

THE SHEEP TICK, while not a true tick, is a bloodsucking parasite which infests sheep on both farms and ranges. It is widely prevalent and spreads rapidly, especially among the close-herded range flocks, where it may cause much damage and loss. The nature and habits of the tick are described, also methods of identifying it.

The only practicable way of destroying the pest is by dipping the sheep. Several kinds of dips are used successfully. The newer dips containing rotenone or DDT are generally reliable for eradicating sheep ticks by one dipping. When other dips are used, however, two dippings are necessary, about 24 days apart, as the first dipping may not destroy all the pupae, sometimes but erroneously called eggs, and from these a new brood may subsequently result.

Methods of dipping large and small flocks are discussed, and plans of a concrete vat, showing details of construction, are given.

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THE SHEEP TICK AND ITS ERADICATION BY DIPPING

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DISTRIBUTION AND ECONOMIC IMPORTANCE

THE SHEEP TICK (*Melophagus ovinus*) is not a true tick but a wingless parasitic fly which passes the various stages of its life on the sheep. In many of the English-speaking countries it is known as the "ked" and is sometimes called the "louse fly" from its habit of living in the wool like a louse, but among the sheep growers of this country it is known as the sheep tick. It is widely distributed in many of the sheep-growing countries of the world, including the United States, where it is known to occur in practically all of the States where sheep are kept. It is most prevalent, however, in the western range States where sheep are herded in large flocks.

Many of the farm flocks of the United States harbor sheep ticks and in some cases they are present in sufficient numbers to cause considerable damage to such flocks. This applies especially to farms where open-fleece sheep are kept.

The sheep tick obtains its food by puncturing the skin of the sheep with its lancelike proboscis or sucking tube and feeding on the blood and lymph. The irritation thus caused is very great, especially in the case of lambs that are heavily infested, and while the quantity of blood drawn by one tick in 24 hours is small, the total amount taken by a large number of ticks is considerable and the drain constant. The irritation caused by the ticks makes the sheep restless so that they do not feed well, and in consequence, they do not grow and fatten as rapidly as when free from ticks. Thus a loss is caused by shrinkage in weight and a general unthrifty condition of infested flocks, with a consequent lowering of the vitality and a reduction in the resisting power of the animals. These conditions not only help to reduce the

¹ Retired. This edition slightly revised by H. E. Kemper and A. O. Foster, Zoological Division.

market value of the sheep but also tend to reduce wool growth, although being a bloodsucker, the tick does not feed on the yolk of the wool or directly injure the fibers to any great extent.

During the course of the investigations conducted by the Bureau of Animal Industry bearing on the problems of eradication, estimates of the average annual losses caused by sheep ticks were submitted by a large number of sheep owners in Utah. According to these estimates, the average annual losses are 25 cents per head for lambs and 20 cents per head for ewes in infested flocks. These figures are undoubtedly very conservative, as in estimating losses caused by parasites the indirect losses are seldom taken into consideration. Any factor operating to lower the vitality and resisting powers of domestic animals usually causes indirectly a considerable death loss during unfavorable seasons.

LIFE HISTORY

The sheep tick, being a wingless fly, is in no way directly related to the true ticks. A true tick in the adult stage has eight legs, while the so-called sheep tick has only six legs and in general form and structure is entirely different (fig. 1).² Like other insects, sheep ticks vary in size, but the average length of adult females is about one-quarter of an inch. The life cycle of the sheep tick is divided into four natural stages or divisions, namely, the egg, the larva, the pupa, and the adult or sexually mature insect.

The egg is not laid, but is retained in the body of the female, where it develops into a larva in about 7 days. At the time of birth the larva is covered with a soft white membrane, which turns brown and becomes a hard shell, called a puparium, in about 12 hours (fig. 2, *A*). The term "pupa" applies to that stage in the life of the sheep tick from the time the pupa is deposited until the young tick emerges. During this stage the pupa remains within its hard shell or puparium, which is attached to the wool fibers by a gluelike substance which dissolves readily in water. These shell-covered pupae are commonly called eggs. In from 19 to 24 days from the time it is deposited the shell of the pupa is broken open at one end and the young tick emerges and becomes active in the fleece. The time between the depositing of the pupa and the emergence of the young tick is usually called the period of incubation, and its duration is influenced by the temperature. During warm weather the average period of incubation is about 19 days, while during cold weather it is about 24 days, and in some cases longer. However, in practical operations under average conditions, 24 days has been assumed to be the longest period.

At the time the young tick emerges from the shell it is almost as large as a full-grown tick (fig. 2, *B* and *C*). It develops very rapidly and reaches sexual maturity in 3 or 4 days. The female deposits her first pupa within 8 to 10 days after being fertilized.

The life history of the sheep tick, from the practical standpoint, may be summarized thus: Counting from the time when it emerges from the shell, the young tick deposits its first pupa or so-called egg in about 14 days. From this pupa a young tick emerges within 19 to 24 days.

² Figures 1 to 5 are from photographs by W. T. Huffman, and the picture on the title page is from a photograph by George A. Lipp.

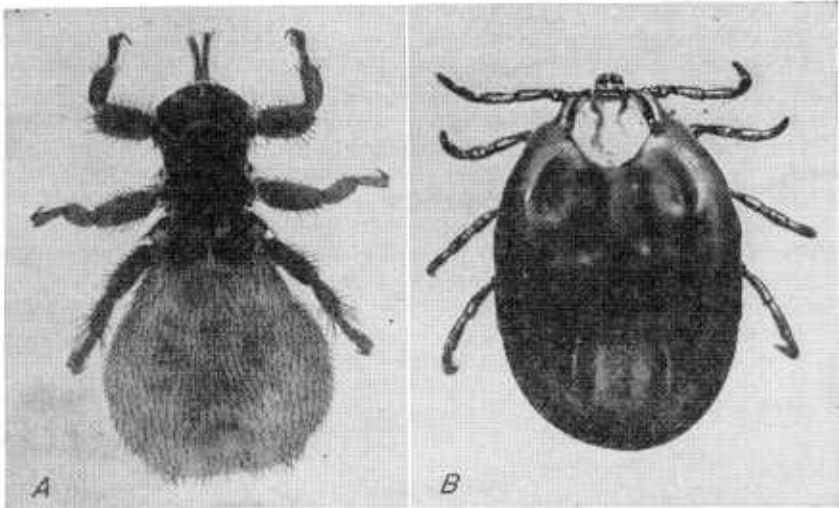


FIGURE 1.—Comparison of form and structure of sheep tick and true tick: *A*, sheep tick (engorged female, enlarged); *B*, true tick (engorged female, enlarged).

