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KENYA

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" SHEEP SCAB : REMEDIAL MEASURES REVIEWED "

BY

DR. E. A. LEWIS

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The Colonial Secretary of the Colony and Protectorate of Kenya presents his compliments to the Under Secretary of State for the Colonies, and has the honour to transmit six copies of a paper prepared by Dr. H.A. Lewis, Veterinary Entomologist, on the subject of "Sheep Scab: Remedial Measures Reviewed".

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SHEEP SCAB: REMEDIAL MEASURES REVIEWED.

BY

E. ANEURIN LEWIS, B.Sc. (Agric.), M.Sc., Ph.D.,
Veterinary Research Laboratory, Kabete, Kenya Colony.

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SHEEP SCAB: REMEDIAL MEASURES REVIEWED.

By E. ANEURIN LEWIS, B.Sc. (Agric.), M.Sc., Ph.D.,
Veterinary Research Laboratory, Kabete, Kenya Colony.

(PLATE II.)

Sheep scab has existed from early times. It was known to the ancient Greeks and Romans. It was familiar to the Hebrews, and writers on agriculture in the Middle Ages were acquainted with its ravages, and suggested means of preventing and curing it. Laws to control the disease were introduced in Britain at the beginning of the eleventh century, and subsequently other countries also adopted legislative measures against it. Regulations have been renewed and amended from time to time to conform with the progress made in the studies of the disease and its cause. The strictness with which they are applied vary in accordance with the economic importance of the sheep industry in any particular country, and their success as preventive measures is dependent upon their stringency and upon the co-operative support given to them by all sheep-owners.

Sheep scab is a disease which in many countries continues to cause much anxiety to the majority of flock-owners. There are, however, certain farmers who regard it as something to be accepted and suffered as chronic and incurable, and consequently to be put up with; they practise the formality of dipping in order to conform with the law, and perhaps to ensure a fair crop of wool. It must also be stated that a vast amount of literature has been published on the various aspects of sheep-scab control and eradication, much of which is confusing to the layman who has neither the time nor the training to enable him to search the literature. Only a small proportion of the mass of literature has been available to the writer, and from a perusal of this it appears that there are differences of opinion on policies of control, apparent discrepancies in the recommendations on treatment, and what would seem to be inconsistencies to the farmer anxious to adopt the best methods practicable under his particular conditions. Many publications dealing in general with the disease and its control omit the important details essential to the practical farmer. Not infrequently authors content themselves with repeating the advice of others without verifying or extending the observations made, and applying them to local conditions.

The scab mite lives on the skin of sheep, and may be found in the wool in cases of heavy infestation. It is usually spread from sheep to sheep by direct contact. Sometimes it may be transferred to healthy animals if they are kept in an enclosure recently occupied and contaminated by scabby sheep. There is nothing to support the old belief that the disease appears by spontaneous generation when the sheep are in poor condition; but there is some evidence indicating that the mites on untreated sheep tend to disappear at certain periods of the year, or during some phase of the disease, only to reappear later in many cases. The difficulty experienced in finding live mites during certain periods is suggestive of a latent or relatively inactive stage in the life of the mite—a difficulty which may mislead casual inspection or deceive even the careful diagnostician. It will be shown later that there are certain sites favoured by the mites; these should be searched when parasites appear to be absent from other parts of the body.

It is generally accepted that the mites can be destroyed, and the disease cured, by the application of parasiticides in the form of dips or baths, and dressings. It is acknowledged that proper treatment involves repeated applications within specified periods, and that the preparations used must penetrate the wool and come into contact

with the parasite. The interval between any two dippings has been determined by studies on the life-cycle of the mite. It has been shown that the eggs may survive the first dipping and hatch out to form a new generation. A second treatment is therefore necessary to ensure that this new generation does not develop and deposit eggs. The principle of double-dipping within the prescribed period has been accepted as sufficient to control the disease. Theoretically this is, no doubt, sound; from a practical point of view a third dipping is sometimes advisable, especially where the previous dippings have been hurriedly done or when infestation is heavy and crusty layers of scabs have been left unbroken.

