. P. I. graduates have promising opportunities for service open to them. As more men with this type of training go forth into the state their influence will be felt in agriculture.

The agricultural engineering curriculum is designed to give the student a thorough training in the fundamental subjects requisite to success in the profession of agricultural engineering. On account of the great variety of work required of agricultural engineers in practice, a number of subjects peculiar to other curricula are included, so that the student receives a considerable breadth of training. Engineering principles applied to agriculture have played an important part in the advancement and development of our agricultural practices. Agricultural engineering as a profession, however, is of only comparative recent development, but it is rapidly becoming recognized as one of the more important of the engineering professions, since it is identified with the most important of our industries, agriculture. An agricultural engineering course is especially suited to the boy brought up on the farm, as it prepares him for a professional, business, or farming career, and enables him to capitalize on his farm training. He has a very promising and constantly expanding field open to him. It has been impossible to supply the demand for trained agricultural engineers, as comparatively few are being graduated by the agricultural colleges.

Some of the more promising fields of work for graduates in this curriculum are with companies manufacturing mechanical and structural agricultural equipment, as designing, production, experimental, service and sales engineers; motor transportation engineers; engineers with electric and other public utilities serving the farmer; engineers and managers connected with irrigation, drainage, land clearing, and other reclamation projects; power farming; managers of large agricultural estates, and large scale farming projects; consulting agricultural engineers and rural architects; contractors in connection with agricultural development; agricultural engineering editors of farm and trade journals, instructors, investigators, and experimental and extension workers in agricultural engineering in the United States Department of Agriculture, land grant colleges and experiment stations. The first year of this curriculum is the same for all freshmen taking engineering courses.

AGRICULTURAL ENGINEERING CURRICULUM AT V.P.I.

First Year	I	II	III
Chem.113-123-133 - Inorganic Chemistry	3(3)	3(3)	3(3)
Chem.114-124-134 - Inorganic Chemistry Lab.	4(1 1/3)	4(1 1/3)	4(1 1/3)
Educ.117-127-137 - Introduction to Engineering	1(1 1/3)	1(1 1/3)	1(1 1/3)
Eng.111-121-131 - English Composition	3(3)	3(3)	3(3)
Graph.111-121-131 - Drawing	7(3)	2(2 2/3)	2(2 2/3)
Graph.122-131 - Descriptive Geometry		5(2 1/3)	5(2 2/3)
Math.112-122 - Algebra	3(3)	3(3)	
Math.113-123 - Trigonometry	3(3)	3(3)	
Math.134 - Analytical Geometry			6(6)
*Mil.111-121-131 Basic Course	3(1)	3(1)	3(1)
Ph.Ed.011,021,021 - Physical Training	2(0)	2(0)	2(0)
Ph.Ed.111-121-131 - Hygiene	1(1 1/3)	1(1 1/3)	1(1 1/3)
Credits each quarter	18	18	18

*Omitted for women students and other students excused under regulations

Second Year	I	II	III
Ag.Eng.213 - Farm Implements	5(3)		11(4 1/3)
Ag.Eng.234 - Agricultural Surveying & Drainage			
Da.Husb.221 - Dairy Engineering		3(3)	
Eng.211-221 - English and American Literature	3(3)	3(3)	
Geol.231 - Agricultural Geology			3(3)
Graph.211-221 - Engineering Drawing	4(1 1/3)	4(1 1/3)	
Math.212-222-232 - Calculus	3(3)	3(3)	3(3)
Mech.A.213-223-233 - Machine Shop Work	4(1 1/3)	4(1 1/3)	4(1 1/3)
*Mil.211-221231 - Second BasicCourse	3(1)	3(1)	3(1)
Phys.212-222-232 - Physics	4(4)	4(4)	4(4)
Phys.213-223-233 - Physics Laboratory	4(1 1/3)	4(1 1/3)	4(1 1/3)
Credits each quarter	18	18	18

*Omitted for women students and other students excused under the regulations

Note: The numberals I - II - III indicate first, second, and third quarters. The numbers in quarter columns indicate the number of hours the class meets per week and in parenthesis the number of credits.

Third Year	I	II	III
Ag.Eng.311-321 - Internal Combustion Engines	8(4)	6(2)	
Ag.Eng.323-333 - Farm Structures		5(3)	6(2)
Ag.Eng.334 - Advanced Agricultural Surveying			7(3)
Agron.322- Soils		3(3)	
Agron.325 - Farm Crops			3(3)
Ap.Mech.311-321-331 - Mechanics	3(3)	3(3)	3(3)
Ap. Mech.314 - Mechanical Engineering Lab.	6(2)		
Bus.Ad.322 - Business Law			3(3)
Ap.Mech.336 - Hydraulics			2(2)
Econ. 312-322 - Principles of Economics	3(3)	3(3)	
Elec.Eng. 312 - 322 - Dynamo-Electric Machinery	2(2)	2(2)	
Mech.A.311 - Advanced Machine Shop Work	6(2)		
*Military or non-technical electives	(2 - 4)	(2 - 4)	(2 -4)
Credits each quarter	(18-20)	(18-20)	(18-20)

*Students not taking military will arrange electives with their course advisers. Military darries 1 or 4 credits each quarter. If no military is taken the non-technical electives must carry 2 credits each quarter.

Fourth Year	I	II	III
Ag.Ec.-421 - Marketing Farm Products		3(3)	
Ag.Eng. 411 - Drainage and Irrigation Engineering	3(4)		
Ag.Eng. 423-433 - Agricultural Engineering Problems		1(1)	1(1)
Ag.Eng. 424-434 - Rural Architecture		4(2)	7(3)
Ag.Eng. 425 - 435 - Automobiles, trucks, and tractors		8(4)	4(2)
Ag.Eng. 426 - Rural Sanitary Equipment		5(3)	
Ag.Eng. 432 - Rural Electrification			4(2)
Agron. 422-432 - Farm Management		3(3)	3(3)
Bus. Ad. 313 - Salesmanship	3(3)		
Bus.Ad. 411 - Personnel Administration			2(2)
Electives	2(2)		
Elec.Eng.411 - Electrical Engineering Lab.	6(2)		
Eng. 412 - Agricultural Journalism	3(3)		
Eng. 413 - Public Speaking	2(2)		
Eng. 435 - Business English	(2-4)	(2-4)	3(3)
*Military or non-technical electives	(2-4)	(2-4)	(2-4)
Credits each quarter	(18-20)	(18-20)	(18-20)

*Students not taking military will arrange electives with their course advisers. Military carries 1 or 4 credits each quarter. If not military is taken the non-technical electives must carry 2 credits each quarter.

EXTENSION WORK IN AGRICULTURAL ENGINEERING

The college is giving engineering aid to the farmers of the state through its extension division by means of

A. Short Courses and Meetings, which consist of illustrated lectures, moving pictures, laboratory work, and talks at meetings.

B. Publicity and Propaganda, which is handled through correspondence, bulletins, circular letters, newspapers and farm journals articles, and exhibits at fairs.

C. Field Projects and Demonstrations, which consist of supplying technical information and service to individuals, communities, and organizations of the state. Individuals, county or home demonstration agents, or community organizations make application to the department for the services of the specialists. The individual project is visited, in company with the county agent, surveys and other notes are made and a detailed report, plans and suggestions furnished. Demonstrations consist of visits and meetings at projects under construction and at finished projects, in order to instruct on methods and show results obtained. The specialist endeavors to instruct in such a way that those in attendance at the demonstration can carry out the practice recommended without further assistance. Many of the projects are self-advertising, such as improved farmsteads, farm home or other buildings, new operating equipment, water systems, and other conveniences in the home and reclamation projects, such as drained fields, terraced hillsides and cleared land.

The recognized agricultural engineering projects which are stressed by the department are: farm drainage, irrigation, land clearing, terracing to control erosion, farm water supply and sanitation - which includes all home labor saving conveniences, rural electrification or the supplying of high line electric service to the farms of the state, farm structures and farmstead planning, and farm power and machinery. Miscellaneous engineering service is also given as the demand arises.

RESEARCH WORK IN AGRICULTURAL ENGINEERING

Research work was started in a small way in 1922. One man devoting only one-fourth of his time to this important phase of the department's work. In 1925 one man was devoting three-fourths of his time to research and during 1925 and in 1927 only one-half. Beginning the year 1928 one man will devote his full time to reserach work in agricultural engineering for the experiment station.

As research is the foundation on which all resident instruction as well as extension is based, this should be the most important branch of the department. There are many and varied problems demanding attention but with only one man devoting his time to research much real progress is impossible. There should be at least three men devoting their full time to research work on experiment station time. With three men on research, three in resident instruction, and three on extension the department would be well balanced and in position to more adequately handle the numerous demands being made upon it for information and assistance.

Research studies in agricultural engineering have been made to date as follows: An Economic Study of Tile Drainage; Farm Power and Machinery Survey; Farm Water Power Development; the All-Purpose or Cultivating Tractor; Individual Gas-Engine Electric Light Plants; the Application of Electricity to Agriculture; The Adaptability of the Combine Harvester-Thresher to Virginia Conditions; Soil Erosion Survey of Charlotte County; A Study of Spray Nozzle Pressures.

The research work now under way is a further study of the Combine harvester with special reference to proper harvesting periods, grain drying and cylinder speeds for soybean harvesting; feed grinding studies in cooperation with the dairy department. Studies also in progress by graduate students are "The

Comparative Value of Gasoline and Kerosene for Tractor Motors," and "The Individual Gas Engine Electric Plant Under Working Conditions." A study of irrigation is also being made through the extension division in connection with the rural electrification program.

LAND DRAINAGE

Practically every farm in the state has some land under cultivation that is in need of drainage. Farmers of the state lose thousands of dollars annually by working land that is not adequately drained. Drainage is one of the best investments a farmer can make as a drainage system properly installed will result in an increased production of from 20 to 100 per cent.

The 1920 Census lists Virginia with 18,561,112 acres of land in farms of which 9,460,492 acres are improved, with 225,068 acres provided with drainage, and 1,172,580 acres in need of drainage. There is also 1,400,000 acres of unreclaimed swamp and overflowed lands. In addition to the acreage listed by the Census, there are thousands of cultivated acres that must be drained before successful crops can be raised in average wet years. At the present stage of over-production of agricultural products, we are not concerned with reclaiming any of the swamp or overflowed land but we are vitally interested in improving the thousands of acres of land in cultivation that should be drained in order to prevent the excessive losses in wet years. Wet fields have time, labor, and fertilizer spent on them which are always partially, sometimes totally, lost. The most unprofitable land on the farm is the land that is just dry enough so that it can be bultivated and yet wet enough so that about three crops out of five are lost. If this land were just a little wetter, it would be impossible to work it at all, and the loss would not be so great.

While drainage is needed in practically every section of the state, it is in the Tidewater section where the need is most apparent. In a study made in 1924, over 30 per cent of the average farm area of Accomac and Northampton counties was reported as wet land. This drainage study was made by the division of agricultural engineering, U. S. Department of Agriculture, in cooperation with the department of agricultural engineering, V. P. I. Personal interviews and occasional inspections on the farms of 75 land owners who had installed tile drains were made by the investigators. Forty-four of the farms were in Northampton and thirty-one in Accomac County.

It was shown from the questionnaire that the average size of farms in the two counties was 116 acres, 40 per cent of which or 46.4 acres, was in timber, and that the average area of wet land reported was 35.5 acres per farm or 30.6 per cent of the farm.

In 1917 the Bureau of Soils of the United States Department of Agriculture made a survey of the two counties on the eastern shore of Virginia. A total of 436,480 acres of land was shown, of which 143,170 acres was indicated as tidal swamp, coastal beach and dune sand, deducting this amount from the total leaves 293,210 acres of land for farming, forestry and other purposes. The 1920 Agricultural Census for Virginia reports a total of 127,400 acres of improved land in farms in these two counties. It was indicated from the questionnaire that about 50 per cent of the entire cultivated area in the two counties was wet.

If this ratio is applied to the total area of improved land in farms in the two counties viz. 127,400 acres, it will give 63,700 acres of wet land.

This figure should not be taken too seriously, however, as it was derived from the questionnaire which secured data from the owners of about 4 per cent of the total area of improved land. It is thought that fully half of the amount above, would require fairly complete drainage to insure the production of all crops which it seems at present the land owners will continue to grow.

On the 75 farms which were visited, it was found that the average potato crop on poorly drained land was 116 bushels per acre. The average increased production on this land after drainage was 28.4% or 33 bushels per acre.

From a survey made in 1928 it is estimated that since 1916, when the extension engineer made the first drainage surveys in this section, over 150 farmers have installed approximately 3,000,000 feet of tile to drain over 4,260 acres of potato land in Accomac and Northampton counties. An approximate cash value of this drainage work can be estimated by taking the average price of early potatoes in these two counties for the five year period 1923 to 1927 which was $1.34 per bushel. Using this figure as a basis with 33 bushels as the average increase per acre due to drainage, the average per acre annual cash value of drainage was $44.22 or over $188,000 for the 4,260 acres drained, not to mention the increase in the value of the land drained. Since the average cost per acre to completely drain this land was $66.50 with tile spaced an average of 58 feet apart, the average increased production on potato land in one year was sufficient to pay 66% of the entire cost of drainage.

"No investment I ever made has paid me as well as the tile drainage of my farm," said Martin Hall, Accomac County, Virginia. Mr. Hall was the first farmer in his county to install an extensive tile drainage system. A drainage survey was made for him in 1915 by the extension agricultural engineer and in 1917 he installed a complete tile drainage system on 70 acres of his farm. The tile was laid at an average depth of 3 feet and spaced 50 feet apart thoughout the entire 70 acres. Mr. Hall says, "Prior to draining this land did not produce enough revenue to pay taxes on it. In 1918, the first year after draining, I raised 2200 barrels of white potatoes on 22 acres of the tiled land, which sold for $4.00 to $4.50 per barrel. The net income from this first crop after draining, was more than enough to pay the complete cost of tiling the 70 acres. The following year 28 acres of this land yielded 100 barrels of potatoes to the acre and these sold for $7.00 per barrel. I have raised potatoes on this land annually for the past ten years and have gotten splendid yields each year."