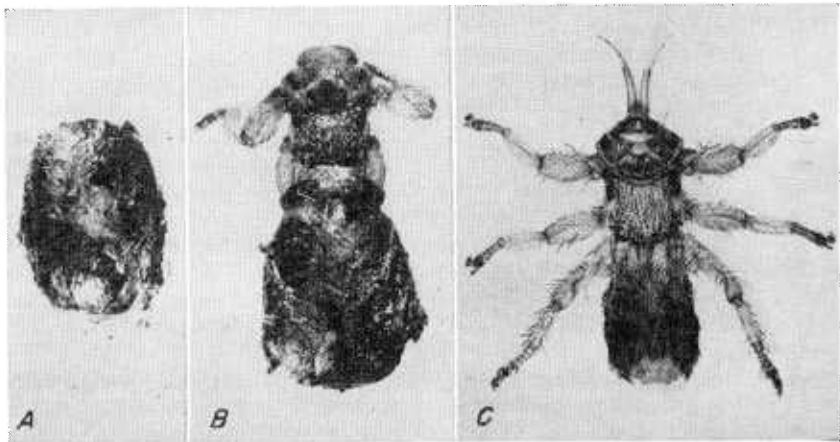


FIGURE 2.—*A*, pupa of sheep tick, commonly called the egg, taken from the fleece of sheep; *B*, young sheep tick emerging from the puparium; *C*, young sheep tick just after emerging from the puparium. Enlarged.

These two stages in the life history have an important bearing on the problem of eradication.

Dipping, if properly done in dips containing derris or cube powder of 5-percent rotenone content, or in water dips containing DDT, can usually be depended upon to eradicate sheep ticks in one dipping. These dips kill the adult ticks, and the insecticide remains in the wool sufficiently long to destroy all young ticks as they hatch from the pupae. Other kinds of dips usually destroy all of the adult ticks, but cannot be depended upon to destroy newly hatched ticks because they lack the residual toxic action of the aforementioned substances. With

these dips, therefore, the viable pupae that remain in the wool after the first dipping will produce a new generation of ticks.

This new generation must be destroyed by a second dipping before they have had time to develop and deposit pupae. On the other hand, the second dipping should not be done before all the pupae which were in the wool at the time of the first dipping have had time to mature, otherwise they may emerge after the second dipping and reinfest the flock. Consequently, it is important to allow a proper interval of time between the first and second dippings if the results are to be successful. The first dipping probably destroys many of the pupae that are less than 4 days old, and the dip remaining in the wool has a tendency to prevent the development of young ticks and probably kills many of them. Under average conditions during early fall dipping, 24 days should elapse between the first and the second dipping.

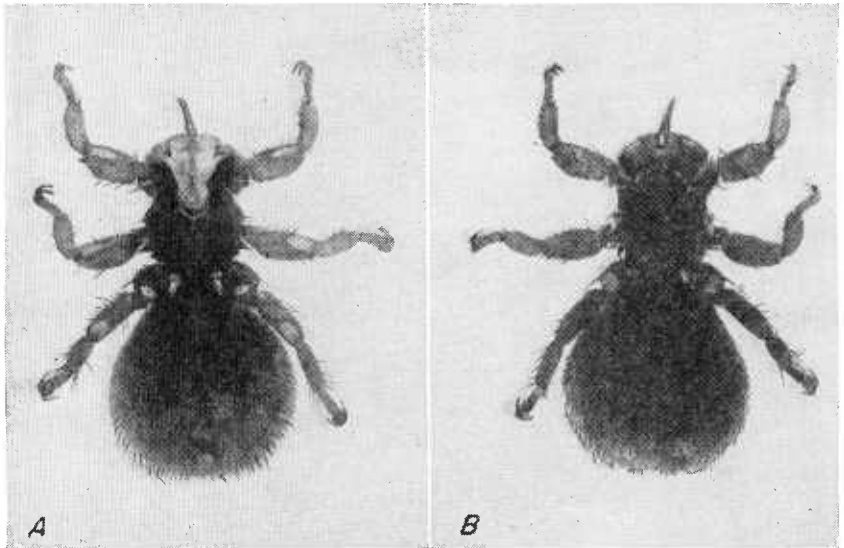


FIGURE 3.—A, Mature male sheep tick, dorsal view; B, mature male sheep tick, ventral view. Enlarged.

NATURE AND HABITS

True ticks, such, for example, as the cattle-fever tick, do not pass their entire life on the animal which they infest, but always drop to the ground to lay their eggs. The life history of the sheep tick (fig. 3) is more simple. It does not drop off the sheep to lay eggs, but deposits its pupae in the fleece. Each female deposits an average of from 12 to 15 pupae during her lifetime, 1 being laid about every 7 or 8 days. These pupae, or so-called eggs, are attached to the wool fibers, usually from one-half inch to an inch from the skin. Consequently when the sheep are shorn the majority of the pupae are removed with the fleece.

Sheep ticks when feeding attach themselves temporarily to the skin of the sheep by burying their sucking tubes in the tissues; when not feeding they move about in the fleece. During cold, inclement weather

they remain deep in the fleece close to the skin for shelter and warmth, but when the days are warm they are found near the surface and often can be seen in great numbers crawling over the tips of the wool. Sometimes they are dislodged from this position and thus temporarily infest trails, pastures, corrals, bed grounds, and premises. When dislodged from a sheep they crawl upon another at the first opportunity.

The sheep tick does not transmit any known disease to the sheep, but it harbors a very small one-celled animal organism, related to forms which are transmitted by insects to various animals, including man, and which cause serious diseases.

When the flock is heavily infested the ticks may be found on any part of the body, but they usually select locations where the wool is thin and occur in greatest numbers on those parts where they are protected from the efforts of the sheep to dislodge them. The neck, breast, shoulders, belly, and thighs are the favorite locations.

Many of the ticks are removed with the fleeces at the time of shearing, especially if machine shearing is practiced. The freshly shorn sheep offers very little protection for the ticks, and consequently, during the shearing season, the ticks migrate to the lambs in large numbers. The lambs of the flock suffer most from the ravages of this pest, and if they become heavily infested receive a setback at an important period in their development, thus causing considerable financial loss to the owner.

SPREAD

Although sheep ticks do not seem to possess the instinct of migration to any great extent, nevertheless, once introduced into a flock, they spread rapidly until the entire flock is infested. As range sheep are usually close herded, crowded into corrals, and come into close contact on the bed grounds, the ticks pass readily from one animal to another. On farms, where the sheep are not close herded but graze in fenced inclosures, the conditions are not so favorable for rapid spreading; but during cold weather, when such sheep are placed in corrals, sheds, or barns, in close contact, every member of the flock as well as the premises will almost certainly become infested if there are ticks on any of the sheep.

While sheep ticks will not propagate or live for any considerable time on animals other than sheep or goats,³ they may be harbored temporarily by dogs or other animals which have come in close contact with an infested herd. Men working among infested sheep may carry the parasites on their clothing and thus be the means of introducing them into clean flocks. If separated from the sheep the ticks do not live longer than about 4 days as a rule, and it might be assumed that places from which all sheep had been removed would become free from sheep ticks within a very few days. However, the survival of dislodged ticks is not the only factor influencing the length of time premises may remain infested after the removal of

³ Experimental data seem to indicate that sheep ticks may live and propagate on goats. E. R. McClure placed 12 ticks on an Angora goat and held the goat under observation for 60 days. The ticks lived and propagated during this period, at the end of which time the goat was returned to the flock and observations were discontinued.

infested sheep. Tags of wool to which pupae are attached may be pulled out by bushes, fences, etc., or by the sheep themselves. If the weather is warm and other conditions favorable these pupae will emerge as ticks and infest the premises.