The legal provisions for the control of sheep scab are fundamentally similar in most countries. In Britain, it is a notifiable disease. The execution and enforcement of the regulations appertaining to affected animals are vested in the local authorities acting under the guidance of the Minister concerned. The policy of isolation of scab-infested sheep, their detention and enforced dipping is governed by law when necessary; and inspectors are appointed to advise and assist in the control of disease. Movements of diseased sheep are restricted, and the importation of such animals regulated. The laws also help the farmer with advice on the preparation of suitable and effective dips against sheep scab; they control proprietary sheep-dips by approving only those which, on analysis, satisfy the official chemical criteria that they are of the recognised standard strength. A proprietary dip must be labelled with a statement that it has been approved by the Minister and giving the directions for the dilutions to be used. The law also includes clauses on the cleansing and disinfection of places and things used for, and which have been contaminated by, infested sheep. The rules and regulations however, are often explained and amplified by less ambiguous advisory leaflets made available to those seeking information.

The situation with regard to scab in Britain is that outbreaks have been reduced to a comparatively small figure though there are fluctuations. It is most prevalent in, though not always confined to, the thinly populated mountainous and moorland districts where the flocks range over wide unfenced areas, and where a complete gathering of sheep for examination and proper treatment is difficult to achieve. What may be the reluctance of Government to interfere unnecessarily with the enterprise of other industries, and the difficulties of fencing and of sheep control on the part of farmers, no doubt account for the persistence of sheep-scab in the island of Britain.

Australia and New Zealand present a different picture. The sheep industry constituted their principal economic feature, and sheep scab threatened to ruin the source of livelihood of the colonists. Legislation was introduced early in the nineteenth century, and, apparently, the flock-owners made determined efforts to eliminate the disease. The policy was similar to that adopted in Britain; it was more rigidly enforced in every direction and rigorously applied for many years. The States were divided into a number of districts, each of which was in charge of an inspector who was authorised to inspect, seize, detain, and if necessary, resort to the treatment of sheep at the owner's expense. Severe penalties were provided for any person obstructing the inspector or refusing to give information as to the origin of any sheep, or refusing to carry out instructions regarding disinfection of vehicles, etc., or dipping of sheep. Owners of scab-infested sheep were required to warn people of the existence of the disease, to brand diseased sheep and to prevent movement. Quarantines were enforced, and heavy penalties, including imprisonment, were imposed on persons removing sheep from those quarantines.

The methods were bold and drastic, but thoroughly effective. The history of the campaigns in both Australia and New Zealand is most interesting. In 1864, Queensland was free from scab; in 1868 the disease had been eradicated from New South Wales; in 1871, South Australia was clean; in 1876 and 1879, Victoria and

Tasmania respectively were declared free; and in 1898, when the disease was eradicated from Western Australia, sheep scab was finally extirpated from all Australia. New Zealand cleaned its last infested flock about 1885; the last certificate, however, was not issued until 1890.

In the United States of America, sheep scab was formerly widely distributed; it was the greatest pest that sheep farmers had to contend with. The regulation to prevent the spread of scabies in sheep prohibits the "picking" of a flock or the removal of any visibly diseased animal and then offering any portion of the remaining flocks for inspection or movement. Vehicles of transport for diseased sheep must be prominently placarded. Segregation and quarantine are enforced, and provisions are made for compulsory dipping. An organized system of inspection and supervision is in force; and other conditions analogous to those in the English Sheep Scab Order¹ are incorporated in the regulations. Trading interests, however, are treated as subsidiary to administrative control. Considerable reduction has been effected in the incidence of the disease, which has nearly been cleared out of the greater part of the Western States. At present, it is largely a matter of cleaning up relatively small infections in the range areas of Louisiana, Arkansas, Missouri, Iowa and Minnesota, and in scattered portions of the mid-western States.

