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Science serves your farm and home.

Homer C. Evans

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SERVES YOUR FARM AND HOME

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**AGRICULTURAL EXPERIMENT STATION
WEST VIRGINIA UNIVERSITY**

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Science

Serves your farm and home

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BULLETIN 537

Science Serves Your Farm and Home will be sent free to any resident of West Virginia in response to a written request to the Director, Agricultural Experiment Station, West Virginia University, Morgantown, West Virginia 26506.

Editor-in-Chief JOHN LUCHOK

Managing Editor . . . JACK CAWTHON

Photographer DAVID CREEL

Resource Development— Same Objectives But New Responsibilities

Homer C. Evans
Asst. Director

RESOURCE DEVELOPMENT means different things to different people. To me, it means use of resources in such a way as to increase the satisfaction of man's wants.

Land is probably most often thought of in terms of resource development, although all resources are involved. The relationship between man and land is quite fundamental. Our natural resource environment—or land as the economist knows it—is necessary for human survival. It provides us with standing room, with living space, with food, and with the vast array of raw materials we use in the satisfaction of our many wants.

COVER: Jane Gamble, senior in Horticulture, prepares a mixture of apple cider and orange peel. See page 6 for more details about this research. (Photo by David Creel)

EDITOR'S NOTE: "Water Insurance: Farm Ponds" in the Summer issue was written by Dr. Harold A. Wilson, Bacteriologist. We regret that Dr. Wilson's name was inadvertently dropped from the article.

The Agricultural Experiment Stations throughout the nation have been concerned with resource development since their beginning. In fact, farmers have quite an enviable record in resource development. In 1860 each farm worker provided enough farm products for himself and 4 others; today each farm worker provides enough farm products for himself and 34 others. In past years, the development of our land resources has been primarily the responsibility of individual farm units, and much of this development has occurred through the substitution of capital and new technology for labor. However, as farming became more commercialized, more mechanized, and more specialized, farmers became the recipient of gains in resource development that occurred beyond the farm gate. With an ever-increasing reliance upon purchased inputs (fertilizers, tractors, equipment, insecticides, seeds, etc.) gains in resource development by the suppliers of agricultural inputs were partly appropriated by farmers. Thus, interdependence was created between farm and non-farm business units. Accompanying this increase in interdependence has been an increase in population and growth in real per capita income. As a result of these influences we have the time and income to demand things other than farm products from the land, and these demands have led to relative scarcity of land.

Consequently, resource development has assumed a new complexion and we are beginning to think of such things as adequate water supply, outdoor recreational facilities, urban and industrial uses of land, air pollution, and the whole complex of environmental conditions associated with land and space. Thus our concern with resource development is being expressed in such terms as planning, zoning, taxation, public policy, community development, and improvement of our environment.

In summary, we have new responsibilities in resource development, and to a larger degree these deal not only with the individual, but the community as a whole and call for a different kind of action to bring about resource development, namely action in the public sector. However, our objective is the same as always: to increase the satisfaction of man's wants through more efficient resource development.

West Virginia

and the

Year 2000

Marvin R. McClung
Animal Scientist

(Chairman, Animal Industry
and Veterinary Science)

BY THE YEAR 2000 there will be an estimated world population of $5\frac{1}{2}$ to 6 billion people, contrasted to a population today of slightly more than 3 billion. As late as 1900 there were only 2 billion people in the world. The reasons for the population increase are obvious. People are surviving as a result of improved living conditions. There have been population explosions not only in Asia but in the Western Hemisphere as well. Argentina, once a surplus beef producing area, is not meeting the beef needs of her people today. The population explosion increases the need for food and decreases the available land for production of food.

The population of the United States is around 197 million people, and is expected, according to some estimates, to increase to about 250 million by 1980—a mere 14 years away.

At the present time, it is estimated that 90 million people live within 500 miles of West Virginia. By the year 2000, the estimated population of the United States will be between 380 and 400 million and many of these people will be compacted into a solid city from Norfolk, Virginia, to Boston, Massachusetts. This city will bulge out in a doughnut shape along the New York Thruway on the north and the Pennsylvania Turnpike on the south. This megalopolis, which will be the largest city in the world, will be in West Virginia's back door, and the State cannot afford to pass up the opportunities that will be part of it. Some of the ill effects of it will be by-passed in West Virginia, and the State will have a great oppor-

tunity to import some of the raw materials produced to the west, manufacture them into food products, and send them to the markets of the Northeast.