Under ordinary conditions the period of incubation is from 19 to 24 days and in some cases longer, the length of the period being influenced by temperature and other factors. Laboratory experiments have indicated that the incubation period of pupae removed from sheep may be as long as 46 days. Infested sheep, in their efforts to obtain relief from the irritation and itching, may dislodge some of the ticks and pupae. The ticks will die in a few days, but if conditions are favorable the pupae will retain their vitality and emerge as ticks in due time. The pupae dislodged from the sheep during cold weather or when the nights are frosty will not emerge, but will be destroyed. It seems reasonably certain that freezing temperature will destroy the vitality of the pupae. These facts have an important bearing on the problem of eradication. Premises or places occupied by ticky sheep may become infested, and if conditions are favorable for the development of the pupae they may remain infested for a period of from 45 to 50 days from the time ticky sheep were removed. A safe basis of practice during warm weather is to consider all premises occupied by ticky sheep as infested for a period of 60 days from the date of infestation. During cold weather, when the temperature drops to freezing at any period during the day or night, infested premises probably would become free from infestation within a day or two, except in places well protected from the cold, such as sheds and stables.

During warm weather infested corrals or enclosures should not be used for clean sheep. If it is necessary to use such corrals they should be cleaned and disinfected by removing all litter and manure, cleaning down to a smooth surface, after which the floors and sides should be sprayed with a good disinfectant. The coal-tar creosote dips diluted to double the strength recommended for dipping are suitable for this purpose. The cleaning should be done carefully in order that all pupae may be removed with the litter, as the disinfectant probably will not destroy the vitality of the pupae. All litter and manure from infested premises should be spread on the ground and plowed under or disposed of in such manner that sheep cannot come in contact with it for at least 60 days. An economical and effective method of disinfecting stone or wire fence corrals is to scatter straw or brush over the surface of the ground and burn it. If the brush or straw is dry so it will burn readily sufficient heat will be produced to destroy the parasites.

DETECTING TICKS IN THE FLOCK

When sheep are heavily infested with ticks they bite and scratch and rub against any available object, including other members of the flock. The natural position of the wool is disturbed by these efforts to obtain relief from the intense itching; more or less wool is pulled out, and the fleece may have a ragged appearance (fig. 4).

If sheep ticks are causing the trouble, they may be found by parting the wool over the neck, breast, shoulders, belly, and thighs. They are large enough to be seen readily and are of a brownish color.

On warm days they often may be observed crawling over the tips of the wool. If ticks are present pupae usually will be found attached to the wool fibers. These are seen easily with the naked eye, being about one-eighth inch in length. Their color varies from yellowish white to dark brown, and the shell is glossy and firm (fig. 5).

Any condition which causes the sheep to bite and scratch themselves may be mistaken temporarily for ticks. In every instance close examination should be made and the cause definitely learned. It should be remembered, however, that the presence of ticks does not exclude other possible causes of the irritation, such as scab, lice, common ticks, bearded seeds, thorns, etc.

ERADICATING TICKS BY DIPPING

Dipping consists of immersing the animals in a medicated liquid that will kill the parasites, and is the only practicable method known for eradicating sheep ticks. The process of dipping is shown in the illustration on the title page. In order that the medicated liquid or dip may exert its killing powers it is necessary that it come in direct contact with the parasite. Very few of the known dips will kill the ticks immediately; therefore the length of time the sheep are held in the vat is not the sole determining factor, provided they are held in the dip a sufficient length of time to saturate the fleece. The length of the wool, the quantity of dip retained in the fleece, the length of time the dip remains active in the wool, and the nature of the active principle, all have an important bearing on the results.

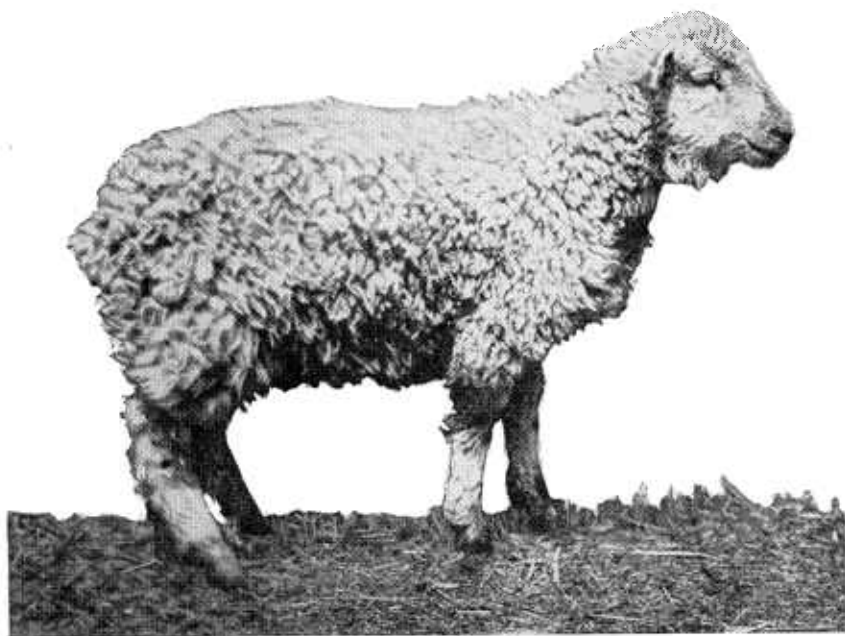


FIGURE 4.—Lamb grossly infested with sheep ticks, showing roughened conditioning of fleece.

Other factors being equal, the dip that remains longest in the wool and retains its killing power for the longest period is most desirable, not only for destroying the parasites on the animal but also for preventing reinfestation.

In dipping sheep for ticks the entire flock, together with all goats, dogs, or other animals which may have been with the sheep, should be dipped regardless of the number showing infestation. The fleece should be saturated thoroughly, but as there are no crusts or scabs to be penetrated, it is not necessary to hold the animals in the vat longer than about one minute. The head of each animal should be submerged at least once and care taken that every part of the fleece is wet. As only coarse-wool and medium-wool sheep usually become infested heavily, and as such fleeces are penetrated easily by the dip, it is not considered necessary to maintain the dip at a high temperature. However, it should not be cold enough to chill the animals; the range should be between a minimum of 65° F. and a maximum of 95°. The temperature of the dip should be ascertained accurately by using a thermometer. If a proprietary dip is used the



FIGURE 5.—Close view of portion of neck of lamb shown in figure 4, showing ticks and pupae in wool.

printed instructions on the label of the container should be followed both as to the time the animals are to be held in the dip and the temperature at which the dip is to be used.

The season best suited for dipping to eradicate ticks depends upon the altitude, the climatic conditions, and the methods of handling the sheep. In those sections where spring shearing is practiced, July and August are considered the best months for dipping. If the lambs become heavily infested shortly after shearing, which often occurs, the flock should be dipped as soon as the shear cuts heal. One objection to dipping too soon after shearing is that the wool is short and the fleece will not retain much of the dip. For this reason fall dipping probably would prove more effective than summer dipping in eradicating ticks. It is advisable, however, that all flocks in any given neighborhood be dipped at about the same time in order to lessen the chances of reinfesting the neighborhood.