Dr. G. W. Holland, of Northampton county, was probably the first farmer in his county to install a complete tile drainage system. Dr. Holland tiled 80 acres in the fall of 1915 and early winter of 1916. Before draining his land was extremely unsafe. The year previous to draining 50 acres of early potatoes were an entire loss, due to poor drainage. This loss convinced Dr. Holland that he must tile or stop raising potatoes on this piece of land. The year following the completion of the tile drainage system, which was an extremely wet year, Dr. Holland marketed 11,000 barrels of potatoes, nearly all of these being raised on the land that had been tiled. Dr. Holland wrote the extension engineer later that he never made an investment which paid better dividends than his tile drainage system.

From 1914, when extension work in drainage was started, to 1927 the extension engineer made 713 individual drainage surveys throughout the state, totaling 46,513 acres of farm land, or an average of about 65 acres per farm. During this period the farm demonstration agents report that 1982 farmers have tile drained 38,914 acres, and that 4139 farmers have drained 43,914 acres with open ditches.

While there are numerous instances of a 100% or more increase in production after tile drainage, investigations show that an increased production of at least 25% can be expected on average farm land. Using $43.30 as the per acre value of all farm crops in the state for 1927, a 25% increase in production for the 28,914 acres which the county agents reported tile drained would amount to over $420,000. not to mention the increased production on the land that was drained by open ditches, or the increase in value of all land drained.

DISTRICT DRAINAGE

Considerable area of farm land, especially in Tidewater Virginia needs improved drainage outlets to take care of the excess surface water. In numerous counties the old drainage channels have been clogged up by years of accumulated debris and do not afford adequate surface outlets in times of extreme rainfall. Norfolk and Princess Anne counties, Virginia, may be cited as an example. It is estimated that approximately 50% of the cultivated land (or over 54,000 acres) in these two counties suffer in wet years from inadequate drainage outlets.

The cleaning out of old drainage channels, or the construction of new ditches for surface drainage in large areas is a cooperative problem that can best be handled by the organization of drainage districts under the state drainage law. Norfolk county is leading the way in this type of drainage improvement and now has three drainage districts to her credit. These three districts comprise approximately 26,500 acres of farm land. It is notable that with the exception of the first drainage district which was organized years ago, these drainage districts are for the drainage of present occupied farming areas and not for the reclamation and settlement of idle land.

"This is the first spring in seventeen years that water has not stood on at least half of my land," a farmer told the extension agricultural engineer when inspecting the Sunray Drainage District No. 2 of Norfolk county while the construction work was still under way. This man is one of a number of Polish farmers who settled on this land about 20 years ago. "Some of our original colony have become discouraged and moved away, but those of us who have"stuck it out" feel that our patience has at last been rewarded. With the drainage ditches only half completed, we can see remarkable improvement. We have excellent trucking soil here, once the excess water is removed. As lack of drainage has been our biggest problem, we feel very much encouraged and believe we can now make a success of farming."

This drainage district, consisting of approximately 2,000 acres, contains about 60 farms. The project cost $45,000 for all financing, which is represented by special securities that will be retired at maturity from the proceeds of special levies on lands within the district bounds.

The final report of Norfolk County Drainage District No. 5, known as the Butts Road Drainage District, has been field and construction work on this project is expected to start soon. There are about 600 farms with a total of 14,410 acres in this district, while approximately 16,500 acres will actually be benefited by the drainage improvements. The proposed drainage calls for 33.43 miles of canals, with 556,000 cubic yards of excavation. The cost of the work is estimated at $234,930 or an average of $16.00 per acre.

During one extremely wet year many times the estimated cost of the drainage is lost by the farmers in this district. The completion of the drainage work as planned will not only make the land safe for truck crops but will considerably increase the value of the land, as it is within only a few minutes of Norfolk, the second largest city of the state, which has splendid shipping facilities, both by rail and water. The organization of these drainage districts is largely due to the untiring effort of F. L. Portlock, the county farm demonstration agent. Mr. Portlock has been preaching the gospel of better drainage in his county for years. He says, "The successful completion of these two drainage districts will fulfill the ambition of my life, as lack of drainage has been the most serious obstacle to successful farming in my county. Once the results of these drainage works become apparent, drainage practice will go ahead rapidly in this section of the state."

DRAINAGE INVESTIGATIONS

As a result of the survey conducted in Accomac and Northampton counties the following investigations are suggested:

Open Ditches

The incomplete inspection of open ditches and study of the questionnaire data indicates that better and perhaps cheaper drainage, considering maintenance, can be secured by the construction of cooperative outlet ditches, either open or of tile. It seems that some agency that could instruct the land owners and assist them in the formation of small drainage districts is desirable.

Tile Drainage

Size of Tile Mains - There seems to be a tendency for the contractors engaged in laying tile to use larger mains than are commonly recommended by Federal and State drainage authorities. This may be due to the drainage demand of truck crops where injury from excess water is greater than the ordinary grain or forage crops. The measurement of the volume of water discharged and the duration of flow from typical mains would shed some valuable light on the design of tile drainage systems for this section.

Depth and Spacing of Tile Lines - There seems to be considerable diversity of opinion and practice in the matter of spacing and depth for drains. One contractor makes a pretty general practice of laying his mains as deep as his machine will cut, and the laterals from 3 to 4 feet , or even deeper, spacing them from 40 to 50 feet apart. Another contractor plans his mains to be about $4\frac{1}{2}$ feet deep, laterals $2\frac{1}{2}$ to 3 feet deep, and spaced about 60 feet apart. The former system costs the landowner about $90 to $100 per acre and the latter from $70 to $90 per acre. The information from the questionnaire does not indicate any material difference in the drainage secured by these different systems. It does appear, however, that quick sand troubles and the later development of suck holes depends somewhat on the depth.

A study of ground water movement in drained and undrained tracts would be of great assistance in determining the probable economic spacing and depth for tile drains.

Surface Inlets and Silt Basins - It has been the practice of drainage engineers to recommend the construction of surface inlets and silt basins in many systems of tile which they have planned. The questionnaire shows that not many such accessories to drainage have been constructed and that they are more of a novelty than a utility. In several cases where surface inlets have been constructed to receive water from an open ditch a great deal of trouble has been experienced in keeping these inlets free from floating debris to make them effective. Such structures placed in open fields are nuisances as they interfere constantly with the cultivation of the land. It is a rare farmer who will inspect and clean such structures as frequently as they should be to keep them effective.

Large quantities of sand were frequently seen in the ditches below main tile outlets, indicating that considerable sand does get into the tile lines and that some of it washes on through.

Some field studies could profitably be made in inspecting tile outlets and tile mains to discover whether or not sand has collected in the mains and whether or not the presence of silt basins has any effect on preventing these deposits.

<u>Bedding with Pine Shatters and Trash</u> - Placing organic matter, such as indicated above, on tile lines before filling is, or was, common practice in Northampton county. The idea being that it would prevent sand from entering the tiles and perhaps aid in permitting the water to enter the tile lines faster. It seems that this practice is expensive and of doubtful value. This subject might be investigated more fully in the field.

<u>Surface Water Standing Over Tile Lines</u> - This condition may be quite common to these soils. The landowners did not consider it unusual. From the casual observations, it does not appear that under drainage is a remedy. It seems that studies by soil specialists in conjunction with drainage specialists should be made in connection with this problem.

IRRIGATION

The possibilities of irrigation in Virginia are unlimited. The extensive drouths which have occurred in recent years have stimulated interest in this subject. Nearly every year the crops in some section of the state are seriously retarded by lack of sufficient rain fall. There is usually a long period in the spring of the year when insufficient rain falls. In many sections it is a comparatively simple matter to supplement the rainfall with water from streams or wells.

Overhead Irrigation

Virginia is subject to drouths of more or less severity which damage all growing crops, but especially such truck crops as lettuce, tomatoes, strawberries, and potatoes which are materially injured by short periods without rain. To safe-guard these crops from drouth it is often feasible to install irrigation systems to provide a water supply to supplement the rain fall. The most common method of applying water to truck crops in the humid region is known as overhead or spray irrigation.

The most successful vegetable growers of the state find it is extremely difficult to make a success with small vegetables unless they are equipped to irrigate. Overhead irrigation systems are coming into quite extensive use in the trucking sections of the state. Farmers who have installed such systems invariably say that they would not try to raise truck crops without such irrigation.

Mr. L. W. Purdum, a farmer near Danville, Virginia, has made an outstanding success of truck farming. Mr. Purdum started farming on his present property some 35 years ago. He began with general farming and gradually worked into specialized truck farming. After several years trying to raise vegetables on a commercial scale without irrigation, he became convinced that he could never make much of a success depending on the rain alone for moisture. In 1915 he installed the first unit of an overhead irrigation system and seven years later completed this system for 32 acres. The entire installation cost about $9000.00. After the completion of the isrigation system the 32 acres were tile drained.

The overhead irrigation system consists of a main pumping plant and an elaborate pipeline distribution system. The pumping plant is located on the banks of a small stream at the lower edge of the farm. The pumping unit consists of a

3 cylinder 7 by 8 Goulds pump directly connected to a 20 H. P. 220 volt - 3 phase Wagner motor. The suction lift is 13.5 feet, while the highest point on the farm to which water is pumped is about 100 feet above the water level in the stream at the pump plant. The distribution system consists of 1450 feet of 4 inch overhead pipe lines. One acre inch of water can be sprayed on 8 acres in from 10 to 12 hours. In extremely dry seasons two irrigations per week are made.

The principal crops raised under irrigation are tomatoes, cantaloupe, lettuce, celery, spinach, turnip salad, peppers, and purple turnips. Tomatoes has been one of the best revenue producing crops and Mr. Purdum usually tops the market with his tomatoes which are raised under irrigation.

Surface Irrigation

While overhead irrigation is satisfactory for intensive truck farming, such installations are too expensive for general farming. When the land is not too rolling surface irrigation, or the spreading of water over the land through furrows, etc. can be practiced to advantage. Such crops as potatoes and alfalfa need ample water and irrigation tests conducted so far in this state on these crops have proven very promising.

Mr. B. G. Locher, Glasgow, Virginia, is irrigating 75 acres of alfalfa, pumping water direct from the river flowing through his farm. In 1926 the average yield from the second cutting of alfalfa on a 30 acre field was only 400 pounds, due to the dry season. Part of this field was irrigated for the third cutting and in addition received one good rain and two showers. The yield on the irrigated portion was 2150 pounds per acre, and on the un-irrigated portion 1204 pounds per acre. In other words, had the second cutting received two irrigations, indications are that the yield would have been increased from 400 to at least 2000 pounds per acre.

The irrigation of potatoes has very promising possibilities. In 1927 on a small test plot in Accomac county, an increase yield of 9 barrels per acre was secured from one irrigation during the dry spell in May. This increase was made in spite of the fact that, due to ample rains later in the season, the potato yield in this county was one of the largest ever experienced. An irrigation test plot was established this year (1928) on the Eastern Shore Experiment Station in Accomac county. On the early potato crop an increase of 46 bushels was secured by irrigation. There was ample rain during the growing season this year also so the results secured from irrigation in a year of ample rainfall indicates what can be expected from irrigation in a dry year.

IRRIGATION INVESTIGATIONS NEEDED

There is need for engineering and economic studies on surface and overhead irrigation in the various sections and with different crops to determine on what crops and to what extent irrigation will pay. In addition to the increase in yield from irrigation, there is the insurance factor to consider. An irrigation system is good insurance against drouth.

The increased yield as a result of irrigation on potatoes and alfalfa in seasons of normal rainfall seem to indicate that water pumped from streams or from shallow wells may contain considerable quantities of plant food. In other words the fertilizing value of such waters may account to some extent for the increased yields. This is a subject worthy of investigation in cooperation with soil scientists and chemists.

The irrigation of apples also offers possibilities. Orchardists who are raising a high quality of fruit for special markets say that during dry years the quality, size, and color of the apples are seriously affected and result in large losses. These orchardists are convinced that irrigation will pay in average dry years.

Mr. F. H. Wissler, a large orchardist of Shenandoah county, has installed a pumping plant and distribution system to irrigate approximately 60 acres of his apple orchard. It is estimated that this system will cost $5000 but he is convinced it will pay for itself in one dry year. Several years ago Mr. Wissler tested out his theory be hauling water in barrels to a group of trees. He found that the increase in size and improvement in quality and color of the fruit on the trees watered was sufficient to pay for even this expensive means of irrigation.

Mr. J. G. Hopkins, another large orchardist in Botetourt county, during the drouth of a few years ago, hauled water for two weeks to 900 early transparent trees. He thereby not only saved his crop but produced a good quality fruit which he sold for a big price, while apples of this variety in adjoining orchards were a complete failure.

What little investigations that has been attempted so far has been through the extension division, cooperating with orchardists and farmers who have asked for assistance and are carrying on these studies at their own expense. This is fundamentally research work and the Experiment Station should make provision for conducting studies of this nature.

SOIL EROSION

"Soil erosion, or the washing away of the soil, takes $200,000,000 annually out of the pockets of the farmers of the United States," says H. H.

Bennett of the Bureau of Soils, United States Department of Agriculture. Mr. Bennett further states: "Erosion carries away 20 times as much plant food material every year as is permanently removed by crops. Not less than 10,000,000 acres of land formerly cultivated have been permanently ruined by rain wash. A single county in the Piedmont region was found by actual survey to contain 90,000 acres of land formerly cultivated lands which have been permanently ruined by erosion. Another county in the Atlantic Coastal Plain has 60,000 acres ruined beyond repair. Much of this land could have been saved by timely terracing, and a great part of it should never have been plowed in the first place because of its extreme susceptibility to erosion. Such land should be maintained in timber or pasture." Soil scientists agree that most of the worn out soils of the world are in their present condition because much of the surface washed away and not because they have been worn out by cropping.