To the west, just across the Ohio River, are the corn and soybean production centers of the world. West Virginia is closer to these raw materials than any other producing area.

Today, we are consuming about 600 pounds of animal protein per person in the United States. Beef,

poultry, and turkey consumption continues to go up. Egg production today is about the same as it was in 1940. Milk and milk products continue to be fairly stable, although there is some shifting in consumption of various dairy products. If consumption per capita does not increase by 2000 there will be a need to produce twice as much beef, eggs, broilers as today just to keep pace with the increased population. If these foods are kept available, it is likely that per capita consumption will increase.

West Virginia's Eastern Panhandle is feeling the effects of megalopolis today. As many as five Grade A milk routes go by a single farm. This megalopolis will require more milk from more of West Virginia in the future, if it can be supplied.

If beef has to double by 2000 it means there will be only seven or eight generations of cattle produced in that time. The big increase in cattle production will have to come primarily from east of the Mississippi River. The climatologist tells us the range country is now producing pretty well up to its potential with present water supplies. All the water in some rivers is being used for irrigation or human use at present. West Virginia is blessed with a 40-inch average rainfall and an average elevation of 1,500 feet which is the highest of any state east of the Mississippi. Both of these factors are important in animal production, but neither has been used to the best advantage yet.

West Virginia has about $3\frac{1}{4}$ million acres of land designated as pastures—permanent pasture, woodlands, and pasture croplands. To the west lies the corn and soybean centers, mentioned previously, and the big markets for feeder cattle. Rainfall and elevation are assets in such animal production. If technology can be put to work properly, West Virginia's location can certainly be an asset to certain types of production agriculture in years to come. *To create wealth in West Virginia the pasture land must be utilized.*

Grass from hillsides can be marketed through sheep. No enterprise makes a better return on capital than sheep. Then, a logical question: Why do sheep numbers continue to decline? To stem the reduction in numbers will take some real ingenuity and the application of technology. High density sheep production may have a place in West Virginia.

The Pavlick Report* pointed out some of the problems of setting large acreages together. An economic unit in the beef cattle business must involve large acreages if an acceptable standard of living is to be attained from this enterprise alone.

In the dairy industry, we must stop talking in terms of a one-man dairy producing 400,000 pounds of milk per year, considering that it takes only twenty 20,000 pound cows, and some herds are averaging 20,000 pounds in the United States, to produce this amount. Or it takes forty 10,000 pound cows, and the

DHIA average in the State last year was better than this. An 80-cow herd as good as the average DHIA herd can meet these requirements. A two-man dairy is better still because it doesn't tie one man to a job year-round.

What else can be done with hillside land except produce forage? Some say more of it should go back into trees. However, there are probably many north hillsides in trees today that should be in grass. Forests are a little too slow for most investors. The returns from the national forests equal about 50 cents per acre per year over the long run. Forest land taxes in most of our counties will run about 12 to 25 cents per acre per year. If the more than 3 million acres in West Virginia aren't used to produce grass, then we will be far from realizing the potential of agriculture in this State. Multiple use of land for timber and recreational purposes, of course, is going to find a place to serve this megalopolis, but there is plenty of land in addition to the 3 million acres that can be used.

FACTORY OR INTENSIVE AGRICULTURE

Let's consider the potential for factory-type agriculture, or the agriculture that will be using a lot of the corn and soybeans to the west, turning them into animal protein for the markets to the east. Such types are commercial broilers, commercial eggs, turkeys, feeder pigs, and feeder cattle production.

For plants some intensive types would be greenhouses and fruits, operations which require small acreage but enormous amounts of capital, technology, and labor. In such cases the problem of putting the large land holdings together is eliminated. Almost any size business desired in the enterprises mentioned can be built on 5 to 20 acres.