IMPORTANT PRECAUTIONS

If the dipping is to be successful, it is necessary to give close attention to the details and to see that the work is performed carefully and thoroughly. Sheep should not be dipped immediately after shearing; a period of at least 10 days should elapse between shearing and dipping in order that the shear cuts may heal. It is dangerous to dip sheep in some of the dipping preparations if there are any fresh wounds on the animals; consequently, dogs that bite the sheep should not be allowed in the dipping corrals. The chutes, pens, and dipping vat should be examined closely for nails, broken boards, or any object that may puncture or wound the skin of the sheep. Animals having fresh wounds when dipped in some of the dips usually develop a condition commonly known as blood poisoning, and the mortality from this cause is high. After the wounds have granulated or healing is well started there is little or no danger from this source. Rough handling of the sheep at the time of dipping results in more harm and damage to the flock than is caused by the dip. When sheep are placed in the dipping vat by hand, the men handling them should be instructed to do so carefully. They should not be allowed to catch the sheep by the ears; this is sometimes done, and has resulted in breaking or bruising the skin, causing the heads to swell after dipping, and resulting in considerable death loss.

Ewes and lambs should not be dipped together; if put into the vat at the same time the danger of drowning some of the lambs is much greater than when they are dipped separately. The lambs should be "cut out" and dipped separately, and they need not be held in the swim as long as the older sheep. It has been stated that the ewe recognizes her lamb more readily when they are dipped together; this, however, is probably not correct. A ewe recognizes her lamb by smell and not by sight, consequently after the flock has been dipped and the ewes and lambs have been turned in together there is considerable commotion for a time, as the ewes fail temporarily to recognize their offspring. However, the members of the flock will adjust matters for themselves, and, as a rule, practically every lamb will be recognized by its mother. It often happens that an undipped sheep will jump out of the pens and get in with those that have been

dipped. This should be carefully guarded against and all such sheep dipped before the flock leaves the vat.

Prior to bringing the sheep to the vat for dipping they should be watered and fed so as not to be thirsty or hungry at the time of dipping, although they will probably stand the effects of dipping better if not too full of feed and water when dipped. If they are watered and fed 3 to 6 hours before dipping they are likely to be in the best condition for the operation. When the weather is cold or stormy dipping operations should be commenced early in the morning and finished for the day in time to give the last sheep dipped opportunity to dry off before night. During winter weather dipping for the day should be finished by noon, so that the flock may have time to dry off and fill up with feed before night, as a sheep with a full stomach will withstand much cold and hardship. If these precautions are observed sheep may be dipped with reasonable safety during cold weather.

Bucks should be dipped separately from ewes and lambs. They should not be driven fast and then put into the vat before resting and cooling off. As they succumb very easily in the vat, it is necessary to give them careful attention. At the large vats the buck herds usually are dipped first, while the vat is full, so as to afford them more swimming room.

DIRECTIONS FOR DIPPING

The quantity of dip in the bath should be sufficient to submerge the sheep completely; that is, the depth of the dipping fluid in the vat should be not less than 40 to 48 inches, depending on the size of the sheep. The quantity of fluid necessary to fill the vat to the required depth should be ascertained before it is prepared. Freshly shorn sheep and short-wool lambs will carry out on an average from 1 to 2 quarts of dip, depending on the size of the sheep and the length and grade of wool, while full-fleeced, fine-wool sheep will carry out and retain in the fleece as much as 2 gallons. At late fall dipping the average medium-wool sheep will retain in the fleece about 1 gallon of dip. In estimating the quantity of dip required, these facts should be taken into consideration. After computing the quantity of dip required to charge the vat, the average quantity which each sheep will carry out should be estimated; this should be multiplied by the number of sheep to be dipped, and the product so obtained added to the quantity required to fill the vat. If the vat and draining pens are water-tight, so that no dip is lost through them, the total as given above should show the approximate number of gallons of dip required to complete the work.

After the vat is filled to the required capacity the contents should be well mixed by stirring, in order that the temperature may be uniform throughout. A good method of stirring the dip in large vats is to take a 5-gallon pail or dip container, punch holes near the top, insert a wire for a bail, allow the can to fill and partially sink, then drag it with a dipping fork rapidly from one end of the vat to the other, and repeat the process until the temperature is uniform, as shown by taking it at several points in the vat. Stirring plungers are useful implements, and, as they are easily made, one or more should be provided at every vat. They are used in a manner similar to the move-

ment of the dasher of an old-fashioned hand churn. The plunger is pushed to the bottom of the vat and raised rapidly, the process being repeated as the operator moves slowly along the vat. The style shown in figure 6A is the one most commonly used.

The dip should be changed as soon as it becomes filthy, regardless of the number of sheep that may have been dipped in it. In emptying the vat the entire contents should be removed, including all sediment and foreign matter. After the liquid portion has been drained off, the sediment and dirt at the bottom should all be removed and the bottom cleaned by sweeping or scraping with a hoe or spade. As a rule a dip that has been used for sheep should not be used again after it has stood in the vat 10 days or more.

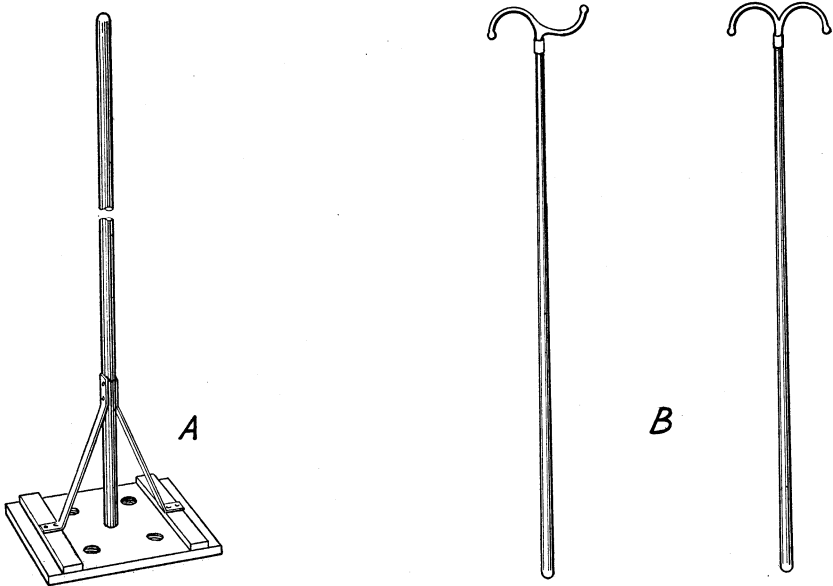


FIGURE 6.—A, stirring plunger for mixing liquids in the vat; B, two styles of dipping forks.