The department of agricultural engineering of the Virginia Polytechnic Institute conducted a soil erosion survey in Charlotte county, Virginia, in 1926, for the purpose of determining the amount of farm land that is being washed away or is subject to the process of erosion. The preliminary report of this survey shows that 89% of the farm land is subject to erosion, while 71.5% of the farm land is actually washing to some extent, either by sheet or gully washing. As a result of soil erosion, approximately 3.9% or nearly 4000 acres of farm lands in Charlotte county that was once the best farm land was abandoned to farming that year. Either the fertile top soil has been washed away or gullies had formed to such an extent that the soil has been rendered too poor or unproductive to farm. If proper methods of controlling the flow of water had been in use, this land would still be in cultivation. Proper methods of control can still reclaim this land. The condition in Charlotte county is typical of at least 25 of our Virginia counties.

Soil erosion is due primarily to the rapid movement of the rain water over the surface of the ground. Methods of preventing erosion, therefore, must provide for the rapid absorption of the water by the soil or allow it to flow away slowly to a drainage ditch. It should be the aim of every farmer to increase the absorbtive power of his soils. Permeable soils will absorb surface water rapidly and thereby check erosion. Deep plowing, plowing under organic matter such as manure, stubble, stalks, and cover crops, and tile drainage are methods of increasing the permeability of soils. Contour plowing will materially assist in preventing erosion. The beginning of a great many gullies on hill lands is due to the practice of plowing and cultivating directly up and down the slopes.

Bare soils are much more susceptible to erosion than are soils having some suitable vegetation. It is, therefore, extremely important that some kind of cover crop, such as vetch, clover, oats or rye, be grown on the land during the winter or at such times that the land is not used for other crops.

Terracing is the most effective method of preventing erosion, and when used with the above methods it is doubly effective. Terracing consists in plowing up a series of broad base ridges that catch the water and carry it gradually off the land. The terraces should be placed close enough together to prevent a large accumulation of water from flowing rapidly down a slope and carrying the soil with it. Properly planned and constructed broad base terraces do not interfere with the use of machinery and they can be constructed at small cost with equipment made by the farmer himself. A small investment in terracing holds back large losses of moisture, soil, and plant food.

"Terracing is the first step in improving land in this section," says J. W. Chaffin of Halifax county. "In the last three years I have terraced 150 acres of my farm. Before constructing the terraces my land was washing badly with small gullies starting. The approximate cost of constructing the terraces was $3.00 per acre. I believe my land is worth twice as much since terracing, at least from a cultivation standpoint. It is useless to try to improve land in this section by sowing peas, beans, or clover and letting the land wash away in the course of two or three years. I have found terracing the most effective means of checking soil erosion. The Farmers Social Club, of my neighborhood, thinks so much of terracing that it has bought levels and terracing equipment for the use of farmers in the community." This testimonial of Mr. Chaffin typifies the interest farmers of the Piedmont section of the state are taking in terracing as a method of controlling soil washing, and conserving moisture and soil fertility.

Farmers of the counties subject to soil erosion are calling on the extension service for help in terracing their farms. This assistance is rendered through terracing schools and field demonstrations. In this way farmers are learning the use of the farm level for laying off terraces, and proper methods of constructing the terrace. In some counties this work is the most important project of the farm demonstration agent. Since 1917, when this work was started as an extension project, the agricultural engineers have terraced 4515 acres at 244 terracing demonstration and schools at which 2603 farmers were given instruction. During this period the farm demonstration agents assisted 4397 farmers to terrace 27,505 acres of farm land.

SOIL EROSION INVESTIGATIONS

We devote much time and money to the study of fertilizer, crop improvement, etc. and rightly so, but no money has as yet been spent in this state for investigations in soil erosion control. Soil scientists agree that most of the worn out soils of the world are in their present condition because much of the surface has been washed away and not because they have been worn out by cropping. If this is true, then it is indeed time that some attention be given to investigations in methods of checking such tremendous waste of land.

In our southern Piedmont counties where erosion is so general, considerably more than 50% of the crop land lies idle or fallow each year. As an example, according to census figures, Charlotte county had 75,437 acres of crop land in 1925. In 1924, 45,475 acres were harvested and 29,506 were left idle or fallow. In some of our counties the proportion of idle or fallow land is even greater. Since erosion is especially active on this idle land, studies should be made to determine the most practical, inexpensive, and satisfactory methods of control Studies to determine the satisfactory crops that are cheap enough to use on these idle lands should be made.

The rapid run-off from farm lands is an important contributing factor in the cause of floods. Methods of controlling this rapid run-off is, therefore, of unquesticnalbe importance in any comprehensive flood control measures and should receive the study and attention it deserves from the flood control standpoint as well as from its relation to agriculture.

LAND CLEARING

Farmers are finding it is necessary to rearrange their fields and in some cases their whole method of farming. One can no longer make a success of farming land cluttered with stumps and other obstructions. Fields must be of the proper size and the land free from obstructions for the efficient use of machinery. Studies of the length of time required to plow two fields in Georgia - one with the average South Georgia growth of stumps and the other cleared of stumps, both of the same size and shape, plowing at the same seasons, and with equally fast teams - showed that the cleared land could be plowed in three-quarters of the time required for plowing the stump field. In other words, a cleared field of eight acres could be plowed as quickly as a stump field of six acres.

It is not uncommon to find ten per cent of the acreage of a field taken up with stumps and the land which cannot be seeded because of them. A farmer pays taxes and interest on all of his land, but where there are stumps in his fields he gets a crop from only a part of his land. This waste land is not only unproductive, but actually injures the remainder, in addition to increasing cultivation costs.

In the last three years farmers of the state have taken advantage of the surplus war explosive, "Pyrotol," which was distributed by the United States Department of Agriculture through the department of agricultural engineering of the State agricultural college. Eighteen hundred and fifty-three farmers purchased approximately one-half million pounds of this explosive for which they paid $49,000. From reports received from 300 of these farmers, it is estimated that the 1853 farmers saved approximately $57,000.00 on the purchase price as compared to the cost of the same amount of commercial explosive of equivalent strength. Basing estimates on the reports received, the 1853 farmers removed stumps from 6786 acres of new land and 14,017½ acres of cultivated land. By removing stumps from the cultivated land, yields were increased 21.4%. The new land increased in value $250,479.00 and the cultivated land $277.501.00. Taking the state average per acre value of all crops for 1927, which was $43.20, the increased yield reported as a result of removing stumps from the cultivated land would amount to $9.42 per acre or $129,521.00, not to mention the returns for the new land cleared of stumps.

Since 1919, when the land clearing project was begun, the extension engineers have held 169 land clearing demonstrations which were attended by 4,793 farmers. The farm demonstration agents report that 5,749 farmers have removed stumps from 25,849 acres during this period.

FARM WATER POWER DEVELOPMENT

Virginia has innumerable small streams that flow through the farms of the state. Many of these streams can be developed at reasonable expense for the generation of electric power, pumping for irrigation, and water supply. That farmers are interested in developing their water power is indicated by the large number of inquiries received by the extension service. Since 1922, hundreds of letters have been answered on this subject and 192 surveys of small water power sites have been made for farmers. A number of these have been developed and are giving satisfactory service.

In order to obtain data with regard to the possibilities of small-stream development, preliminary surveys were made of a number of typical streams in Virginia. The result of this study is published in U. S. Department of Agriculture Farmers' Bulletin #1430 entitled "Power for the Farm from Small Streams."

The installation on the farm of H. P. Givens, Giles county, is typical of the smaller farm water power developments. The source of power was obtained from a spring which had a maximum flow of less than fifteen gallons per minute. The spring was 125 feet above and 1500 feet from the residence. There was not sufficient available power to run even the smallest generator, so an earth dam was built below the spring to pond the water for several hours. Next a two-inch pipe line was run from the dam to a six-inch impulse water motor located in the cellar of the residence. The water motor was then belted to a 36-volt 1/4 kilowatt generator which charged a 90-ampere hour storage battery for a few hours each day. This plant cost less than $450, including all labor and materials. Second hand pipe was used to convey the water and auto generators taken from junked cars were used to motor several of the appliances, such as washing machine and a tool grinder. The plant furnishes necessary power for lighting the nine room dwelling, machine shop and barn, and for the operation of numerous small appliances such as washing machine, churn, cream separator and tool grinding equipment in the shop. This plant has been in continuous operation for eight years. The batteries are still in good condition and indications are that the plant is good for many more years of service.

"After using electricity around the farm, I would not know how to farm without it. If I did not have water power, I would sell my farm and locate where I could get electric service from a power company," says C. W. Fricke, of Albemarle county. Mr. Fricke has harnessed the stream running through his farm for the generation of electric power. His water power plant develops around 30 horse power and he uses an electric load of 10 kilowatts, day and night in winter, and five kilowatts on an average in summer, or a total of 75,640 kilowatt hours per year.

Some of the electrical appliances used by Mr. Fricke are: In the house, a homemade house heater, an electric range, water system, water heater, washing machine, churn, sewing machine and other usual small appliances. In the poultry house is used, incubators, brooders and drinking fountains, all heated by electric current, also electrically driven feed grinders and feed mixers.

Welding and soldering apparatus, battery charger and electric driven saws are used in the shop.

Mr. Fricke says, "While our water power development did represent a good deal of money, $3600, for the complete investment, yet some of our most useful electrical appliances in the home have actually cost even less than other substitutes. For instance, our electric heating equipment, including additional wiring, cost considerably less to install than a hot air furnace. The cost of operating the electric heater is also very much less and considerably less troublesome. In fact, we figure that what we really save in the cost of light, heat, power and labor each year amounts to considerably more than the interest on the investment, plus the maintenance and depreciation of our power equipment."

FARM WATER SUPPLY

Running water is the greatest single convenience in the home. It is not a luxury but a real necessity and this equipment is fully as important as any other farm machinery. Every farm home in the state should at least have running water in the kitchen but basing conclusions on State and Federal Census, extension division reports, and all available sources of information, only approximately 7% of the farm homes in Virginia have running water as compared to 12% in the United States as a whole.

Closely connected with the subject of farm water supply is the matter of sanitation. The improper disposal of sewage and unprotected water supplies on the farm are responsible for much sickness and many deaths in the state. Such diseases as typhoid fever, dysentery, diarrhea, and enteritus result mainly from the improper disposal of body and household wastes, and from the contamination of unprotected water supplies. Proper disposal of all body and household wastes and the adequate protection of the water supply is the first step necessary in the prevention of these diseases.

The agricultural engineering department of the extension division for the past ten years has been giving attention to the question of farm water supply and sanitation. Since 1920 the extension engineers made water supply surveys on 903 farms. In addition to help on water systems on each of these farms, advice was given on sewage disposal, protection of the water supply, heating and lighting systems. The farm and home demonstration agents report 2488 water systems, 187 heating systems, 695 sewage disposal systems, (septic tanks), and 3716 lighting systems installed by farmers according to plans furnished since 1920.

A farm water supply campaign was recently conducted in Bedford County in April of this year. Weekly newspaper articles were run in the several papers serving the county and all schools, churches, merchants, bankers, etc. cooperated in advertising the campaign previous to the actual visit of the engineer. As a result of this propoganda 135 requests were received from farmers for assistance. The engineer spent about three weeks in the county visiting the farmers interested and advising on the type of water supply system best suited to the particular farm. Several of the farmers visited have already installed water systems and indications are that most of the farms visited will have running water in the home by the end of the year. Arrangements have been made to put on campaigns in a number of counties each year as greater results can be secured in this way for the time and expense involved than by any other method of conducting the project.

"I expect to die soon anyway so I do not care to spend money on such things," was the reply of one farmer when asked by the home demonstration agent if she could help him plan a water system for his home. It was estimated that the house wife, in carrying water from the spring, up the hill to the kitchen, was walking 140 miles a year and expending enough energy in lifting water to do the work of two horses in plowing eleven acres of land. When presented with these facts, the son agreed to spend $50.00 of his own money toward putting running water in the kitchen for his mother.

A small hydraulic ram, storage tank, kitchen sink, and pipe with the necessary fittings was purchased for $49.00. The agricultural engineer then gave a demonstration on the installation and operation of the system. This demonstration was attended by a large number of farmers and members of the local Home Economics Club. The father did not believe the system would work, even up to the time that the ram pumped water into the tank. However, after enjoying the convenience of running water in the kitchen, he took a hand himself and had a complete plumbing system installed. A request was later received from him for advice on harnessing a small stream on his farm for the generation of electricity for his home. Since he has learned how to live, he has taken an increased interest in life and has decided to live a little longer.

RURAL ELECTRIFICATION

The question of central station electric service for farms is receiving nation wide attention at the present time. Farmers want and are entitled to this service but before farm electrification spreads very extensively many problems have to be solved. In its broadest aspects the rural electrification problem is one of finding uses of electricity on the farm which will insure a volume utilization of current sufficient to justify the service at a price the farmer is willing to pay and the power company is willing to accept. The following quotation from the report of the Committee on the Relation of Electricity to Agriculture expresses clearly the main problem of extending electric service to the country.

"The chief obstacle that lies in the way of a general widespread supplying of electricity to farms is the cost of distribution. In the rural districts three or four possible users to the mile of transmission line represent a good average, while in more closely populated sections and cities from one dozen to several hundred or even more consumers will be served from a line of one mile in length. Distribution expenses are by far the biggest items in the cost of electricity due to expensive transmission lines, transformers and maintenance. It can readily be seen that without the pro-rating of costs between many customers possible in thickly populated communities, something to balance this condition must be made effective before electricity will be economically possible for both the farm and the power company. This will be accomplished by the consumption of a much greater amount of electricity than is used by urban dwellers. This, obviously, will be practicable because of the greater need of the farm over the city for power and through the development of electrical apparatus suited to the needs of the farmer.