Canada appears to be in the happy position of having eradicated sheep scab. The "Regulations relating to Sheep Scab"² are short but comprehensive, and include the rule that no sheep or any wool or other portion or product thereof shall be removed out of any place declared to be an infested place without a licence signed by an inspector. Inspectors may order scab-infested sheep to be collected, detained, isolated, dipped or otherwise dealt with, as may to them appear advisable; and they may order that no sheep shall be allowed access to any field, common yard, stable, or other place or premises where sheep scab exists or has existed. Compensation is paid only in cases of authorised slaughter of scabby sheep.

The Union of South Africa, which has made a substantial and rapid advance among the sheep-raising countries, has made similar strides in the reduction of scab outbreaks. The total number of outbreaks for the six provinces has been reduced from 2,250 in 1926-27 to 424 in 1933-34. The heaviest infection is reported from the Cape Province, which is subject to severe drought conditions, and stock have to be moved far afield for grazing. The Orange Free State is practically free from sheep scab. In the scab regulations³ scab means a disease in the case of sheep caused by mites known as *Sarcoptes scabiei* var. *ovis* and *Psoroptes communis* var. *ovis*, and in the case of goats by the mite known as *Sarcoptes scabiei* var. *caprae*, *Psoroptes communis* var. *caprae* and *Chorioptes (Symbiotes) communis* var. *caprae*. Areas are scheduled as native areas, isolation areas, protected areas, and semi-protected areas. Veterinary inspection, compulsory dipping, restricted movements of sheep, cleansing of premises, etc., used by infested sheep are provided for. Compensation may be paid for sheep lost as a direct result of dipping under official supervision.

Basutoland illustrates a courageous effort to cope with the disease among native-owned flocks. In 1923 it was estimated that approximately 50 per cent. of the flocks were infested with scab. In 1926 there were about 2 million sheep in the territory, a large proportion of these being Merinos, the most valuable possession of the Basutos. In spite of the altitude (7,000 to 11,000 ft.) of the best sheep country and the difficulties of transporting material for the construction of dipping tanks, a policy of compulsory simultaneous dipping reduced infection so that in 1934 no outbreaks were reported. In the "Rules for the Prevention of Scab"⁴ the sarcoptic, psoroptic and symbiotic parasites of sheep and goats are included as causal organisms of the disease. Inspectors—European and Native (as dip supervisors)—are engaged in a campaign of control. Sheep may be branded according to the area of origin, and all infested sheep must be marked. Movements from one area to another are controlled. No infested flocks in tanked areas are allowed to move until they have passed through three dippings.

It is hardly necessary to outline the legislation concerning scab in all sheep-raising countries; and it is clear that the liberty of the farmer is not interfered with so long as he deals efficiently with the disease in the course of his ordinary routine on the farm.

Diagnosis.

The detection of scab in its early stages is extremely important; it enables the farmer to arrest its spread before extensive damage is done and reduces the amount of labour and difficulties in treatment. The absence of clinical symptoms even in the case of woolled sheep renders early detection and diagnosis difficult, and demands considerable experience and powers of observation. In well-established cases detection is comparatively easy, except, perhaps, in the fine-woolled breeds, in which the mites lurk in the heavy folds. In non-woolled sheep lesions are not easily discernible, and such animals may maintain and spread infection.

Frequent and regular inspection of flocks is essential therefore; and if any animals show symptoms of the disease, a closer examination may reveal live parasites. Then treatment of all sheep which have been, or are suspected to have been, in contact with that animal or flock should be resorted to without delay.