In these enterprises there is a need to be realistic. Competition is part of the free enterprise system, and producers in the State must compete with farm operators in other areas of the United States and world. Our farmers must increase their output and sales of farm products per unit. To accomplish this, they must do at least four things:

1. Control sufficient land and capital.
2. Increase levels of management.
3. Develop more efficient marketing systems.
4. Increase adoption of technological innovations, and these innovations must be adopted currently, not five years behind and not two years behind in some cases. Technological innovation must be adopted in such steps as production, processing, and distributing.

A few years ago about 75 per cent of the inputs that went into an agriculture enterprise was labor, and 25 per cent capital; today it is just the reverse. This fact alone means that a producer cannot lag two, three, four, or five years behind in technology because business today is using too much capital for this.

*W.V.U. Agr. Exp. Sta. Bull. 499T.

We are in a fast dynamic era. Changes come fast but no more certainly than in past centuries. We are engaged in a breakneck race toward discovery. It is estimated that half of today's knowledge in agriculture will be obsolete in ten years. This is a sobering fact for those concerned with keeping abreast of the times. We must put technology to work quickly and rapidly if we are to be competitive with other areas in the United States and the world.

There are some natural advantages in our key location in certain types of resources, but to succeed, technology must be put to work. Efficient operators and top management will be needed—people who can put the total package together and make the operation competitive all the way. The team approach for managing capital, land, and labor will be needed, and above all, efficiency will be needed in the management of problems of credit and finance. We have been handicapped by hesitancy to use credit for production purposes in agriculture. We must begin looking more at capital as one of the production tools. The credit and capital needs of agriculture will increase in this fast-growing and fast-changing agriculture. This is particularly true in animal agriculture. The new combination of ownership will get larger all the time. Contracts and credits will be an important phase of those serving in agriculture. Sound financial management is one of the major keys to successful development of the farm unit. By 1980 assets per farm worker and per farm are expected to double. Much of this will be in machinery.

The old school of banking in which the bank was the depository and investment of funds was placed

in liquid assets and securities is no longer applicable in today's modern agriculture. Bankers must look at the growth of the farmers and what their potential in agriculture will be. They must look not only at the first profits but future growth. In agriculture, loans must be analyzed from a performance pattern and not by reduction of debt. Financing belongs with the banks for capital improvements, working capital, and new equipment. Banks will have to share contract financing with others as loan size increases. PCA, FHA, public stock ownership, and other forms of credit will have to be tapped.

West Virginians must realize their assets, but above all, they must be shown how to put them to work. For example: One person caring for 10,000 hens and doing no marketing may not realize full-time employment; a 1/10-pound better feed efficiency per dozen eggs means 8 cents per hen per year; a savings of \$2 per ton with the same feed efficiency means 10 cents per hen per year; a half-cent per dozen more for eggs means 10 cents per bird per year. These three items can add \$2,800 additional income to a 10,000 bird operation in one year, more income than is found on many farms. It can mean a difference of whether or not we are competitive.

We must shake off a lot of our bad habits such as spending our time talking about what others do or don't do, but doing nothing ourselves. It is said that the first great rule in life is to put up with things. The second great rule is to refuse to put up with things. And the third, and hardest, is to distinguish between the first and the second.

Are we too easily settling for the first rule?

Dr. Robert L. Smith Authors Textbook

Dr. Robert L. Smith, Assistant Wildlife Biologist for the Agricultural Experiment Station, is author of a new field biology textbook entitled *Ecology and Field Biology*. Published by Harper and Row, the text is the result of seven years of preparation by the author.

The book has been designed to provide college sophomores and juniors with either a terminal course in a liberal arts curriculum or as a background for such advanced classes as wildlife, forest and range management, agriculture, marine biology, and plant or vertebrate ecology. It will help meet a need caused by a growing interest in field biology in colleges and universities.

Written in a "down-to-earth" style, the book is enhanced by 184 illustrations that graphically unravel some of the mysteries of the outdoors. The artist is Ned Smith, well known to sportsmen for his work in leading hunting and fishing magazines and formerly of the Pennsylvania Game Commission staff.

The book, in its second printing, has been well received by educators throughout the country. Dr. Smith has received letters from biology and wildlife professors congratulating him for writing a textbook that is both scientifically sound and easily understood.

Dr. Smith is author of more than 60 professional papers and popular articles, and he writes "Outdoors West Virginia," a weekly column in the Sunday Morgantown *Dominion-Post*.