The drowning of sheep in the vat can be avoided by proper care. Men with dipping forks should be stationed along the vat on both sides to attend the sheep and prevent accidents. When the vat becomes filled with sheep their progress is retarded and they frequently attempt to raise themselves out of the dip by placing their forefeet on the back of the sheep in front. The men along the vat should prevent this by keeping the sheep properly arranged in the vat. The dipping forks should be used to keep all of the sheep's body submerged except its head while it is passing through the vat, this can be done by placing the dipping fork over the shoulders of the sheep and gently but firmly pushing it under the dip. The animal will raise its nose so that the neck and part of the head can be submerged without danger of strangling. The head of the sheep should be pushed under the dip twice while the animal is going through the vat. Old ewes that have been dipped a number of times are sometimes difficult to handle,

both in the chutes and in the dip. They will often lie on their sides in the vat, bracing themselves with their feet against one side and their backs against the other. When pushed under they will make efforts to regain this position and may strangle. Sheep that are affected by eating loco weed often drown in the vat unless they are piloted through. When strangling occurs the sheep should be taken from the vat. If it does not get upon its feet, pull the tongue forward, dash cold water over the head and body, and if necessary induce artificial respiration. When it has regained sufficient strength, and if it has not been in the dip long enough, the animal should be returned to the pens and piloted through the vat again.

DIPPING FORKS

In using large vats dipping forks are necessary for the efficient handling of the sheep and should be provided as a part of the equipment at every plant. Several different styles are made, but the two shown in figure 6*B* are the ones commonly used. The one with both hooks turned upward seems to have the preference for the reason that when it is in use either side may be hooked under the neck of the sheep for raising the head in case of strangling. The handles should be strong and from 5 to 6 feet long. The hooks should be made of half-inch round iron and firmly held in the handle by an iron ferrule. These forks can be bought ready-made or may be made by any blacksmith.

EXPENSE OF DIPPING

The cost of dipping naturally varies in different sections; it also varies in the same section, depending on the number of sheep to be dipped, the location relative to the necessary supplies, and the facilities available for the work. The labor, fuel, and cost of materials are the three principal items of expense. In the sheep-growing sections of the West the average cost of dipping sheep varies from 2 to 3½ cents a head for each dipping.

WATER FOR DIPPING PURPOSES

Sheep dips are most effective when used with soft water. If it is necessary to use alkaline water for diluting such dips, the water may be "broken" by using sal soda in the proportion of from 1 to 4 pounds for each 100 gallons of water, depending upon the "hardness" of the water. Where the water intended for dipping purposes is very impure the owner should have it analyzed and obtain the advice of a competent chemist on methods of correcting the water to render it suitable for diluting the dip he proposes to use. Some of the dips, if used in unsuitable water, may injure the sheep, as will any that are used too strong.

Before diluting coal-tar-creosote or cresol dips with hard or alkaline water a test should be made to determine whether a separation occurs in such water. In a clean bottle or jar of clear glass place a measured quantity of dip, and while mixing thoroughly pour in the amount of water, preferably warm, which should be added to make approximately the proportions used in dipping. If after the mixture stands for 1 hour an oily layer or mass of globules appears either at the top or the

bottom of the liquid, the dip should not be used with that kind of water. Sheep may be killed by dips, even when there is no apparent separation in the dips when they are tested by this method.

Dips deteriorate by use. After a number of sheep have passed through the vat the active principle of the dip falls below the standard required for effective work. Before approving a dip for use in official dipping one of the requirements of the Bureau of Animal Industry is that there shall be a practical field test for such dip, so that the strength of the dip in the vat can be ascertained at any time.

KINDS OF DIPS

The dilute rotenone dips, and dips containing DDT, are effective in eradicating sheep ticks by a single dipping. Although these dips are relatively new, experimental and field trials indicate that they are probably the best dips to use for the purpose. Some proprietary dips, on account of their content of cube or rotenone, are also usually dependable in one dipping. Certain other types of dips, which usually require two applications at intervals of about 24 days, are described herein because they are effective, if properly used, and well-known.

Dilute Rotenone Dips

Experiments conducted by the Bureau of Animal Industry with derris and cube powders (the finely ground roots of tropical plants widely used as insecticides) have shown that these materials are remarkably cheap and efficient for the control of sheep ticks with one dipping. The derris or cube powder should contain not less than 5-percent rotenone, which is the principal active ingredient of the powders.

In preparing rotenone dips, 6 to 8 ounces of derris or cube powder are mixed with each 100 gallons of water (approximately 4 to 5 pounds of powder per 1,000 gallons). Nothing else need be added. The dry powder should not be added directly to the vat, but should first be made into a thin paste in a tub or barrel by stirring it vigorously with about 5 gallons of cold water. This thin paste is then poured over the surface of the water in the filled vat, and the entire vat contents thoroughly stirred. Neither derris powder nor cube powder is soluble in water, but they form suspensions which impart a slightly muddy appearance to the water. Fine particles of derris powder or cube powder may settle out of the water after a few minutes' standing, and the mixture in the vat should be well stirred before use.

No field test is available for determining the rotenone content or actual potency of derris and cube dips. Large-scale experiments, nevertheless, have proved that even after a thousand sheep have passed through a vat, carrying large quantities of mud into the water, the effectiveness of the dip was not noticeably impaired. Information as to the length of time dilute derris and cube mixtures will remain fully effective has not been determined. As the cost involved is extremely small, however, it is advisable to refill the vat with a fresh mixture after 4 to 5 days, or when the water becomes extremely filthy. If replenishing the contents of the vat is required when the mixture in the vat is still relatively fresh and clean, the water and derris or cube are simply added at the rate of 8 ounces per 100 gallons.

The powder should be mixed, as described, in a tub or barrel, with a small quantity of water. Water of varying degrees of hardness may be used with these drugs.

Dilute derris and cube dips are harmless and odorless, will not soil or mat the wool, and will permit lambs and ewes to "mother-up" promptly after they have been dipped. A single dipping is usually effective in eradicating the sheep tick, provided all animals in the flock are properly dipped. The sheep should be held in the swim for at least 1 minute, and the head submerged for an instant, at least once. The adult ticks are killed within 24 hours after dipping, and all ticks hatching thereafter from pupal cases attached to the wool will usually die.

DDT Dips

Experimental and field trials indicate that dips containing 0.2 percent DDT can be relied upon to eradicate sheep ticks in one dipping. Because technical DDT powder is not soluble in water and cannot be mixed satisfactorily with it, specially prepared forms of the chemical must be used in making up dipping liquids. Wettable DDT powders (for example, 50-percent wettable DDT) and DDT stock solutions in soluble pine oil, both of which are commercially available, are especially suitable for the preparation of dips by direct admixture with water. About 3½ pounds of 50-percent wettable DDT in 100 gallons of water gives the necessary concentration for the purpose. Using a stock solution (for example, Stock Solution No. 1235) which contains 1 part of technical DDT in 5 parts (by weight) of soluble pine oil, 10 pints of the stock solution must be added to 100 gallons of water.

Caution.—Both rotenone and DDT are poisonous to fish. In emptying vats, therefore, care should be taken to prevent the material from flowing into fishing streams or ponds. In disposing of used dip containing DDT, the liquid should not be allowed to form in pools from which animals may drink, or to drain upon vegetation on which livestock are permitted to graze.