Farmers with large flocks and good shepherds look upon scab as a serious menace, and deal with it accordingly; but those with small flocks (possibly a dozen or more to provide meat for the table) are apt to ignore the existence of the disease among their sheep, or consider it as trifling, and neglect treatment. There are some, also, possessing large and numerous flocks who do not insist on periodic inspection of the sheep; or when the flocks are gathered for this purpose regard the straying of a few sheep as unimportant, not realising that those stray sheep may harbour the parasite and form a nucleus for re-infection of the flock.

It is obvious that no reasonable system of official inspection can be as effective in locating infective sources as the diligence of the farmer himself, on whom falls the onus of early diagnosis. In this connection the policy of table inspection adopted in the Basutoland campaign of eradication is noteworthy. In order to determine whether a flock is clean or otherwise, every sheep is caught and placed upon a table for thorough examination.

Hand-dressing.

The complete immersion of sheep in a dipping fluid is the customary remedy for scab. In chronic cases, however, layers of hard crusts or scabs prevent the penetration of the liquid to the mites which are often secreted beneath. These scabs must be broken up with a light curry-comb or an old maize cob, and hand-dressed prior to dipping. The hindquarters may be fouled with faeces, which should be removed. There are other sites favoured by the mites which demand careful attention and treatment; they are the inside of the ear, the lachrymal or infra-orbital pouches—the pits or cavities below the eyes; the bases of the horns, the perineum, the prepuce of the rams, and the wrinkled scrotum of the castrated male or wether.

Compounds recommended as hand-dressings include a mixture of fuel oil and sulphur; two parts of Stockholm tar, two parts of oil, and one part of turpentine; a mixture of two parts of linseed oil and one part of paraffin; solutions of the dipping fluid at normal or double strength of the bath dilution; and in some instances tobacco extract in oily or greasy media.

As dipping in an aqueous solution is usually carried out soon after hand-dressing, it is better to confine the use of oily mixtures to the ear cavities and the lachrymal pouches, as these mixtures tend to hinder the uniform penetration of the dip through the fleece. A short, stiff-bristled brush is useful for cleaning the glandular lachrymal pouches, and a slightly longer brush is convenient for dressing the deeper cavities of the ears.

Hand-dressing the visibly affected lesions is not in itself effective as a cure. The South African regulations provide for the prohibition of the hand-dressing of sheep in lieu of dipping. An American bulletin⁶ on sheep scab states that hand-dressing or "spot-doctoring" acts as a palliative and tends temporarily to check the disease, but will not cure scab. It adds that in many cases it is responsible for spreading the disease, for the reason that the sheepman too often depends on this method to effect a cure.

It should not be necessary to point out that the use of a poisonous solution or mixture in hand-dressing should be followed by careful washing of the hands, especially where natives are employed; and that in using lime-sulphur dressings the hands should be well smeared with oil or grease to avoid severe blistering of the skin.

Counting and Marking.

There is no doubt that the counting of sheep at a gathering of the flocks has many advantages; it acts as a check on the number in the stockbook or register, and is a means of accounting for any losses from death or straying. The shepherd may be able to make a further search for stray sheep, and to ensure that no animal is omitted from the treatment to be given in the case of an outbreak of sheep scab. Strange sheep may be present and by enquiry their origin may be ascertained; and it may be possible to trace the source of infection.

When hand-dressing is being carried out, comparatively little additional labour is involved in marking those which have been examined and treated; and this enables the farmer to identify at a glance any animal which may have joined the flocks after hand-dressing, or which may have escaped attention.

It is needless to emphasize that unmarked sheep in the flock should receive treatment whether they belong to the farmer or not.

Dipping Tanks or Vats.

There are several types of dipping tanks, vats or baths, in common use; they vary in size, form and construction according to the requirements and taste of the owner. When there is only a small number of sheep to be dipped, a portable canvas bag may be used. A sheep may be lifted into this, and held in the liquid for the required length of time, and then taken out to the draining floor. It is a laborious and troublesome method, however, and suitable only when six or a dozen sheep exist on the farm.