THE FLAVOR of the usual commercially available apple juice must be improved if it is to compete successfully with other juices used as a breakfast drink or daily beverage. In some apple producing regions there often is a surplus of dessert-type apples or of processing apples which require the addition of other apple varieties to give a well-balanced juice having a desirable range of acidity, aroma, and astringency. Often a larger volume of juice is made from a single variety since it is less costly to keep a juice plant operating every day and it is not economical to store juice apples with low unit value. At other times, when the market for fresh apples is good, there may be a shortage of apples suitable for blending with the variety which is in greater supply.

Taste panel evaluations at the West Virginia Agricultural Experiment Station have shown a great preference for Delicious juice containing a minimum of 10 per cent crab apple juice as compared to 100 per cent Delicious juice. Similar results were obtained for juices using Rome Beauty as the base. However, crab apple varieties are not presently available in large enough quantities for blending. To encourage growers to raise crab apples specifically for juice blending would be questionable since more labor is needed to harvest crab apples, which generally are much smaller in size than the apples commonly grown in the United States. Rising costs of labor coupled with an uncertain supply of reliable labor prompted the investigation of other ways of increasing the taste acceptance of apple juice.

Juices of other fruits, such as boysenberry, blackberry, cherry, and grape have been successfully blended with apple juice to make palatable juices. In 1953 juice prepared from immature persimmons was added to Red Delicious juice acidified to a pH of 3.35 with malic acid (the predominant acid in apples). The astringent properties of about 0.7 per cent persimmon juice in the acidified Delicious juice resulted in a distinct preference for this juice over acidified Delicious, unaltered Delicious, or unaltered Delicious with persimmon juice added. Inasmuch as persimmons are not readily available, attention was next directed to the potential value of grapefruit, lemon, and orange peels, which are by-products of the citrus juice industry and presumably in great supply.

In 1954 a concentrate of orange peel in Delicious apple juice was made by homogenizing 200 grams of orange peel with 600 milliliters of Delicious juice in a Waring blender. This homogenate, containing 25 per cent orange peel, was strained to remove the coarser peel particles. Similar homogenates of grapefruit peel and lemon peel with apple juice were prepared for evaluation by taste

Apple Cider Impro

Jane Gamble measures acidity of a
tions were used in tests for a mixture

Orange Peel: Taste

ce sample. Several juice combina-
the best taste acceptance.

panels composed of students and staff members of West Virginia University, townspeople, and guests.

Preliminary taste panel tests involved only two juices per test in which the taster indicated his or her preference of the two juices. In later tests four to ten juices were compared. Each juice was ranked from best liked to least liked. The statistical significance of differences obtained was calculated.

Several series of Delicious apple juice were prepared with concentrations of orange, grapefruit, and lemon peel varying from as low as 0.01 per cent to as high as 5 per cent to determine the lowest levels detectable, as well as amounts considered too high. The concentration ranges most generally preferred were: (1) 0.4 to 0.5 per cent for orange peel; (2) 0.35 to 0.5 per cent for grapefruit peel; and (3) 0.4 to 0.6 per cent for lemon peel. Taste panel results consistently indicated a preference for juices containing orange peel to those containing grapefruit or lemon peel. Evaluation of grapefruit peel blends was discontinued because several panel members found the bitter taste objectionable. Some tasters, however, considered the addition of grapefruit peel to apple juice to afford a very pleasant and distinct "change of pace" drink.

Taste panels evaluated Golden Delicious, Red Delicious, Grimes Golden, Jonathan, Rome Beauty, and Stayman juices—with and without orange peel—over a period of several years after the first use of orange peel in 1954. Throughout these tests two-thirds of the tasters preferred the juice or juice blend containing 0.4 to 0.5 per cent orange peel over the comparable juice without orange peel. Many tasters expressed a definite preference for apple juice with orange peel over canned orange juice. The addition of orange peel to canned or bottled juice also was preferred by two out of three panel members over the same processed juice without orange peel.

Only limited results are available regarding the quality of apple juice processed after the addition of orange peel. The larger peel particles tended to settle during processing and subsequent storage. The physical characteristics of the peel particles were more pronounced and objectionable when juices were tasted after processing. If apple juice containing orange peel were to be processed and stored, considerable attention would need to be directed toward particle size and potential off-flavors from peel oil constituents. The small amounts of orange peel oil in the apple juice are responsible for the delicate aroma and flavor; however, the orange peel oils may cause off-flavors after processing and storage.