Nicotine Dips

The nicotine or tobacco dips are sold under various trade names, and flock owners are more or less familiar with their use in dipping for scabies. When used in 0.07 percent solution, these dips will eradicate sheep ticks if 2 dippings are given with an interval of 24 to 28 days between dippings. Any brand of nicotine or tobacco dip approved by the Bureau of Animal Industry for use in official dipping of sheep for scabies is suitable for use in eradicating sheep ticks. These dips should be used in accordance with the instructions printed on the label of the container and they should not be heated above 110° F.

Coal-Tar Creosote Dips

The coal-tar creosote dips are sold under a large number of trade names. They are made from coal-tar derivatives and the principal ingredient is so-called creosote oil, which is made soluble in or miscible with water by means of soap. When diluted with suitable water they are very efficacious in eradicating sheep ticks from a flock if 2 dippings

are given with an interval of 24 to 28 days between dippings. There is no field test for determining the deterioration of these dips, and consequently in replenishing the dip the percentage of active principle in the vat is largely a matter of guesswork.

These dips should contain, when diluted ready for use, not less than 1 percent by weight of coal-tar oils and cresylic acid. In no case should the diluted dip contain more than four-tenths of 1 percent nor less than one-tenth of 1 percent of cresylic acid; but when the proportion of cresylic acid falls below two-tenths of 1 percent the coal-tar oils should be increased sufficiently to bring the total of the tar oils and the cresylic acid in the diluted dip up to 1.2 percent by weight.

In the undiluted coal-tar creosote dips, especially in cold weather, a separation of naphthalene and other constituents of the dip may occur. Care should therefore be taken to see that the dip is homogeneous in character before using any portion of it.

Cresol Dips

The cresol dips are sold under various trade names, and consist of a mixture of cresylic acid with soap. The term "cresylic acid" as used in this connection covers those cresols and other phenols derived from coal tar, none of which boil below 185° C. (365° F.) nor above 250° C. (482° F.). When diluted ready for use a cresol dip should contain one-half of 1 percent of cresylic acid. As there is no field test available for cresol dips, the rate of deterioration cannot be determined at the vat, and consequently after a few sheep have been dipped there is no method known for keeping constant the percentage of cresylic acid in the used dip.

When used with suitable water these dips are very efficacious in eradicating sheep ticks, if the flock is given 2 dippings 24 to 28 days apart.

Fused Bentonite-Sulfur-Cube Dip

A commercial product known as fused bentonite-sulfur-cube is being used to some extent as a dip for sheep ticks. As the name implies, melted sulfur is absorbed into bentonite clay, and the mass is reduced to a granular form. This is mixed with cube powder, resulting in the form in which the product is marketed. When it is added to water in the vat according to the manufacturer's instructions on the label of the container, the resultant mixture is a milky-white liquid and some of the sulfur in it is said to be in colloidal form. When sheep emerge from the vat, the wool becomes temporarily matted, and such fleeces dry very slowly. It is not safe, therefore, to dip sheep in fused bentonite-sulfur-cube dip when the weather is very cold or stormy. It is a safe dip, however, when the weather is warm. The results of field trials indicate that one dipping will usually eradicate sheep ticks.

Arsenic-Sulfur-Rotenone Dip

A proprietary product known as arsenic-sulfur-rotenone has had widespread use by sheepmen. The material is said to contain some rotenone and other derris extractives, and arsenic, combined with specially prepared sulfur. Since the product contains arsenic, a known poisonous substance, due precautions with its use should be observed.

INJURY FROM DIPPING

Dipping often results in a slight set-back to the sheep. There may be a temporary shrinkage in weight or constitutional disturbances, or both. Various factors operate to produce these conditions. They may occur with any of the standard dips, but should not always be attributed to the effects of the dip alone. The age and physical condition of the sheep, the method of handling the flock at the vat as well as before and after dipping, the character of the water used, the method of preparing the dip, and various other factors should be considered before placing the blame on the dip. Young animals in a thriving condition recuperate very rapidly from any temporary ill effects; while old, weak, or emaciated animals succumb very readily and regain lost weight slowly. Injury caused by dipping is more likely to result from improper methods of dipping and handling than from the direct effects of the dip. Rough handling of sheep in the corrals and legging pens; dipping the flock immediately after a long, hard drive before they have rested and cooled off; dipping late in the afternoon when the nights are cold; keeping the sheep without feed and water for long periods before and after dipping; using dogs in the corral; and fighting stubborn sheep to get them into the chutes, are some of the contributing causes of injury. However, some of the dips if used in unsuitable water may cause injury, and any of them when used too strong will injure the sheep.

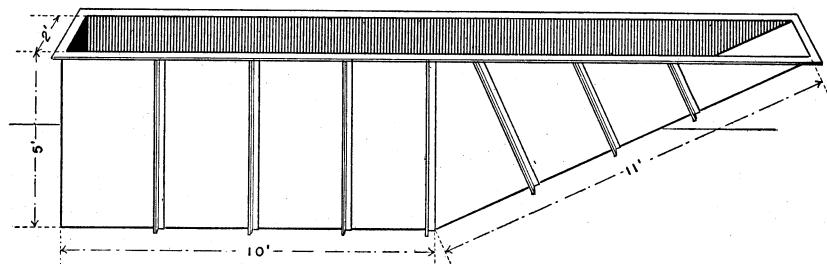


FIGURE 7.—Portable galvanized-iron sheep dipping vat.

The question often arises as to the proper age at which lambs should be dipped to get the best results and cause the least damage. It is perfectly safe to dip the flock when the lambs are not less than 1 month old, provided the lambs are dodged out and dipped separately. Any slight shrinkage caused at this time will be regained quickly and the lambs will grow and thrive much more rapidly after being freed of the irritation caused by the ticks. If the work is done properly and the sheep handled carefully, pregnant ewes may be dipped with safety at any time up to within 1 month of lambing.

DIPPING PLANTS

EQUIPMENT FOR SMALL FLOCKS

The farmer who has but a small flock to dip can use a portable galvanized-iron vat as shown in figure 7, turning a part of his barnyard or sheds into catch pens for temporary use. The portable galvanized-

iron dipping vats, called "hog vats," can be purchased ready-made and will answer the purpose very well for dipping small lots of farm sheep. They are sometimes set on the surface of the ground and the sheep lifted into them, but this method is not very satisfactory. An excavation should be made, the dimensions of which exceed slightly the outside dimensions of the vat, except the depth, which should be less, so that when the vat is set in the trench the top may extend about 6 inches above the surface of the ground. Approaches and draining and holding pens may be provided as desired.



FIGURE 8.—The canvas dipping bag in use.

A canvas dipping bag (fig. 8) is used sometimes when only a few sheep are to be dipped at different points in a given section, as it has the advantage of being easily transported. It is made of heavy canvas, known in the trade as No. 40, and is constructed as follows: Two strips of canvas 8 feet long and 26 inches wide are sewed together to form a bag 48 inches deep and 94 inches in circumference. Seams are triple sewed and top and corners reinforced with leather strips riveted on. Iron rings held by leather ears are riveted to the upper part of the bag as shown in the illustration. The bag is filled with dip, diluted as for use in a dipping vat, the sheep's feet are tied, and the animal is set down in the bag and held the required length of time.