"The cost of delivering the current to the farm is several times the cost of generating it. Rural lines cost from $750 to $2000 per mile to build. Assume a typical case where a mile of line serving three farms cost $1200. The item of interest at 6 per cent amounts to $72.00 per year. If each farm uses 400 kilowatt hours per year the charge of interest will be 6 cents per kilowatt hour, which may be five or six times the cost of generating it. Now if each farm should use 3,000 kilowatt hours per year, the charge for generating would remain the same but the interest cost would be reduced to .6 of a cent per kilowatt hour. In the last analysis, low priced electric service on the farm depends primarily upon spreading the fixed charges necessary to make it available over a large number of kilowatt hours."

In 1924 the Virginia Committee on the Relation of Electricity to Agriculture was organized for the purpose of instituting and executing investigations which would solve some of the problems involved in supplying the farms of the state with electric service. This committee is composed of representatives of the leading electric companies, farm organizations, state department of agriculture, state agricultural college, and representative farmers. As a result of the work of the committee, in cooperation with the National Committee on the Relation of Electricity to Agriculture, much is being accomplished toward the extension of electric service to Virginia farms. In 1924 when this work was started, five of the leading electric power companies had approximately 1500 farm customers. These same companies reported approximately 4500 farm customers early in 1928.

One of the first studies instituted by the committee was a state wide survey of the present uses of electricity in agriculture. This survey brought to light many very interesting and important uses of electricity in agriculture. A rural test line was constructed for the purpose of making studies of certain specified uses of electricity on the farm, such as pumping water for domestic and livestock uses, lighting and poultry house to increase egg production, and the numerous uses of electricity in the farm home. Studies have also been made of the individual gas engine and hydro-electric plants. Studies are now under way on overhead and surface irrigation, feed grinding, and the use of lights for controlling insect pests.

The rural electrification studies have been conducted by the extension division. This work is primarily research and should be handled through the experiment station. As rural electrification promises so much towards the reduction of labor costs and improved living conditions on the farm, and since there are still many problems to solve, provision should be made to carry on this important work through the experiment station.

A number of farmers in the state are already using large amounts of electricity in their farming operations and are finding it profitable to do so. Mr. L. W. Purdum, a successful truck farmer near Danville, Virginia, is demonstrating that in truck farming a large amount of electric power can be used to increase the profits from farming. Mr. Purdum and his five sons operate a farm of 104 acres, 32 acres of which are under irrigation and planted to truck crops. Electric power is used to operate the electric lights to trap the tomato worm moth, and other insect pests; to operate the irrigation pumping plant; to operate a large six car load capacity refrigeration plant; and to supply current for lighting and numerous household conveniences in the two large dwellings on the farm. Mr. Purdum uses for these purposes on an average of 20,000 kilowatt hours of electricity per year.

"I am using between 600 and 800 kw.-hrs. of current per month and have only been receiving electric service from the power company since the first of the year," said S. E. Hostetter, a successful farmer of Warwick county, Virginia. Mr. Hostetter is using electricity for lighting his poultry houses, operating 4 fans continuously from the 10th of January to 15th of May in his 27,000 capacity steam incubator house; operating a 3 H. P. motor for grinding sausage; operating a 1 H. P. motor in his barn for elevating feed; operating a pumping plant, refrigeration plant, and all the usual home conveniences. "I raise and grind all my own feed for my hogs and poultry, and as I am at present marketing an average of 3500 birds a year, market 40,000 baby chicks and custom raise 70,000 more as well as raising 75 hogs each year for sausage, it takes considerable feed. I am at present using a 20 H. P. engine but hope to soon have an electric motor to operate my feed grinder. I also expect to heat my incubator by electricity."

Mr. Hostetter is a member of a Mennonite Colony of approximately 70 farms. The rural line extension of 6½ miles was completed the first of this year with 32 farms connected. The other 43 farms will probably be connected within the year. This extension is typical of the state wide movement to secure farm electric service.

FARM BUILDINGS

Census of Agriculture: 1925 - Virginia

State Table 1. - Farms and Farm Property

Item	1925	1920	1910
Value of farm property			
Land, excluding buildings - dollars	600,675,835	756,354,277	394,658,912
*Buildings - dollars	286,138,184	268,080,748	137,399,150
Implements and Machinery - dollars	40,021,254	50,151,466	18,115,883
Livestock on farms	72,630,566	121,969,281	74,891,438

A study of the above census figures shows that the value of buildings on the farms of Virginia increased in value $18,057,436 in the five year period from 1920 to 1925. This indicates that notwithstanding the agricultural depression of this period and the decrease in value of other farm property, Virginia farmers have been building new structures at the rate of over three and a half million dollars in value per year. Probably considerably of this increase can be accounted for by the stimulation of the poultry and dairy industries in the state. Large numbers of new dairy barns and poultry houses have been constructed in the past seven years. During this period the agricultural engineering department has sent out more plans for poultry and dairy barns than for any other farm buildings.

The department maintains a free farm building plan service for the benefit of the farmers of the state. A large assortment of plans of practically all types and kinds are on file in the office. This plan service is constantly being improved by the preparation of new designs which incorporate the latest ideas in farm building construction. Thousands of requests for plans are received by the department from the farmers of the state each year. Field assistance is sometimes given on building construction, especially in cases of community building projects such as storage and packing houses, fair buildings, etc.

That the farmers are actually building from these plans is indicated from the county farm demonstration agents' reports. During the period 1920 to 1927, the agents report that on 5399 farms, buildings were constructed from plans furnished as follows: 2265 dwellings, 579 barns, 487 hog houses, 4688 poultry houses, 3273 silos and 628 miscellaneous buildings. If we estimate that the average cost of the buildings reported constructed is $2500 per dwelling, $2000 per barn, $100 per hog house, $200 per poultry house, $250 per silo, and $500 per other buildings, we have an investment of approximately $10,000,000. In other words at a very conservative estimate the buildings actually reported constructed from our plans have been at the rate of around one and a half million dollars in value per year.

RESEARCH IN FARM BUILDINGS NEEDED

Since farm buildings represent such a large part of the farm investment (approximately 38% of the value of all land, machinery, and livestock), it is evident that this investment constitutes a large part of production costs, and therefore, represents a correspondingly large problem in economic production. Practically no research of a basic nature has been done along farm building lines. The present plans being distributed to farmers have had to be developed from existing common practices, which are a result of inherited building designs, accepted from the past and in numerous cases they are ill-adapted to modern conditions. The need, therefore, for extensive research in farm buildings is apparent.

Before any great progress can be made in adapting our farm buildings to modern conditions and designing our buildings for greater efficiency and lower costs of production, we must know the conditions that should be provided for and the requirements which result in increased production, or a saving of labor must be shown to be worth the cost of meeting these conditions. Research studies should, therefore, be started as soon as possible. These studies may be divided into two general classes. (1) Those involving the determination of the requirements in structures making for greater productiveness and efficiency and (2) those involving the determination of the means by which the requirements may be met. Studies should be made of such problems as space requirements, arrangement for efficiency and economy, temperature, humidity, ventilation, light, sanitation, and water supply, selection of materials, structural design and equipment.

We must not lose sight of the farm home, for after all, farmers as well as people in other occupations are striving for a better living. The modern farm home should be designed with a view of giving an abundance of light, air, and running water with other conveniences, sound economical construction and convenient arrangement for comfort. While these requirements are largely being incorporated in plans furnished farmers, the matter of architectural beauty has been neglected or forgotten. Very little study has been devoted to the farm home and most of the homes farmers have built and are building have been designed for cities or towns and are not at all suited for country life.

Virginia occupies a rather unique position from the standpoint of its early colonial architecture. The early colonial farm or plantation homes are, of course, not applicable to present farm home conditions, but they were essentially beautiful in design and the best of this early colonial beauty should be incorporated in the modern farm home. It is possible to combine beauty and utility, and this calls for the three-fold efforts of the agricultural engineer, the home economist, and the architect. Research should be made with the idea of studying the best in the old Virginia colonial home and incorporating this early beauty into a modern and distinct type of farm home architecture.

FARM POWER AND MACHINERY

Census of Agriculture: 1925 - Virginia

Value of Implements and Machinery			
1925	1920	1910	1900
$40,021,254	$50,151,466	$18,115,833	$9,911,040

The 1925 Census ranks Virginia nineteenth among the states in the value of farm machinery. Virginia ranks first of the southern states in the value of machinery per crop acre, with a value of $7.45. The value of crops produced per farm worker in different states is almost in direct proportion to the value of machinery used per worker. As an example: using machinery figures from the 1920 Census, and average crop value for 1919 to 1923, we have Alabama at the bottom of the list with the value of machinery per farm worker at $60.00 and the value of crops produced per worker at $480.00; while in South Dakota the value of machinery per worker is $975.00 and the value of crops produced per worker is $1790.00. Alabama uses approximately 1 primary horse power per agricultural worker while South Dakota uses 14 horse power. These figures are graphically illustrated andshow Virginia's ranking in charts nos. 6 and 7 which are appended to this report.

While Virginia ranks below the U. S. average for value of machinery and total primary horse power per agricultural worker, progress is being made in the adaption of labor saving farm operating equipment. The extension agricultural engineers have been conducting demonstrations and short courses in power and machinery for farmers but limited funds and personnel have prevented as much attention to this important phase of agricultural engineering as it justifies.

Since 1918 fourteen tractor demonstrations have been held by the extension engineers, with over 31,000 farmers attending. These early tractor demonstrations were an important factor in promoting tractor farming. The number of tractors on farms in Virginia has increased from about 750 in 1918 to over 10,000 in 1928. Approximately 156 field machinery demonstrations were held at which 3820 farmers were instructed. Eighteen gas engine and tractor short courses have also been held at which 1293 farmers and agricultural club boys received instruction. Farm machinery and tractor instruction is always popular with the farm boy.

Tractor short courses should be extended as rapidly as possible as this is a valuable means of the farmer learning the proper care and operation of his tractor. Inadequate laboratory facilities at the college as well as personnel has prevented much work along this line but provision is now being made to remedy the personnel factor and when proper laboratory facilities are provided, the tractor short courses will be stressed.

In Farmers' Bulletin #1348, U. S. Department of Agriculture, the statement is made that "power and labor together represent on the average about 60% of the total cost of carrying on the farm business." With power and labor involving over one-half of the total cost of production, the opportunity for the farmer to secure larger profits by reducing this one single item is obvious. Moreover, this item of cost is one that readily lends itself to manipulation, whereas the items of land, taxes, fertilizers, seed, sales costs, etc. are practically fixed by conditions beyond the control of the farmer. Since the two items of power and labor are directly subject to the control of the farmer, and since they are factors that engineers are constantly working with, it is apparent that well trained agricultural engineers can do much to improve the condition of the agricultural industry.

An engineering analysis of the so called "farm problem" leads one to believe that a major trouble is an economic balance favoring industry because the farmer is attempting to compete against a mechanically powered and operated business with an old style hand operated farm.

One of the significant defects in the present use of mechanical equipment in agriculture, and one of the defects most difficult to remedy, is the low load factor, or low percentage of total time that the equipment is in use. This is caused by the extremely seasonal demands for power of many crops, and also of two or more crops demanding power at the same time. Also the diversity of crops and operations demanding many types of machines tends to keep down the load factor of the total. The remedy apparently lies in designing and selecting power and machinery units of a size suitable to the needs and of a design that may be used for several operations, and its use not confined to one particular crop or condition. This requires the selection of more efficient machines, less expensive machines, and the substitution of cheaper power for the more expensive human labor.

Although the power and labor costs are high and susceptible to reduction by the substitution of mechanical power and machines, the more wholesale change to tractors, large plows, two row cultivators, corn pickers, combined harvester threshers, and the like, will not solve the problem of large profits for farmers. The proper machines to use for certain conditions, the methods of their use, simplified practices, new methods, and new machines must be determined and developed. The application of fertilizers and the use of proper seeds have been studied until today the proper kind and amount of seed and fertilizer can easily be determined. This is not true of the mechanical equipment offered for the use of the farmer.

RESEARCH IN FARM POWER AND MACHINERY

Realizing this very important problem confronting the farmer, the agricultural engineering department through the Virginia agricultural experiment station undertook a research program in farm power and machinery in September, 1925. Until July, 1928, this work was conducted by one man on a part time basis. In spite of limited funds and personnel some progress has been made in this line of investigation.

A farm machinery survey was first conducted and the results indicated one fact: The Virginia farmer is under equipped and underpowered as compared with the average of the United States, and especially when compared with those states showing the largest monetary returns per farm worker. Appended to this report will be found a series of graphs presenting Virginia's status in an engineering analysis of her agriculture. These charts compare Virginia with the

United States average, the lowest and highest ranking states, and the neighboring states of North Carolina and Tennessee.

This preliminary survey indicated many problems needing solution, but two gave promise of showing immediate results. These problems were the better adoption of the tractor to Virginia farm conditions, and the efficient harvesting of soybeans for seed.

The tractor offers cheap power but it is generally limited to doing the heavier work such as plowing, discing, etc. On the majority of Virginia farms using tractors the number of work stock has been reduced but little. This results from the inability of the average tractor to cultivate row crops successfully. With these facts in view a study of the cultivating tractor was undertaken and is still in progress. Considerable information has been secured and made available to the tractor manufacturers to assist them in developing their tractros so that they may better suit Virginia farm conditions.

The soybean harvesting methods practised in Virginia have been very wasteful of seed. In 1925 approximately 15,000nacres were harvested producing a total of 210,000 bushels of seed, but no less than 90,000 bushel of seed were lost in this harvest. This represents a loss of at least $250,000 to the farmers.

The combined harvester-thresher had proven so successful in the middle western states that it was introduced into Virginia. The combine reduced the average harvesting loss from 25% to 11%, which if it had been used in all the soybean fields of Virginia in 1925 would have saved the farmers approximately $168,000. Furthermore, the actual harvesting cost has been reduced $1.00 to $1.50 per acre, or more. This means $15,000 to $20,000 additional, or a total of approximately $185,000 could have been added to the farm income of the state in 1925 through efficient soybean harvesting alone.