The simple galvanized iron portable tank is convenient for a flock of a few hundred sheep. Each sheep must be handled and raised into this tank; but it is possible to treat many sheep in a day by this method. It has advantages in that it requires little fluid, and the cost is low. The drawbacks are the amount of labour involved in immersing the sheep and the need of holding them for the full period of immersion. In some cases the animals have to be turned on the back and held in the dip—care being taken that the head is held above the surface. The restlessness and splashing of the sheep is not pleasant; and in some cases dangerous to the operator and to the sheep.

The cage bath appears to be less popular. It consists of a galvanized tank sunk in the ground. In this, a cage is raised and lowered by a windlass. One sheep at a time walks into the cage, and is lowered into the bath. In due course, it is raised, and the sheep passes on to the draining yard. Handling is reduced by this method, labour is made easier, and risks are reduced to a minimum.

For large flocks, and where dipping is practised as a routine, it is necessary to provide permanent tanks. The initial cost is greater but is compensated by the saving in labour, and the efficiency in dipping large numbers of sheep. These large

tanks may be constructed in stone and concrete, or in wood. Obviously the former is the more permanent. There are two types—the straight-run swimming tank and the circular (with or without a central island). Both of these permit the sheep to swim in the dipping solution, and continual movement assists penetration of the dip and the thorough soaking of the fleece.

The circular tank seems to have certain advantages over the straight-run tank. In the latter it is often difficult to avoid crushing at the outlet; the animals have to be turned-over frequently and kept moving. When turning there is a tendency for the hooves of one or other of the legs to cut or graze the other and cause bleeding and possibly poisoning. Drowning sometimes occurs when too many sheep are put in at a time; and injuries are not infrequently caused by rough-handling. The straight-run type requires a larger number of attendants than the circular, the use of which reduces labour and difficulties of handling to a minimum. With the circular dip the sheep are allowed to swim more freely and do not become fatigued by rough handling.

It has been estimated that in order to allow a sheep to swim for two minutes in a straight-run tank without turning, the tank should be about forty yards long; in a circular tank, it is merely a question of going round repeatedly until the time is up.

Permanent dipping tanks deteriorate if not given proper attention when not in use. They should be kept full of water to avoid cracking, and before dipping operations it would be well to test for leaks and overhaul if necessary. The pressure of the ground against the sides of an empty tank tends to cause them to bulge inwards; and when these sides are of cement or concrete they crack very badly.

Dips and Dipping.

The active ingredients which are most commonly employed in the manufacture of dips are arsenic, tar acids, sulphur, tobacco or nicotine. Sulphur may be mixed with arsenic or calcic compounds, tobacco or caustic soda. In practically all countries provision is made for the guidance of the farmer with regard to the proper strength and percentage of the active ingredients in all products for dipping against scab, and prescriptions are given to enable the farmer to prepare his own dip when he so requires.

In Britain lime-sulphur dips must contain not less than 1 per cent. sulphur sulphide, which may be obtained by using not less than 18 lb. sulphur with 9 lb. good lime for 100 gallons. The Australian prescription for lime-sulphur is equivalent to about 33 lb. sulphur and 11 lb. lime to every 100 gallons of dip, the New Zealand mixtures consists of 25 lb. sulphur and 12½ lb. lime to a 100 gallons of water, the American regulations stipulate that a lime-sulphur bath must at all times be maintained at a strength of not less than 1½ per cent. of sulphur sulphide, and the preparation should be made up of 24 lb. flowers of sulphur or sulphur flour, 8 lb. unslaked (or 11 lb. commercial hydrated, not air-slaked) lime to 100 gallons of water. In South Africa approved lime-sulphur is prepared from 25 lb. sulphur mixed with 15 lb. unslaked lime (or 20 lb. slaked lime) to every 100 gallons of fluid. This, along with commercial lime-sulphur or soda-sulphur concentrates sold under directions, must contain when diluted for tank use a strength corresponding to not less than 1.5 per cent. sulphur sulphide.