A Permanent Dipping Plant

A permanent sheep-dipping plant is desirable equipment for conducting a sheep business. Such a plant should be so constructed that, if necessary, it can be used in dipping sheep for scab as well as for ticks and other parasites. For that reason the plan for a dipping plant shown in figure 13 includes cooking and settling tanks for limesulphur dip. Information on other types of dipping vats and on special problems will be furnished by the Bureau of Animal Industry on request.

Selecting a Location

In selecting a location for a dipping plant the fact that sheep work better upgrade should be considered and, if possible, the ground used for the receiving corrals and chute should slope up to the end of the vat. The vat itself should be on level ground and preferably extend north and south, with the entrance at the south and the exit at the north, as it has been observed that sheep work better also when not facing the sun. If the ground selected has good natural drainage, it is a point in favor of the location.

Corrals and Chutes

In constructing a dipping plant the arrangement of the corrals is important. The receiving corrals, into which the sheep are driven preparatory to dipping, as well as the holding corrals, into which they go from the draining pens, each should be large enough to hold a full band of sheep, or about 3,000 head. The receiving corral should be constructed so that there may be the least practicable number of corners or places in which the sheep may become jammed or "piled up."

In an effort to get out, a sheep will try to go back to the place where it entered the corral; therefore, if the entrance gate is near the vat the herd will tend to crowd toward the vat and thus save considerable work in getting them into the chute or catch pen. The corrals and chutes may be so arranged that a combination legging pen and running chute is provided. Sheep usually work well in a chute the first time they are dipped at a vat, but in the case of old ewes that have been dipped several times at the same vat it is often necessary to put them into the vat by hand. The location and arrangement of the chutes are sometimes changed from year to year so the sheep may not recognize them so readily. The running chute should be curved to

obstruct the view, and the side on which the men work should be tight-boarded. The usual height for the sides of the chute is 40 inches, and the width of the chute 18 to 22 inches, depending on the size of the sheep. Sheep work well uphill but not down an incline; the chutes and alleys, therefore, should be upgrade to the vat. If necessary, elevate the running chute so that it slants upward to the slide board. A small pen should be provided near the entrance to the vat and so arranged that the sheep may see it. This pen, known as a "decoy pen," is filled with sheep to induce the other members of the flock to work toward the vat more readily in their efforts to join those in the pen. The size and arrangement of the corrals will vary necessarily with the topography of the location and the individual ideas or tastes of the owner.

Draining Pens

When a sheep emerges from the vat it carries out a large quantity of dip in the fleece. Most of this dip drains out of the fleece very rapidly, and it is desirable that it be saved and returned to the vat. Draining pens with water-tight floors sloping toward the vat, therefore, should be provided. The size will depend upon the size of the plant and the number of sheep to be dipped. The relative size shown in the plan illustrated in figure 13 may be followed, increasing or decreasing the size of the pens to correspond to the length of the vat. There should be two draining pens, each having an opening into the holding corral. They may be made of lumber or cement and should have catch basins or screening and settling wells into which the dip drains so as to prevent manure and foreign matter from being carried into the vat. Drawings of screenings and settling wells will be found in figure 13. In constructing draining pens of cement it is advisable to build the outer walls in the same manner as the foundation for a house, except that they are to be 6 inches thick. The space inside these walls is then filled with gravel to the required height and the floor laid on it. Cement floors should have rough surfaces to prevent slipping. A coat of "pebble dash" over the cement floors will afford a suitable surface for the sheep to stand on, or the cement surface, while soft, may be roughened by means of a stiff broom. The floors of draining pens should slope so that the dip will drain away rapidly and not collect in pools from which the animals may drink.

Vats

The dipping vat may be constructed of either lumber or concrete, the concrete vat being preferable. The length of the vat may vary from 30 to 100 feet, depending on the number of sheep to be dipped. Public dipping vats, where from 50,000 to 100,000 sheep are dipped each season, should be 100 feet long. The depth should be 5 feet, width at bottom 8 inches and at top 2 feet. Sheep vats usually are constructed so that the top is flush with the top of the ground, and there should be no crosspieces to interfere with the free action of the sheep or of the men working along the vat. As a matter of individual taste, however, the top of the vat may extend from 9 to 18 inches above the ground. Those of the latter kind afford a better opportunity to handle the sheep and can be operated with less effort than those whose top is flush with the ground. If it is desired that

the top of the vat should be flush with the ground, it should first be built at least 4 inches above the natural surface of the ground and then dirt or gravel may be filled in, thus securing proper drainage along the sides.

Whenever it is possible to do so the gravity method of draining the old dip out of the vat should be adopted, as otherwise it is necessary to pump or dip it out each time the vat is cleaned. The end of the vat having the drain should be slightly lower than the other end so that all the liquid will drain off.

The slide board into the vat should be set at an angle of 45° and extend from the floor of the chute to at least 4 inches below the dip line; it should be made of or covered with a smooth-surfaced material, such as planed lumber or sheet metal. The end extending into the dip should be flush with the vertical end of the vat. A space between the slide board and the end of the vat, if large enough for a lamb to lodge in, is a dangerous arrangement. The runway leading out of the vat should not be too steep. The length varies from 8 to 16 feet, the latter being preferable in large vats.

CARE OF PLANT WHEN NOT IN USE

A dipping plant that does not receive proper care when not in use deteriorates very rapidly. The pressure of the ground against the sides of the vat tends to cause them to bulge inward; this tendency may be counteracted to some extent by keeping the vat full of liquid. Wooden vats which are allowed to stand empty will dry out and the lumber will shrink so that the vat will leak when refilled. At the close of dipping operations the vat should be left full of liquid and water added from time to time to restore that lost by evaporation.

A week or 10 days prior to beginning dipping operations the entire plant should be overhauled and put in good condition. Before charging a new vat or one which has stood empty for some time, it should be filled with water to ascertain whether it leaks.

CONSTRUCTION OF DIPPING PLANTS

A plan for construction of a concrete sheep-dipping plant is shown in figure 9. It is not drawn to a uniform scale; consequently in studying the drawing the scale of each part should be noted. The plant as shown has no superfluous equipment, and the arrangement is as simple as is consistent with efficiency. The size of the plant can be increased or decreased as desired. A corral, chute, and legging-pen arrangement is shown, and cross fences can be added to the corral as desired. Cutting chutes are shown in the plan, as every large dipping plant should have such a chute equipped with a dodge gate so the lambs may be cut out and dipped separately.

If permanent pipes are used for conducting water and dip to the vat they should be laid so as not to act as an obstacle to the men working along the vat. There should be no obstructions to the path along both sides of the vat. The pipes can be placed under the ground, or a portable V-shaped trough can be used for conducting liquids in to the vat and laid aside when not in use.