The combine is an expensive piece of farm machinery, therefore, it must be used to harvest as many crops as possible. To date it has been used in Virginia to harvest wheat, oats, barley, and rye in addition to soybeans. Various problems have presented themselves in the handling of these grains and the agricultural engineering department is engaged in the solution of these, so that the combine may be made a profitable farm machine in Virginia. A saving of approximately $1.50 per acre over the customary harvesting methods can be expected by harvesting with the combine, and it is the job of the agricultural engineer to make this saving possible.

Many other problems present themselves, but lack of funds, laboratory space, and personnel prevent their solution. Farm machinery problems fall into three general classes: (1) methods and practices; (2) equipment; and (3) materials. A study in methods and practices is one involving the introduction of new methods and machines and the engineering solution of their use, as the present work with the combine. An equipment investigation is exemplified by the cultivating tractor problem wherein the practice is established and increased efficiency is sought through the development of better equipment. A materials problem would be one such as a study of the wearing qualities of various material in plow shares or disc blades to determine the most economical material for the particular part.

The agricultural engineering problems in farm power and machinery confronting the Virginia farmer are many, but herewith are listed a few of the more pressing ones which should be studied in the very near future.

Methods and Practices:

1. Proper curing and handling methods for the various hay crops grown in the state.
2. More efficient weed control.
3. Reduction of tillage costs by substituting other land stirring implements for the common plow.
4. Improvement of corn harvesting methods.

Equipment:

1. Improvement of potato digging equipment.
2. Development of spraying equipment operated from a tractor power take off.
3. Labor saving machinery for truck crop production.
4. Proper lug equipment for tractor wheels on different types of soil.

Materials:

1. Metals best suited for wearing surfaces of tillage tools in different types of soil.
2. Length, number of ply, width, and kind of belt for transmission of power.
3. Are anti-friction bearings warrented in farm machine construction, and where?
4. Fuels and oils best suited for tractor operation.
5. Materials best suited for tractor lugs when considering wearing quality, breakage, and transmission of power.

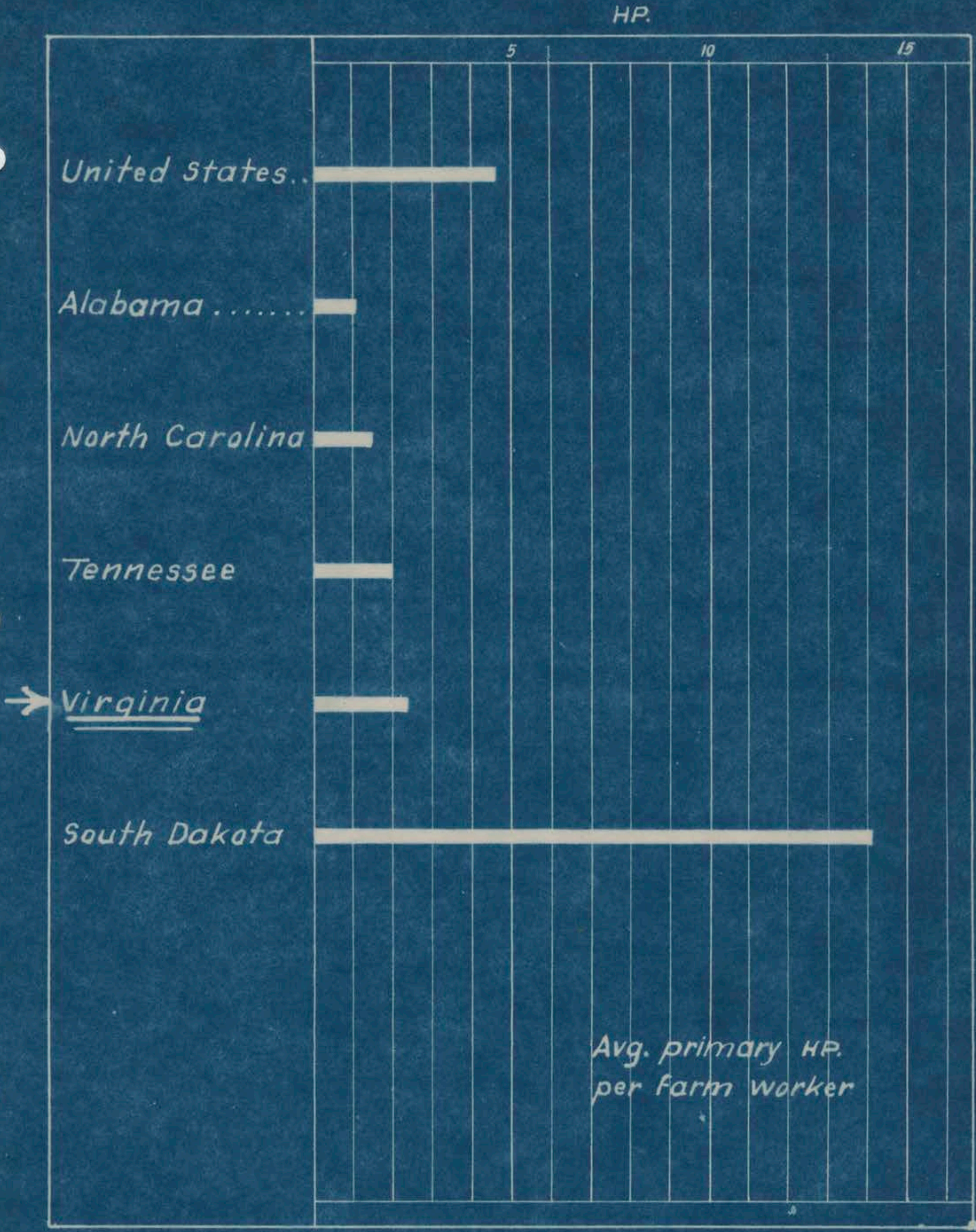
Appended to this report is a statistical summary of power and machinery in agriculture and a series of graphs presenting Virginia's status in an engineering analysis of her agriculture. These charts compare Virginia with the United States average, the lowest and highest ranking states, and the neighboring states of North Carolina and Tennessee.

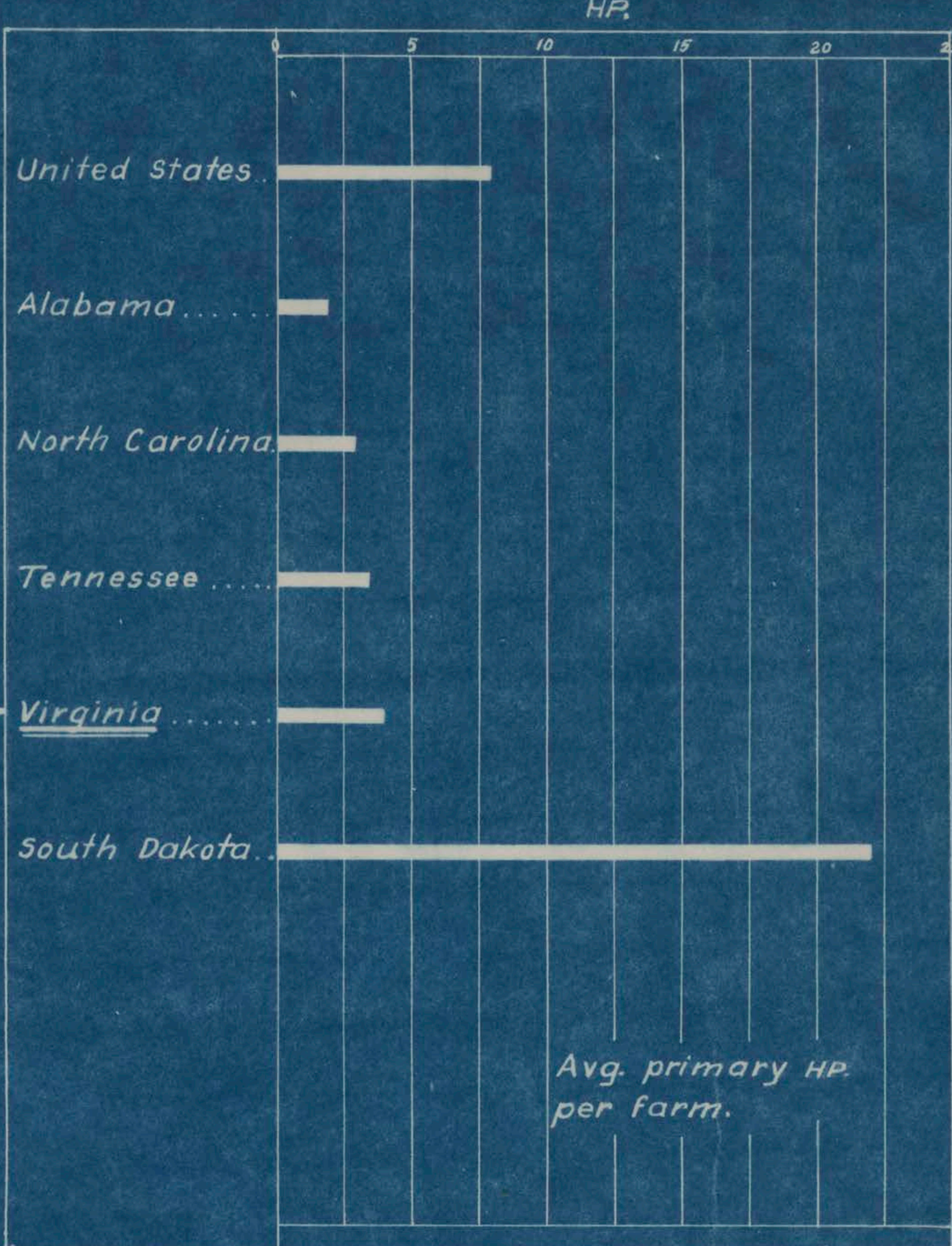
STATISTICAL STUDY OF POWER AND MACHINERY IN AGRICULTURE

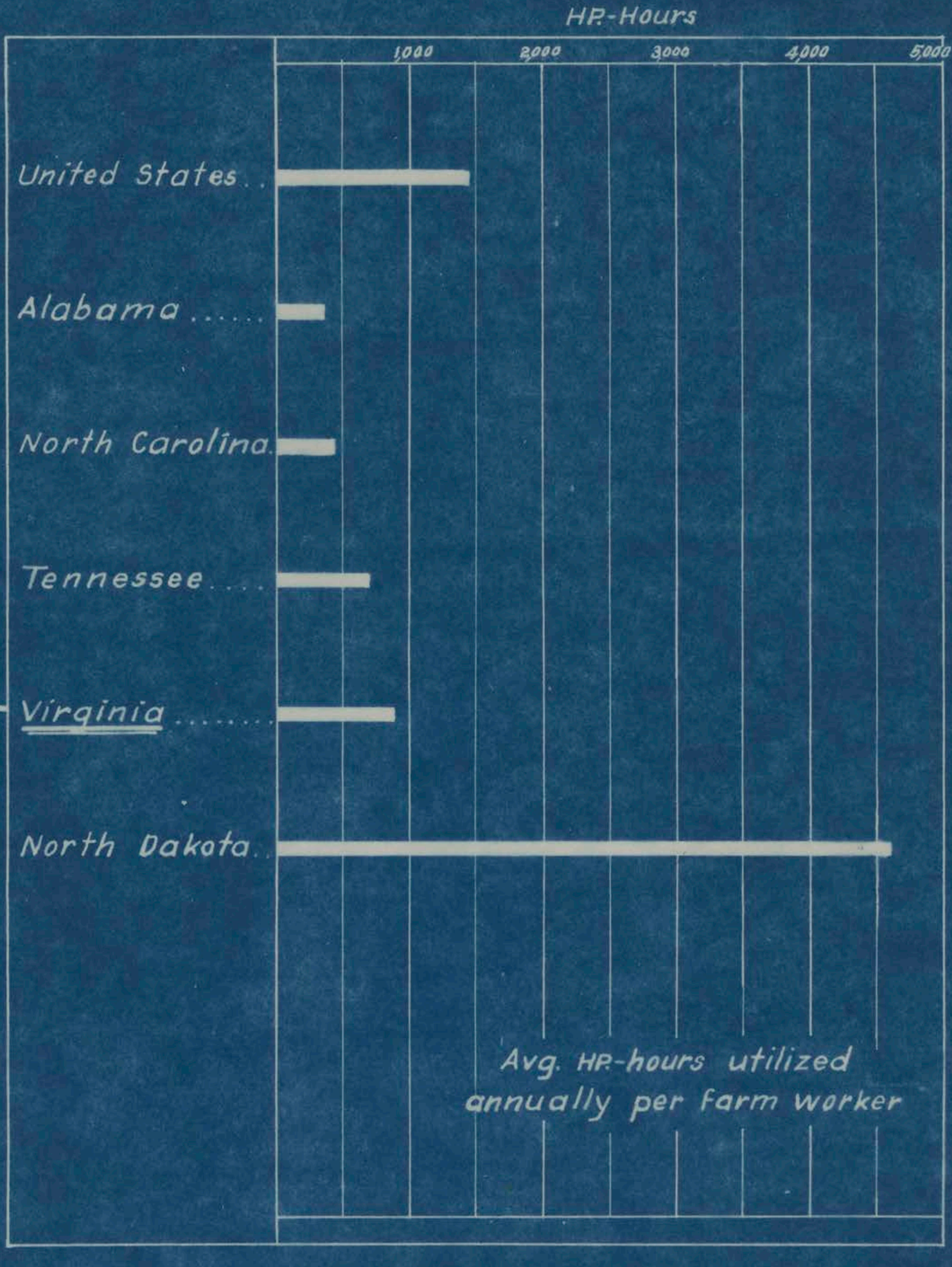
ITEM		U. S.	Virginia	Tennessee	North Carolina
Total population	1900	75,994,575	1,854,184	2,020,616	1,893,810
	1910	91,972,266	2,061,612	2,184,789	2,206,287
	1920	105,710,620	2,309,187	2,337,885	2,559,123
	1925	117,136,000	2,519,000	2,468,000	2,858,000
Farm population	1900				
	1910	32,076,960	1,065,059	1,278,032	1,408,580
	1920	31,645,497	1,064,417	1,271,708	1,501,227
	1925	28,981,668	980,162	1,173,316	1,446,881
Per cent population living on farms	1925	25.6%	40.2%		
Farm Workers	1900				
	1910				
	1920	10,645,497	291,701	395,404	468,605
	1925				
Number Farms	1900	5,737,372	167,886	224,623	224,637
	1910	6,361,502	184,018	246,012	253,725
	1920	6,448,139	186,242	252,774	269,763
	1925	6,372,263	193,723	252,669	283,492
Acres in Farms	1900	838,591,774	19,907,883	20,342,058	22,749,356
	1910	878,798,325	19,495,636	20,041,657	22,439,129
	1920	955,883,715	18,561,112	20,092,000	19,511,000
	1925	924,319,352	17,210,174	17,901,139	18,593,670
Acres in Crops	1909	311,194,516	4,255,282	6,360,928	5,736,176
	1919	348,551,669	4,579,367	6,786,187	5,849,998
	1920	365,348,000	4,871,000	6,951,000	7,443,000
	1925		5,368,188		
Average acres per farm	1900		118.6		
	1910	138.1	105.9		
	1920	148.2	99.7	77.2	74.2
	1925	145	88.8	71	65.6
Average crops acres per farm	1900				
	1910	[illegible]			
	1920	56.59	27.89	28.56	23.23
	1925				
Average crop acres per worker	1900				
	1910				
	1920	34.28	17.81	18.26	13.38
	1925				
Total invested in farms	1900		323,515,977		[illegible]
	1910	40,991,449,090	625,065,383	612,520,836	537,716,210
	1920	77,924,100,338	1,196,555,772	1,251,964,585	1,250,166,985
	1925	57,017,740,040	999,465,839	883,646,221	1,050,015,835
Value of machinery on farms	1900		9,911,040		
	1910	1,265,149,783	18,115,883	21,292,171	18,441,619
	1920	3,594,772,928	50,151,466	53,452,558	54,621,363
	1925	2,691,703,429	40,021,254	40,746,371	46,436,784