(continued on page 11)

Sulfur: The Neglected Nutrient

William G. Martin

Asst. Agricultural Biochemist

THE soil in many areas of the United States is deficient in sulfur. Continued leaching of sulfate, coupled with many years of fertilization with nonsulfur, nonprotein nitrogens has contributed to this situation. The plant and organism populations of our fields and pastures are able to produce only the quality and quantity of nutrients that their environment allows. This plant sulfur deficiency must be corrected by mixed feed supplementation since much of the feedstuffs for meat production originates at many points throughout this and other countries.

Our domestic animals are able, in varying degrees, to convert plant inorganic sulfur into protein and other organic compounds. Microorganisms within these animals are even more efficient in this respect.

Plants depend upon the soil for most of their sulfur in the form of sulfate ion. Many factors are associated with the amount and availability of this nutrient to the plant and, therefore, the optimal rate of growth cannot be obtained. The sulfate ion is taken into the plant and plant enzymes convert it into the organic sulfur compounds needed. However, since this is a chemical reaction, and since practically all reactions in the cell are at equilibrium, there should always be sulfate ion present.

Therefore, varying amounts of inorganic sulfur will be present in these tissues. In most cases, the major source of dietary sulfur is the sulfur amino acids, methionine, and cysteine. During the metabolism of these acids, the sulfur is often used in the formation of other essential compounds. Among these are coenzyme A, glutathione, lipoic acid, the vitamins thiamine and biotin, the penicillins, and the nerve and bile constituent, taurine. In some instances, these compounds are formed directly from cysteine, and cystine from methionine, while in others they originate from inorganic sulfur. This use of sulfate-sulfur may be mediated by intestinal microorganisms from which the host animal then benefits, but some animals are able to use sulfate directly.

From experiments with laboratory animals, we are better able to postulate how our domesticated animals may better utilize the dietary nutrients. For example, we have found that young, rapidly growing chicks can benefit from the addition of sulfate, as sodium or calcium salts, to their diet. Reports from other stations have indicated beneficial results when small amounts of sulfate were included in the ration of beef, dairy cattle, and sheep. Since the commercial feeds are prepared from ingredients produced in many areas of this country, it is possible that nutrient insufficiencies within one or more of the plant products can occur.

If optimum levels of high quality proteins, rich in the essential amino acids (including methionine), are in the animal's food, then the inorganic sulfur concentration is easily maintained. With poor dietary protein and consequently less methionine and other essential amino acids, the animal would depend upon performed or endogenous sources of SO_4^{2-} . There appears to be a need for dietary sulfate even in the presence of adequate methionine.

During the past few years, Agricultural Experiment Station biochemists have been working with ideas which could afford better or more efficient utilization of the dietary components by the growing chick. One such study was to find how inorganic sulfur was beneficial to the chick and, moreover, if it was being used in a role as a sparing agent for dietary methionine.

Initially, studies were made with white rats to study the pattern of utilization or excretion of orally administered $\text{S}^{35}\text{O}_4^{2-}$ since such studies with young chicks are difficult. These were made to facilitate the excretion pattern of the isotope S^{35} , as it would be altered by various dietary changes. During the initial studies, a marked influence of vitamin B_{12} was observed on the sulfate metabolism. Realizing the role of this vitamin in protein metabolism and carbon chain alteration, tests were begun to see if the sulfate was being incorporated into the sulfur amino acids and into the proteins. Negative results indicated that the SO_4^{2-} was associated with reactions of esterification and to minor incorporation roles. It

Figure 1. The relationship of protein quality to the protein utilization by young weanling rats.

TABLE 1

Growth of the Chicks and the Utilization of S^{35} by its Incorporation into Organic Molecules.