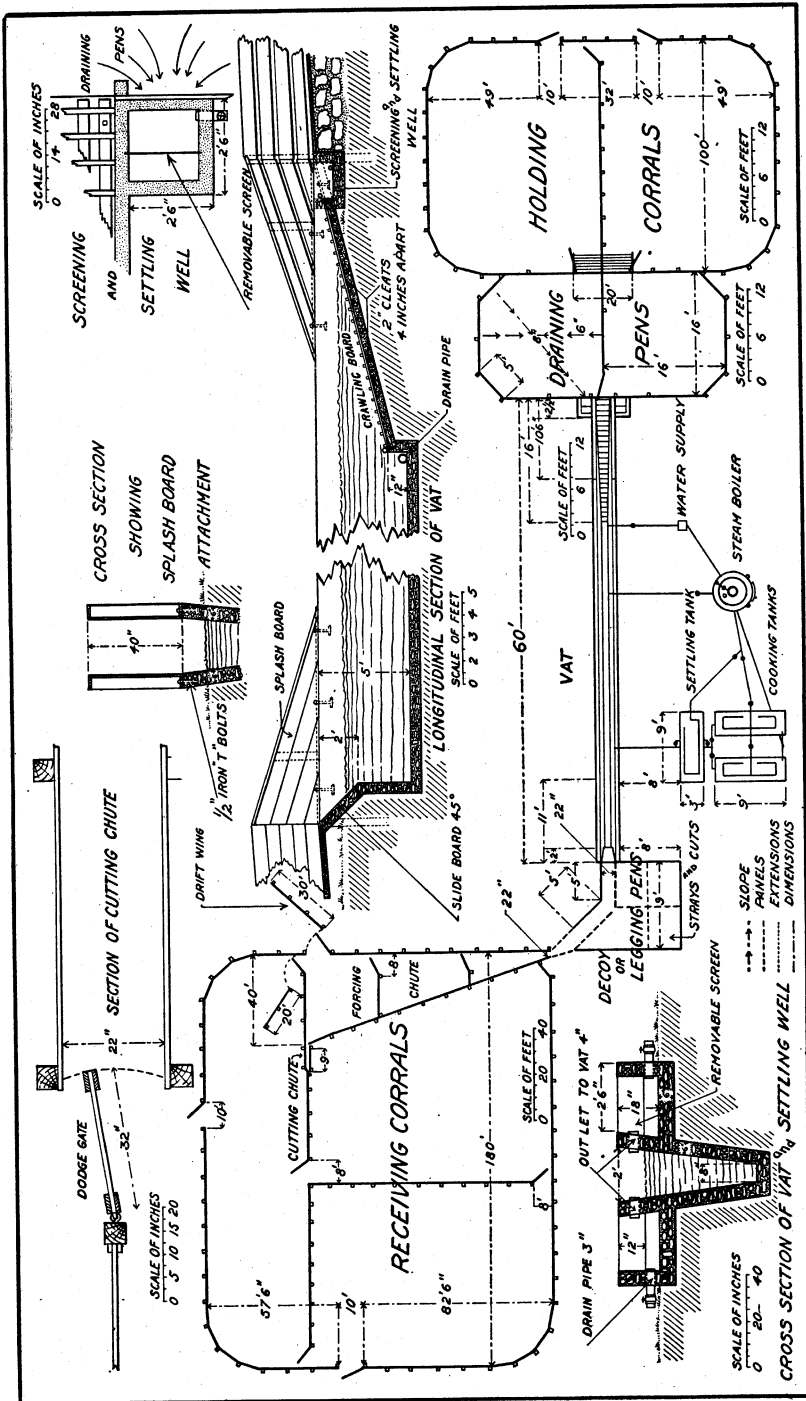


FIGURE 9.—Plan of sheep-dipping plant; concrete vat.

THE CONCRETE VAT

In the plan for the concrete plant (fig. 9) the corrals and chute are very conveniently arranged. The portable panels can be shifted to form either a running chute or a legging pen. The settling and screening wells shown also can be constructed as a part of any vat by changing the slope of the draining pens so the dip will run into the wells instead of down the runway. In making the forms for a draining well, the groove into which the removable screen is to sit should be provided for, as well as the 4-inch openings for drain and outlet pipes.

The trench for a concrete vat should be excavated so that the inside dimensions correspond to the outside dimensions of the vat when completed. If the sides of the trench are smooth and reasonably firm they can be used as the outer wall of the form, but in all cases where the vat is extended above the surface of the ground it is necessary to build forms extending from the surface of the ground to the top of the vat. If the soil is sandy it will be necessary to build outer forms, in which case the trench should be wide enough to allow for these forms. The drain and other pipes shown in the drawing should be placed in the form and should all be threaded and capped so that proper connections may be made. The $\frac{1}{2}$ -inch iron bolts and the iron pipe shown in the drawings should be embedded in the concrete of the incline for attaching the false floor or crawling board. The floor is made of 1- by 6-inch boards laid lengthwise with cross cleats as shown in drawings. The splashboards at the entrance end of the vat and the guides at the exit end are nailed to 2- by 4-inch scantling bolted to the concrete wall, and the bolts should be embedded when the wall is being constructed. Two pairs of bolts should also be embedded for attaching the slide board. Steam pipes should not be molded into the concrete walls, as the vibration of the pipes will crack the wall. They should pass over the top of the vat and down the side in a groove formed in the wall, so they will not come in contact with the sheep or cause annoyance to the men working along the vat.

The walls should be made 6 inches thick, constructed of concrete mixed in the proportion of 1 part cement, $2\frac{1}{2}$ parts sand, and 4 parts broken stone or gravel. The mixture should be placed in the forms as soon as the mixing is finished. To make a dense, water-tight wall, the concrete should be well settled into place by thorough tamping and spading. Leave the forms in place about 3 days, wetting the concrete daily. After the forms are removed, dampen the surface of the concrete and apply a finishing coat composed of 1 part of cement and two parts of screened sand, or mix cement and water to the consistency of cream and apply it, brushing well to form a smooth surface.

THE WOODEN VAT⁴

Two styles of framing are used in constructing a wooden vat. In the cedar-growing sections cedar-post frames are preferable because

⁴A plan for construction of a wooden vat is shown in Farmers' Bulletin 713, Sheep Scab.

they do not decay rapidly, while sawed white pine timbers do. Where hardwood is used instead of white pine the frame timbers need not be so heavy; 4 by 4 inches is heavy enough for framing in hardwood. The frames are set from $2\frac{1}{2}$ to 4 feet apart, depending on the character of the soil and the material used; $2\frac{1}{2}$ feet apart is a safe rule, as the closer the frames are to each other the less tendency there is for the sides of the vat to bulge in between the frames. Two-inch tongue-and-groove planks should be used in making the vat, and they should be beveled so all joints and seams may be properly calked with oakum or similar material.

If the open-tank heating system is used, it is not necessary to have settling wells, as the heating tank acts as a settling well. It has an advantage over the old-style coil-heating system in that the pipes are easily cleaned if they become clogged. A water trap should be provided for in the exit end of the vat with a bridge to fit into the trap while dipping is being done. When dipping operations are finished for the day the bridge should be removed and the valves of the drainpipes opened so water from the draining pens may not run into the vat.