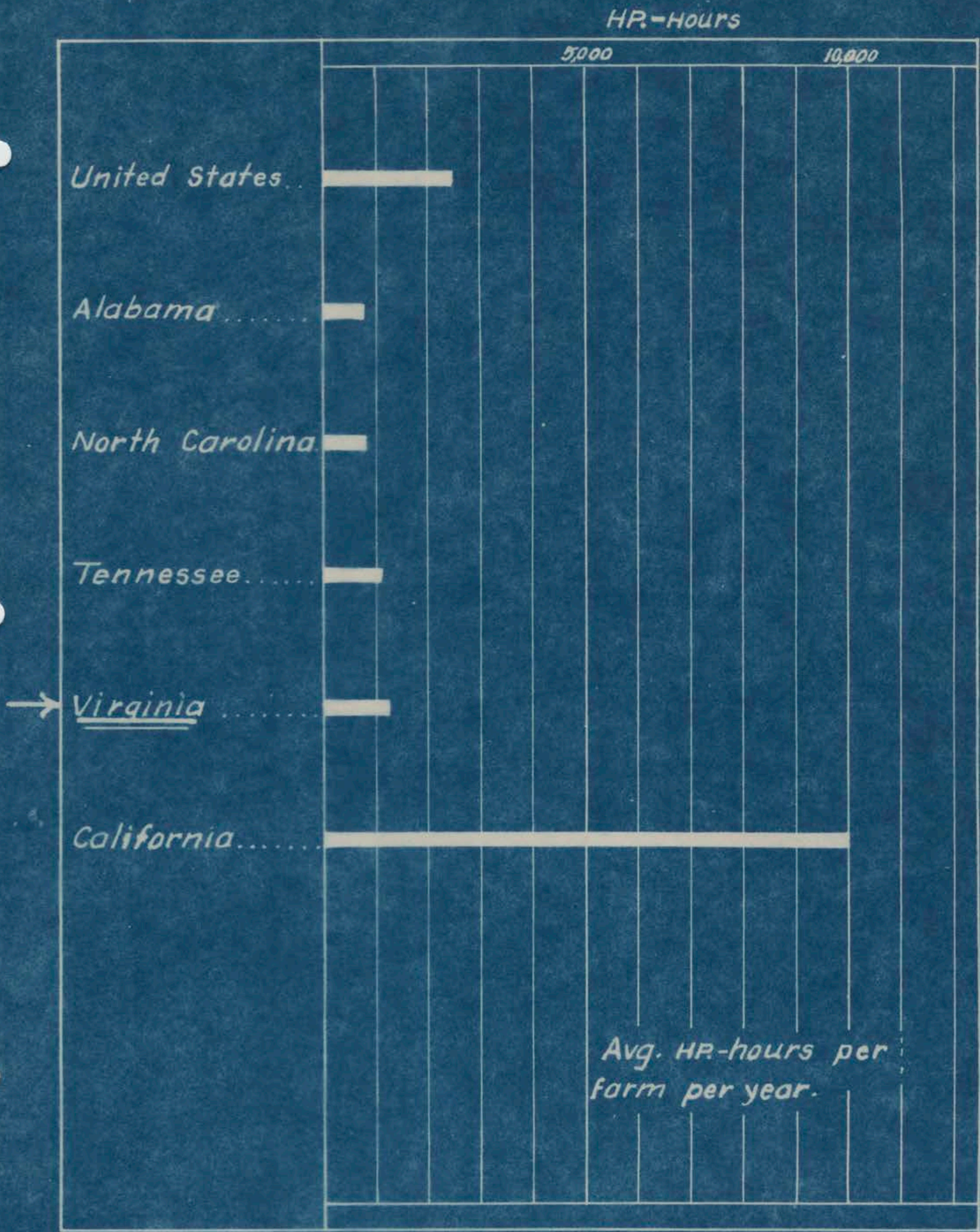
Statistical Study of Power and Machinery in Agriculture, Cont'd.

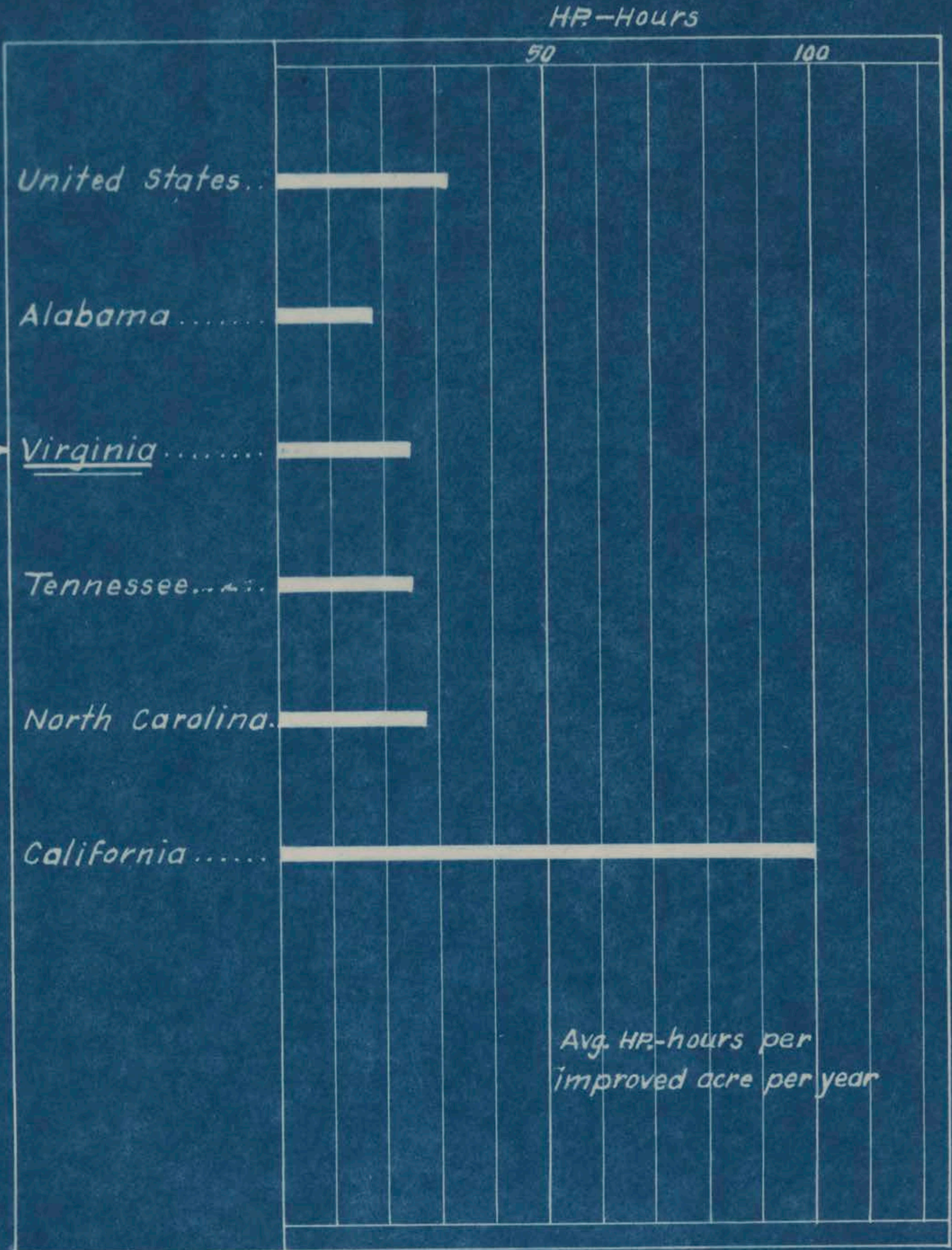
ITEM		U.S.	Virginia	Tennessee	North Carolina
Average	1900	3,563	1,927	1,519	1,041
total	1910	6,444	3,397	2,490	2,119
invest.	1920	12,084	6,425	4,953	4,634
per farm	1925	8,949	5,159	3,497	3,704
Average	1900	131	59	68	40
value	1910	199	98	87	73
machinery	1920	557	269	212	202
per farm	1925		206		
Average	1900				
value mach.	1910	7.35			
per crop	1920	7.35	10.30	5.85	6.25
acre	1925		7.45		
Ave.val. machinery per worker	1920	338.	172.	135.	117.
H.P. on farms (total) Includes: all types of power	1924	47,420,000	703,000	728,000	679,000
H.P. per farm (average)		7.4	3.8	3.0	2.5
H.P. per worker (average)		4.5	2.4	1.9	1.4
No. of	1900	24,042,882	390,446	633,553	341,879
horses and	1920	25,199,552	409,295	670,431	428,005
mules	1924	20,570,000	350,000	546,000	407,000
	1928		311,000		
Average	1900				
no. per	1910				
farm	1920	3.	2.2		
	1925	3.2	1.8	2.15	1.45
Av. weight of horses and mules lbs.		1,150	1,050	940	950
Av. hours work per year - horse		450	430	312	316
Number	1910				
tractors	1920				
	1924	450,000	4,500	3,000	5,000
	1927		(1926) 6,773		
Av. size (h.P.)		23.4	22.4	31.	16.4
Av. hours work per year-tractor		248.	238.	236	128.
Av. H.P. hours per hour human labor		.50	.27	.23	.16

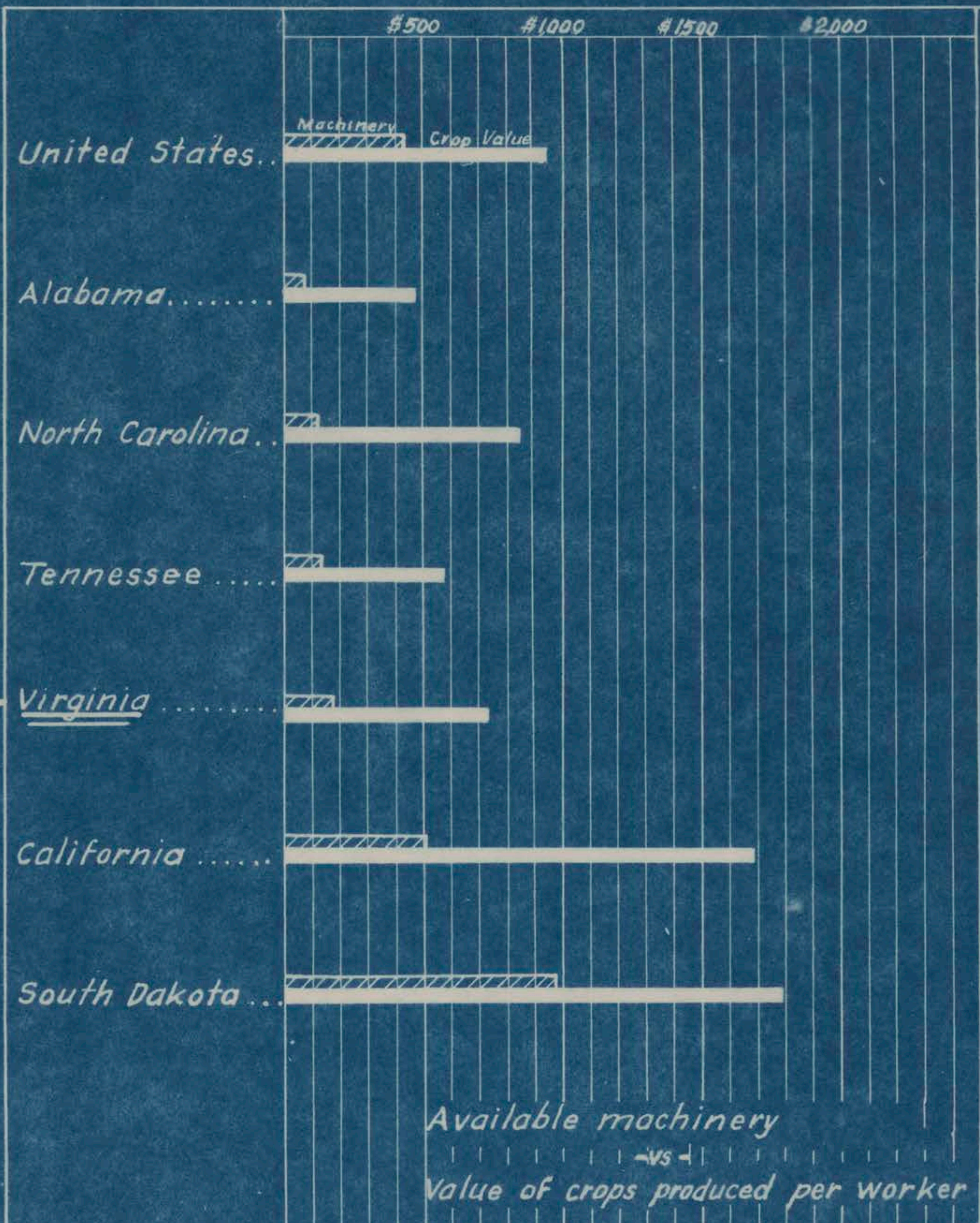

HP.
5
10
15
United States..
Alabama.......
North Carolina
Tennessee
Virginia
South Dakota
Avg. primary HP.
per farm worker


HP.
0
5
10
15
20
25
United States
Alabama
North Carolina
Tennessee
Virginia
South Dakota
Avg. primary HP.
per farm.