Diet Sulfur Supplement	14 Day Weight (gm)	Hours after $S^{35}O_4$ Administration								
		6			12			24		
		Chond. SO_4^1	Taurine S.A. ²	Total Taurine	Chond. SO_4	Taurine S.A.	Total Taurine	Chond. SO_4	Taurine S.A.	Total Taurine
None	97.6	4680	254	37	3891	242	45	2930	114	37
Methionine	108.1	2340	60	64	3057	96	71	—	58	64
Cysteine	105.2	2691	222	11	3978	188	35	2184	130	23
Thiosulfate	79.6	2949	82	50	4360	43	85	2367	109	31
Sulfite	92.1	3183	63	69	4929	143	67	—	38	54
Sulfate	103.5	2505	115	31	4329	218	36	1815	44	43

¹Chondroitin sulfate—the net cpm $S^{35}O_4$ per mg recrystallized chond. SO_4 , net cpm taurine- S^{35} in 1 gm liver²Taurine—the Specific Activity of Taurine = $\frac{\mu\text{gm total taurine in 1 gm liver}}{\mu\text{gm taurine-}S^{35} \text{ in 1 gm liver}}$ ³Total taurine—the μgm of taurine in 1 gm liver.

was observed that a portion of the sulfate was adsorbed to blood proteins and to proteins of liver tissue.

Sulfate association with the protein fraction of biological systems has been established. With optimal growth of an organism we also find maximum synthesis of protein to meet the needs of the new growth. When the growth rate of the white rat was measured by varying the kind and the amount of protein in the diet, a very definite ratio was found between the increased growth rate, the quality of the protein, and the amount of $S^{35}O_4$ retained.

The protein efficiency ratio (PER = average daily gain/protein intake) and a ratio of S^{35} from $S^{35}O_4$ retained by the rat to the amount of dietary sulfur amino acid ingested (inorganic sulfur/organic sulfur) were measured (Figures 1 and 2). These figures indicate that sulfur utilization is definitely associated with growth, in that as the PER (Figure 1) rises to a value of 1 to 1.5, the ratio of S^{35} to amino acid sulfur tends to approach a constant value (Figure 2). This ratio of S^{35} from S^{35} -sulfate administered and retained to the daily sulfur intake is an indication of the available sulfur or sulfate pool of the animal. Sulfate could be used in a general ionic role or perhaps by conversion into actual cellular components as sulfate esters or as organic compounds such as taurine, cysteamine, cysteine, or the hydroxyanalog of taurine, isethionic acid.

The use of sulfate ion by the chick was compared to other forms of sulfur, organic and inorganic. In order that unknown quantities of other sulfur compounds were minimized, six groups of day-old chicks were fed a purified diet composed of purified soybean protein and glucose, a small amount of corn oil,

Figure 2. The retention of inorganic sulfur by rats as influenced by the quality protein and the total sulfur ingested.

and adequate pure minerals and vitamins. The various forms of sulfur were added to this sulfur deficient diet so that each ration contained equal amounts of sulfur. When the chicks were 14 days old, they were orally administered a tracer quantity of the radioactive isotope $S^{35}O_4$ and were sacrificed at 6, 12, and 24 hours after the isotopic dose. The growth of the chicks and the utilization of the S^{35} by its incorporation into organic molecules was observed (Table 1).

Methionine, normally the major source of sulfur in the diet of most animals, gave the best growth rate, with cysteine and sulfate next. Sulfur in the form of sodium sulfite and thiosulfate inhibited growth of the chicks. The amount of S^{35} found in the chondroitin sulfate from chick cartilage indicates that the 14-day-old chick actively uses sulfate in esterification reactions. Without

a dietary source of sulfur added, higher amounts of the isotope were used. Six hours after the isotopic dose, the chicks fed methionine, cysteine, and sulfate had about one-half the activity as did the control chicks due to more rapid growth and greater dilution of the S^{35} -labeled sulfate pool in the body.

The formation of taurine, as indicated by the total taurine of the liver, appeared to be enhanced by the addition of methionine, sulfite, and thiosulfate. Cysteine supplementation suppressed taurine formation, while sulfate showed similar values to the unsupplemented chicks.

Since cysteine yields sulfate upon oxidation, and as similar growth response from feeding cysteine and sulfate were observed (Table 1), another trial was made to ascertain growth and S^{35} use of chicks when fed diets containing various levels

of these sulfur compounds (Table 2).