According to regulations in Britain, nicotine dips must contain not less than 0.1 per cent. nicotine; in America and South Africa a dip strength of not less than 0.05 per cent. of nicotine must be maintained.

Tobacco, nicotine or nicotine and sulphur dips may be prepared in several ways. The proportions and instructions in the preparations of these in different countries are:—

England.

Tobacco and sulphur.—Steep 35 lb. of finely-ground tobacco (offal tobacco) in 21 gallons of water for four days. Strain off liquid, and remove the last portions of the extract by pressing the residual tobacco. Mix the whole extract, and to it add 10 lb. of flowers of sulphur. Stir the mixture well to secure an even admixture, and make up the total bulk to 100 gallons with water.

Australia.

Tobacco and sulphur.—Infuse good leaf tobacco in 100 gallons of water, which has been brought to the boil. Cover the utensil used to prevent the escape of steam which might carry off with it some of the active, curative properties of the tobacco; draw off the infusion and add fresh water to the tobacco until extraction is complete. The amount of tobacco used should be less than 20 lb. to 100 gallons of water. To the liquid extracted add, and mix thoroughly, 20 lb. of sulphur.

America.

Nicotine and sulphur.—The formula for this dip is given as four-tenths of a pound of nicotine, 16 lb. flowers of sulphur, 96 gallons of water. This mixture contains not less than 0.05 per cent. nicotine and 2 per cent. sulphur. In this case 1 lb. of a 40 per cent. solution of nicotine would suffice for 96 gallons of water.

There appears to be no formula for a home-made tobacco or nicotine dip recommended in South African publications on sheep scab and its treatment. Tobacco and sulphur dips were used for scab control in New Zealand and were apparently successful.

A prescription containing carbolic acid and soft soap is officially approved by the Ministry of Agriculture and Fisheries in England. It may be prepared by dissolving 5 lb. of good soft soap, with gentle warming, in 3 quarts of liquid carbolic acid (containing not less than 97 per cent. of real tar acid). Mix the liquid with enough water to make 100 gallons.

A tar dip must contain not less than 0.76 per cent. of total tar products, of which not less than 0.36 per cent. shall be tar acids.

A caustic soda and sulphur dip may be made by mixing 20 lb. of sulphur into a thin cream with not more than 2½ gallons of hot water and sprinkle into this 5 lb. of caustic soda with constant stirring. After 40 minutes the resulting mixture is poured into 100 gallons of water for tank use.

With regard to home-made lime sulphur dip it is agreed that the lime should be thoroughly slaked and free from hard lumps. The finely powdered lime should be mixed with the appropriate portion of finely ground sulphur or "flowers of sulphur" to make a thick, homogeneous paste with three or four gallons of water. The paste is then transferred to a vessel containing boiling water and boiled for a time. The prescription given in the leaflet issued by the Ministry of Agriculture and Fisheries recommends placing the mixture or paste in a strong cloth, tying the ends and suspending in a boiler containing 10 gallons of water so that the water completely covers the contents of the cloth. The cloth must not touch the sides or bottom of the boiler, as otherwise the cloth may be burnt and its contents escape. The boiling should continue for two hours, when the cloth should be removed, taking care that none of its contents escape into the water. The solids can then be thrown away. The liquor in the boiling utensil should now be made up to 10 gallons with additional water, and poured into a tight drum or barrel. This quantity is sufficient when mixed with water to make a 100 gallons of dip.

According to the South African recommendation, the well-mixed paste is thrown into a pot containing 25 to 30 gallons of boiling water and boiled for 30 to 40 minutes. The contents of the boiling-pot are transferred to a barrel, and after allowing the sediment to settle the clear fluid is run off into a dipping tank from a bung-hole four

inches from the bottom of the barrel. One hundred gallons of water are then added to bring to tank strength.