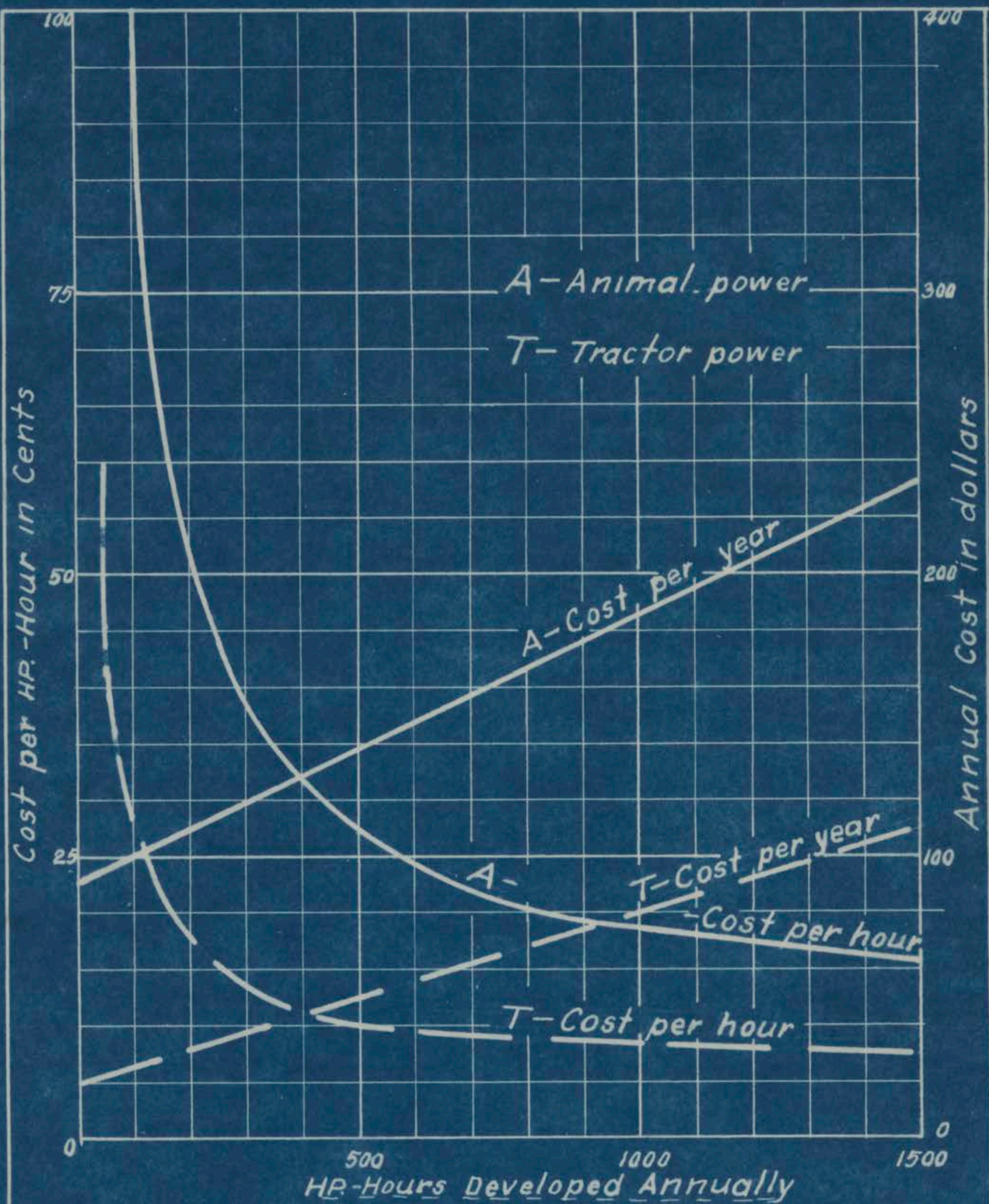

HP.-Hours
1,000
2,000
3,000
4,000
5,000
United States
Alabama
North Carolina
Tennessee
Virginia
North Dakota
Avg. HP.-hours utilized
annually per farm worker


HP.-Hours
5,000
10,000
United States
Alabama
North Carolina
Tennessee
Virginia
California
Avg. HP.-hours per farm per year.

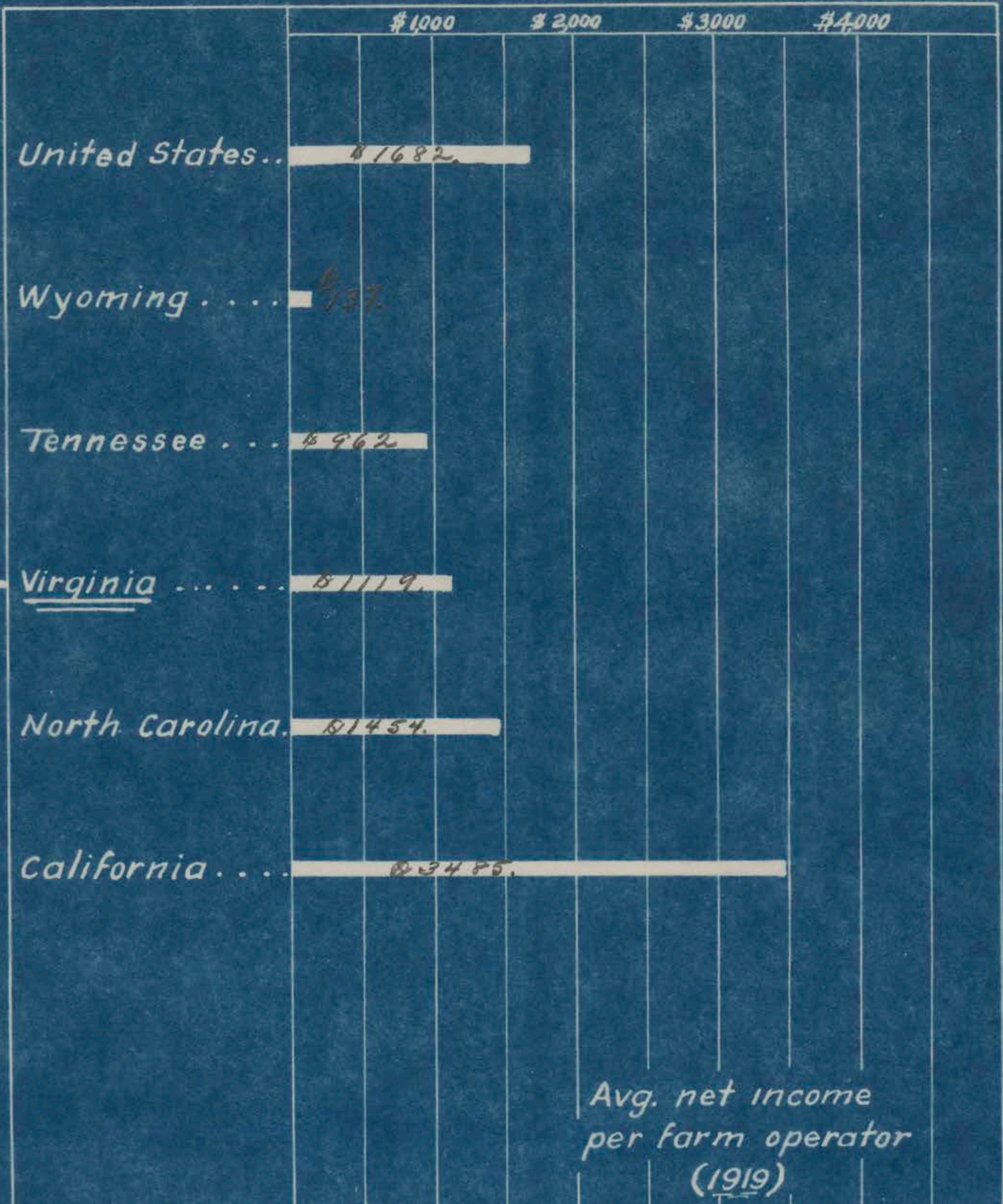

HP.-Hours
50
100
United States
Alabama
Virginia
Tennessee
North Carolina
California
Avg. HP.-hours per improved acre per year

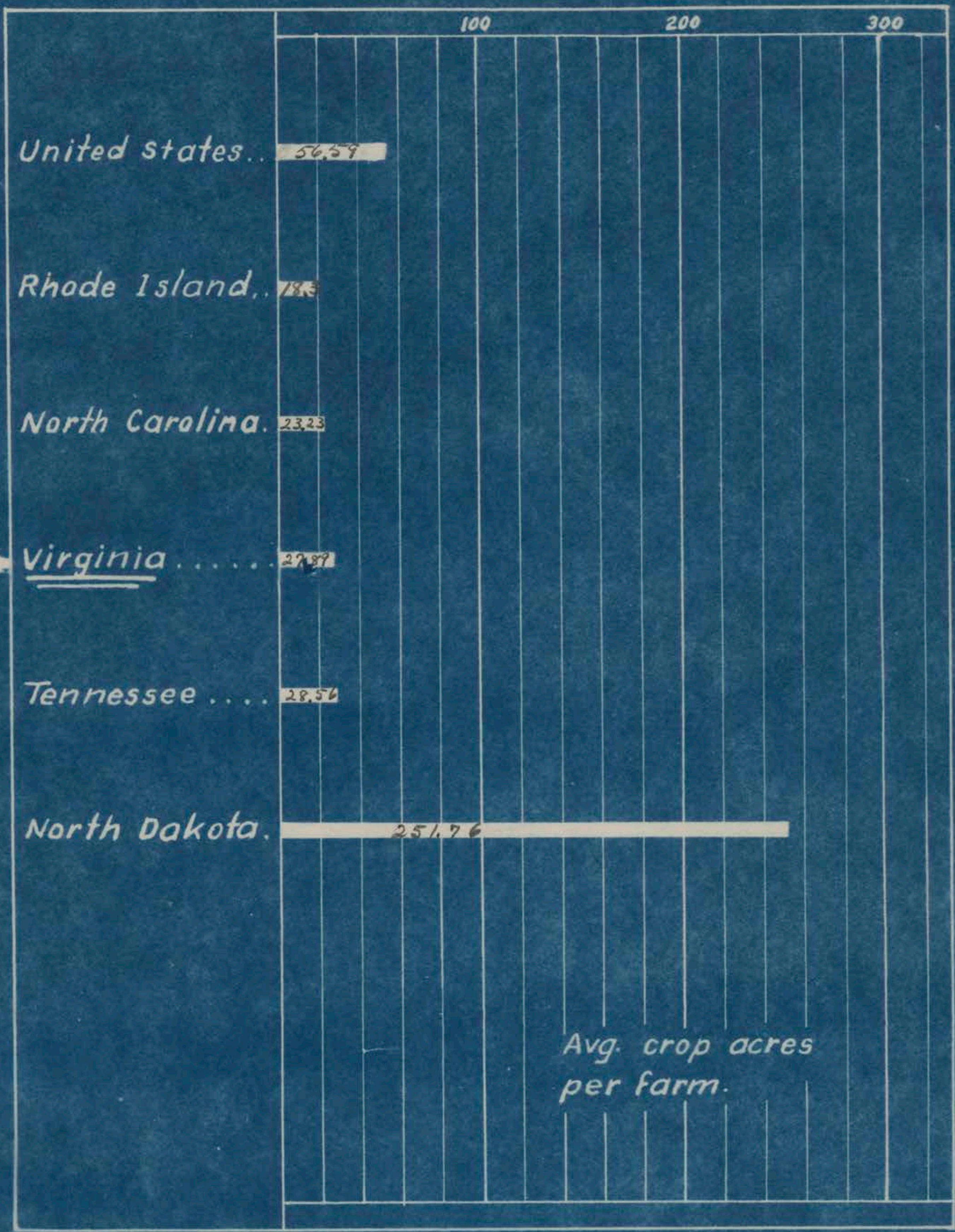

$500
$1,000
$1500
$2,000
Machinery
Crop Value
United States..
Alabama........
North Carolina..
Tennessee .....
Virginia ....
California .....
South Dakota ...
Available machinery
-vs-
Value of crops produced per worker


Value of Crops per Agricultural Worker
0
$500
$1,000
$1,500
$2,000
HP.
Crop Value
United States...
Alabama.........
North Carolina...
Tennessee.......
Virginia..........
Washington......
South Dakota...
0
5
10
15
20
Total Primary HP. per Agricultural Worker