The need of sulfur for growth appears to be supplied best by 2.9 gm cysteine or 2.72 gm of sulfate, as twice this amount of sulfate showed only a slight improvement in rate of growth. The inclusion of higher levels of cysteine was associated with growth rates equal to, and less than, the nonsupplemented group of chicks. We now feel that cysteine, as well as thiosulfite and sulfite ions, may inhibit the enzymes which are responsible for the activation and utilization of sulfate. This enzyme repression has been demonstrated in certain strains of microorganisms with excessive levels of cysteine. We were able to substantiate this by the decreased levels of taurine in the liver of chicks fed the higher levels of cysteine.

The production of bile fluid by the chicks fed increasing levels of sulfate was some three times that of the chicks fed no sulfate. This increased volume of bile fluid may be, in part, responsible for the better growth rate of these birds by better utilization of the ingested feed-stuffs. The action of bile on lipid

TABLE 2
Growth and S¹⁵ Use of Chicks When Fed Diets Containing Various Levels of Cysteine and Sulfate.

Sulfur Compound	Amount in Diet (gm/kg)	14 Day Body Weight	Average Volume of Bile Fluid per Chick (ml)	μgm Taurine per gm Fresh Liver
Cysteine-HCl	0 (gm/kg)	115.7 ²	0.058	32.7
	2.90 (gm/kg)	127.0	0.063	36.3
	5.80 (gm/kg)	118.9	0.100	36.2
	11.60 (gm/kg)	109.6	0.069	33.7
Sodium Sulfate	0 (gm/kg)	115.7	0.058	32.7
	1.36 (gm/kg)	116.9	0.125	37.5
	2.72 (gm/kg)	124.7	0.140	39.4
	5.44 (gm/kg)	125.9	0.137	44.5

¹Each value of this table is the average of samples taken 1, 2, 3, and 4 hours after isotopic administration.

absorption has been known for some time. The limiting factor in the formation of taurocholic acid by combining taurine and cholic acid is the amount of taurine available. Since the chick is able to synthesize taurine from sulfate, then it was reasonable to assume increased taurine levels in the liver of the chick. As seen in Table 2, such was the case when sodium sulfate was added to the diet in graded levels. Bile acids also aid in the digestion

processes by the stimulation of intestinal motility.

These data have pointed to the need of well-balanced diets for our animals if we expect maximum efficiency from them. Over supplementation in many cases can be as detrimental to the animal as a deficiency. A deficiency of sulfur for the domestic animals of West Virginia could well exist when they are fed commercial feed and grazed on improperly nourished pastures.

Temporary Infertility in Sheep Caused by Leptospirosis

Leslie Dozsa
Assoc. Veterinarian

LEPTOSPIROSIS is an infectious disease occurring in various species of animals and in man. The causative organisms are various serotypes of the Leptospire. Out of the more than ninety serotypes, *Leptospira pomona* is the most prevalent. Infection takes place by ingestion of feed or water contaminated with the Leptospiral organism. The most common sources of the causative agent are stagnant water pools which may contain the organisms, derived usually from the urine of infected cattle, in large numbers. Since Leptospirosis in sheep was first reported in this country in 1953, there is increasing evidence that Leptospirosis may occur more frequently than is realized. The clinical symptoms of field outbreaks and experimental inoculations indicate that Leptospirosis in pregnant ewes is always accompanied by a rather high incidence of abortions.

The only reproductive pathology discussed in Leptospirosis, however, is abortion in pregnant ewes, and no

Figure 1. Vacuolized surface epithelium of the uterine mucosa.

information is available as to the effect of *Leptospira pomona* on the uterus of nonpregnant sheep. Experimental work was undertaken, therefore, to study the correlation of *Leptospira pomona* infection and reproductive efficiency in nonpregnant ewes. The investigation was further prompted by Smith's work, which suggested the possibility of venereal transmission of *Leptospira* in sheep.

Twenty-two nonpregnant ewes were inoculated with *Leptospira pomona* positive hamster blood. Blood and urine specimens were collected from the infected animals for culturing and hamster inoculation, and they were sacrificed at various intervals. All the infected ewes had a marked rise in temperature ranging from 104-108.5° F two or three days following inoculation. The temperature rise lasted one to three days. The clinical symptoms observed during the febrile period included depression, inappetance, and occasionally diarrhea. *Leptospira pomona* was isolated from every sheep either by direct culturing or from hamster inoculation. The controls were negative.

Lesions were seen in the endometrium of all sheep, which were positive for *Leptospira pomona*. The changes included vacuolization and disorder of the surface epithelium, inflammatory cell infiltration of the different layers of the uterine mucosa, and degeneration of the

Figure 2. Severe lymphocytic infiltration in the endometrium.

glands. It should be noted that the lesions were in correlation with the time elapsing between inoculation and sacrifice, and were similar in the sheep sacrificed at the same time. The changes of the uterine mucosa were mild in the ewes sacrificed at six and eight days following inoculation. Between 10 and 22 days, however, the lesions became very pronounced and consisted of a disordered surface epithelium, se-

vere lymphocytic infiltration and degeneration of the uterine glands (Figures 1 and 2). After the twenty-fourth day, the endometrium started to improve, and 36 days following inoculation, the uterine mucosa was normal. The histopathologic lesions between 10-22 days were sufficiently severe to interfere with the nidation and development of the fertilized ovum, and cause temporary infertility in the infected ewes.

Apple Cider and Orange Peel

(continued from page 7)

The general conclusions drawn from several years of taste panel evaluations of additions of orange peel to apple juice are:

1. A significant increase in preference of juices from single varieties or blends of varieties was found by the addition of about 0.5 per cent homogenized orange peel to the particular juice or blend.
2. The acceptance of canned or bottled apple juices was increased significantly by the addition of orange peel.
3. Additions of orange peel were more effective in increasing taste acceptance than grapefruit or lemon peel in the various blends and juices tested.

The housewife may wish to improve the flavor of her favorite apple juice or cider by blending a section or two of a whole orange with a quart of

juice. The coarser peel particles may be allowed to settle to the bottom or be strained out before drinking. The orange peel oils will give a pleasant "orange" aroma and improve the flavor of the apple juice or cider.

The author and Miss Gamble recheck lab findings on an apple juice sample.

Parasites, Pasture, and Profits

G. C. Anderson
Animal Husbandman

A NEW ZEALAND lamb producer was visiting in West Virginia recently as part of his tour of the world. After seeing a good deal of the State and just before he left for Europe, he said, "You Yanks are sitting on a gold mine! Now, mind you, I don't know as much about your country as I should, but if ever I saw sheep country, you have it here!"

Why doesn't West Virginia produce more lambs and wool? This question is not a simple one and it never has been satisfactorily answered. Without doubt, there are many factors involved, not the least of which is the control of internal parasites.

Until recent developments produced thiabendazole, the most effective drug the flockman could use was phenothiazine. However, some flocks failed to respond to phenothiazine treatment and the parasite problem became almost unmanageable. In other flocks, phenothiazine performed well only part of the time without any apparent rhyme or reason.

Investigation of these problems soon demonstrated that some of the internal parasites of sheep had developed a resistance toward phenothiazine, particularly the stomach worm, *Haemonchus contortus*. The second problem, variation in response to phenothiazine treatment, was caused primarily by differences in the

amount of impurities in the phenothiazine preparation and its fineness or particle size. Although these two problems may appear to be entirely different, they are in fact closely related.

Soon after the discovery of thiabendazole, extensive trials in West Virginia and elsewhere established that this new drug was effective against all of the important internal sheep parasites. Probably of equal importance was the low toxicity of the compound and its effect against immature forms of the parasites.

Systematic flock treatment with thiabendazole or alternating treatments of thiabendazole and finely ground, purified phenothiazine have provided excellent control. These new developments remove one of the major obstacles believed to hinder the improvement and expansion of West Virginia's sheep industry. The results of extensive parasite control experiments in commercial flocks are described in Bulletin 519, *A Comparison of Several Anthelmintics for the Control of Internal Parasites of Sheep*, and recommended flock parasite control programs are given in Misc. Pub. 129, *A Program for the Control of Internal Parasites in Sheep*. Copies of these publications may be obtained by writing to the Director, Agricultural Experiment Station, West Virginia University, Morgantown 26506.

Heavily parasitized lambs such as this one demand immediate attention. The effects of mild parasitism are not so striking and all too often go unnoticed and untreated. Mild infestations are common and expensive because they can easily lower lamb gains by 15-25 per cent.