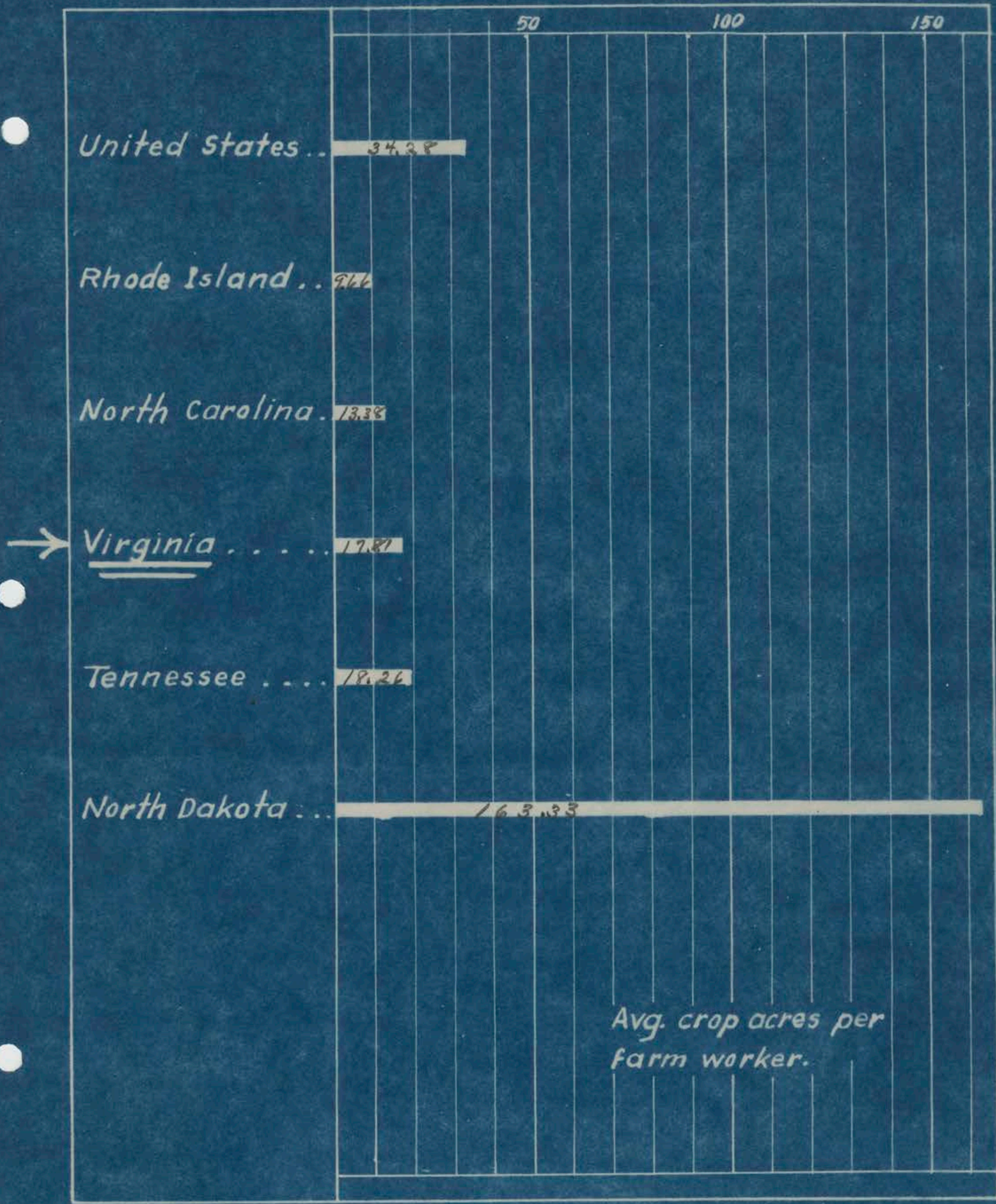
Approximate operating cost of horse and tractor power for different amounts of work performed annually


$1,000
$2,000
$3000
$4,000
United States..
$1682.
Wyoming ....
$137.
Tennessee ...
$962
Virginia .....
$1119.
North Carolina.
$1454.
California ...
$3485.
Avg. net income
per farm operator
(1919)



100
200
300
United States.. 56.59
Rhode Island.. 18.3
North Carolina. 23.23
Virginia...... 27.89
Tennessee.... 28.56
North Dakota. 251.76
Avg. crop acres per farm.


1
2
3
4
United States..
1.65
New Hampshire
1.24
Tennessee...
1.56
Virginia.....
1.57
North Carolina
1.74
Arizona.....
3.56
Avg. number of workers per farm



50
100
150
United States . .
34.28
Rhode Island . .
9.66
North Carolina .
13.38
Virginia . . . . .
17.81
Tennessee . . . .
18.26
North Dakota . . .
163.33
Avg. crop acres per farm worker.

S U M M A R Y

Agricultural Engineering in Virginia

The problems in agriculture that demand the assistance of the engineer are many and varied and the agricultural engineer can contribute much to the solution of Virginia's agricultural problems. Some of the most important ways in which the engineer can be of assistance are; by the design of improved farm homes with all modern conveniences such as running water and bath room fixtures; heating, lighting, ventilation, and other labor saving devices and life improving accessories; design of farm structures of all kinds; drainage of farm lands, flood control, control of soil erosion, irrigation, land clearing; rural electrification; and lowering cost of production through the use of labor saving farm machinery.

The cooperation of the engineer is needed in the solution of problems in every important type of agriculture in the state such as the fruit, poultry, dairy, trucking, livestock, tobacco, and general farming industries. Considerable progress has already been made through engineering in agriculture but the opportunities are so great for greater progress that provision should be made by the state to advance these activities.

Department of Agricultural Engineering at V.P.I.

The department of agricultural engineering at the Virginia Polytechnic Institute is serving agriculture through three major divisions - resident instruction, research and extension.

<u>Resident Instruction</u>. - The resident instruction division of the department is concerned with teaching service courses to all students of agriculture; handling short courses for farmers and farm women; and training professional agricultural engineers through the four year course in agricultural engineering which leads to the Bachelor of Science degree in agricultural engineering. (Three men will be employed in the resident faculty of the department for the coming school year.) Same

80 men have been graduated at V.P.I. with the B.S. degree in agri. engg since the starting of this type of training.

The greatest need of the resident instruction division of the department is adequate laboratory facilities for the efficient handling of the various agricultural engineering laboratory courses and short courses for farmers and farm women.

Extension Work in Agricultural Engineering. - Through the extension division of the department, engineering assistance is given to farmers of the state by means of short courses and meetings, publicity and propoganda, and field projects and demonstrations. The major extension projects of the department are; farm drainage, irrigation, land clearing, terracing, farm water supply and sanitation, rural electrification, farm structures and farmstead planning, and farm power and machinery. Two men are at present employed on the extension faculty. (The greatest present need in bettering the extension work is for the employment of a full time architectural draftsman to assist with the preparation of farm building plans.)

Research Work in Agricultural Engineering. - Research studies in farm power and machinery are being conducted in the research division of the department. There are many problems demanding solution that will have an important bearing on agriculture in the state. The greatest present need is for adequate personnel to handle the most important problems demanding solution. Only one man is at present employed by the Experiment Station. There should be at least three men devoting their full time to research.

LAND DRAINAGE

Of Virginia's 18,561,112 acres of land in farms, 9,460,492 acres are improved, with 225,068 acres provided with drainage and 1, 172,580 in need of drainage. There are 1,400,000 acres of unreclaimed swamp and overflowed lands.

In addition there thousands of acres of cultivated lands that need drainage before crops can be raised successfully in wet years. In Tidewater Virginia at least 30% of the cultivated land should be drained. Millions of dollars are lost in wet years by farming this land. Adequate underdrainage will save the farmers these heavy losses and enable them to increase the production per acre. Tile drainage is the best kind of underdrainage for cultivated land. Properly installed tile drains will result in an increased production of at least 25% on average wet land.

Surface drainage is one of the biggest agricultural problems in such counties as Norfolk, Princess Anne, Nansemond, Greensville, Southampton, etc. At least 50% of the farm lands in certain counties of Tidewater Virginia need improved drainage outlets to take care of excess surface water. The construction of suitable outlet ditches require the cooperation of all the farmers in the community. Organized drainage districts under the state drainage law is the best way of handling large drainage problems. Drainage districts should be organized in those counties where drainage is a big problem. In one wet year the farmers lose more than the drainage would cost them. Thousands of acres of rich bottom land has been rendered unfit for cultivation due to the clogging of stream channels - Such streams should be dredged. The present policy of drainage extension work should be continued and provision made for research along drainage lines. More drainage information in the way of bulletins and circulars is needed.

IRRIGATION

Virginia is subject to drouths of more or less severity which damage all growing crops. Studies show that for the past 30 years an average of one year out of three has been extremely dry. Overhead irrigation for intensive truck crops can be used to advantage and will insure good crops in dry years. Many farms have ideal conditions for surface irrigation by flooding or through furrows.

On the Eastern Shore indications are that the potato yields can be increased materially by furrow irrigation. The possibilities of orchard irrigation are also very promising. Investigations on the possibilities of irrigation in Virginia should be conducted by the Experiment Station and the irrigation work started by the Extension Division continued.

SOIL EROSION

Erosion of the soil by water carries away 20 times as much plant food material every year as is permanently removed by crops. Over 70% of the farm land in 25 counties of the state is actually eroding. If this erosion is not checked the land in time will be unfit for farming. Each year thousands of acres are rendered unfit for farming by excessive erosion. This is one of the most serious problems confronting the state and too much attention cannot be given to means of checking the tremendous waste.

Terracing is the most effective method of preventing erosion now known. The farmers should be encouraged in every way possible to practice terracing. The extension work in terracing should be extended as rapidly as possible. Much time and money is expended in the study of fertilizers, crop improvement, etc. but no money is being spent for investigation in soil conservation. Provision should be made at once by the Experiment Station for studies in soil erosion control.

LAND CLEARING

Maximum results cannot be secured from farming land cluttered up with stumps and other obstructions. It is also necessary to have fields clear of such obstructions and of the proper size and shape for the most efficient use of power machinery. The removal of stumps is, therefore, an important problem in successful farming. While the government explosive "pyrotol" was available this was the cheapest means of stump removal. A combination of explosive and stump puller is probably the cheapest means of stump removal now. Investiagation should be conducted to determine the best and cheapest means of stump removal.

FARM WATER POWER DEVELOPMENT

Virginia has unnumerable small streams that flow through the farms of the state. There is scarcely a square mile without a running stream or bold spring. Many of these streams are possible of development for the generation of electric power, pumping for irrigation and farm water supply. Where it is impossible to secure electric service from Central Stations the farm stream should be put to work. The Extension Division is in a position to advise farmers on the development of their individual water powers. This service should be continued.

FARM WATER SUPPLY + Conveniences

Only approximately 7% [10%] of the farm homes in Virginia have running water. As running water is the greatest single convenience in the home, every farm home in the state should at least have running water in the kitchen.

The protection of the farm water supply and the proper disposal of sewage is vital in the protection of the health of the farm family. Information on farm sanitation should be sent to every farmer in the state. Heating, lighting, ventilation, refrigeration, cooking, washing and other household activities are of even more importance in the farm home than the city home. Such subjects are being studied under research in household engineering. This work should be enlarged as rapidly as possible. The extension work in farm water supply should be continued and enlarged as rapidly as possible.

RURAL ELECTRIFICATION

Approximately 4500 farms are receiving electric service from Central Stations at the present time as compared to 1500 in 1924. The use of electric power on the farm promises much toward the reduction of labor costs and improved living conditions. Central Station electric service for farms will be possible when sufficient uses are found for electricity on the farm to justify the service at a price the farmer is willing to pay and the power company is willing to accept. Considerable progress has already been made toward focussing attention on this problem. Investigations to find new uses of electricity on the farm should be conducted by the Experiment Station and the work already started by the Virginia State Committee on the Relation of Electricity to Agriculture should be continued and enlarged as rapidly as possible.

FARM BUILDINGS

The value of buildings on the farms of the state were $286,158,184 in 1925 ~~as compared with~~ $268,080,748 in 1920 and $137,399,150 in 1910. Buildings increased in value over $18,000,000 in the five year period 1920 to 1925 while the value of land, live stock, and machinery decreased in value many millions. These figures show that Virginia farmers are building new structures at the rate of over three and a half million dollars in value per year.

The department of agricultural engineering maintains a free building plan service for the farmers of the state. Extensive use is being made of this plan service by farmers. A considerable proportion of the buildings constructed during the last seven years have been from plans furnished by this department. This plan service is handicapped by lack of personnel. A full time architectural draftsman should be employed at once to work up new plans.

Farm buildings represent about 38% of the value of all land, machinery and livestock on the farm and, therefore, constitute a large part of production costs and represents a correspondingly large problem in economic production. There is very definite need for comprehensive research in farm buildings so that the farmers will be enabled to spend their money for new structures to the best advantage. Provision should be made at once for research work in farm buildings.

FARM POWER AND MACHINERY

Virginia's agriculture is under-equipped. The value of machinery on the farms of the state decreased in value from $50,151,466 in 1920 to $40,021,254 in 1925, but increased in value to $44,319,253 in 1930. (~~During the last two years, however, the farmers have bought machinery in increasing quantity.~~) As power and labor together represent about 60% of the cost of carrying on the farm business and as these two items are directly subject to the control of the farmer, it is evident that the farmer can secure larger profits by reducing his power and labor costs. This can be done by the selection of more efficient and less expensive machines and the substitution of cheaper power for the more expensive human labor.

Farmers should be instructed in the use of improved machines and shown how production costs can be lowered by the use of such machines. Research work in power and machinery should be extended to solve the more pressing problems.

(Get investigation etc.)
Household Engr.