The quantity of water used with the paste for boiling is of importance, in so far that a small quantity of water affects the solution of lime, and the proportion of sediment, when the paste is not contained in a bag or cloth, is proportionately greater. If the paste is not covered, the boiling mixture can frequently be stirred to prevent the paste from setting and caking on the bottom of the vessel, and to assist the combination of the ingredients. When the mixture can be stirred in this manner, it would appear unnecessary to boil for more than forty minutes, but if it is held in a bag the period of boiling must be extended to two hours. It is interesting to note, however, that the American Bulletin recommends boiling the loose paste in thirty gallons of water for two hours, frequently stirring the mixture.

The final liquor should be of a chocolate or dark-amber colour and should not contain any sediment, as this will injure the wool and the eyes of sheep.

Special mining and sedimenting tanks can be constructed for dip-making, or the farmer may choose one or other of the more simple methods quoted above.

The home manufacture of tobacco and sulphur dip seems to be a lengthy and tedious process, hardly practicable to the ordinary farmer. The nicotine and sulphur dip is a more convenient mixture. The nicotine solution and the sulphur should be mixed together with water before adding them to the water in the dipping tank, and it will be borne in mind that the dip should be heated.

These are the usual home-made dips, and many more proprietary makes are available to the farmer. There has been some controversy as to the relative values and efficiency of the home-made brands and proprietary products. It is not proposed to enter into this dispute. It will suffice to state that there is, for the farmer, a wide range of choice from home-made and proprietary dips which have proved effective in destroying the scab parasite. The cost of a dip will naturally affect the farmer's choice, but while it requires consideration there are other matters also to be taken into account. A product when diluted according to instructions should prove destructive to the parasite; it should also serve as a protection against reinfection to some extent, and to kill the larvae which might emerge from the eggs. With reasonable and proper care in its preparation and use, the dip should be safe to the labourers and to the sheep. The solubility of the concentrate is an important factor, as is also its penetrative qualities. It is obviously more desirable from a practical point of view that a dip be effective when used in a normal cold solution. Heating apparatus increases the costs of dipping operations. The dip should not discolour or affect the value of the wool. The portability of the concentrate or of the ingredients needs consideration where transport is difficult or costly. The question of labour, especially with home-made products, must be taken into account in estimating the costs involved. The quality of the ingredients must also receive attention as will be seen later in this article.

Experiments carried on under the direction of the Sheep-Dipping Committee in England in 1904⁷ demonstrated that lime-sulphur, arsenic and sulphur, carbolic dips, tobacco and sulphur, and others, were quite effective against the scab-parasite, and did not deteriorate the quality of the wool further than to discolour it to some extent. Since that period the preparation of dips has improved; the amount and proportion of ingredients in concentrates have been adjusted, and dilutions carefully studied and established so that, consonant with scab-curing properties, their injurious effect is practically negligible when administered properly.

In a pamphlet⁸ on Sheep Scab issued by the British Ministry of Agriculture and Fisheries, prescriptions for three home-made dips are given, and it is explained that the Ministry has not included in their Schedule any preparation containing arsenic. "It is not to be assumed, however, from this omission that the Ministry does not

concur in the view that arsenical dips are thoroughly effective against sheep scab. There is a possible danger to human beings, attendant upon the preparation of such dips, which renders it advisable that the dips should be compounded by qualified persons only. It is also important to note that a certain amount of risk may be incurred by dipping sheep twice, with a short interval, in a poisonous dip, and that when a poisonous dip is used for the first dipping, it is much safer that a non-poisonous preparation should be used for the second." The prohibition of the use, for the second dipping, of a dip containing arsenic in the Sheep Scab Order of 1922 was revoked in the Sheep Scab (Amendment) Order of 1929 (4634)⁹, and it appears that owing to pressure by the National Farmers' Union, the Ministry has recently waived its prohibitions of arsenic on the understanding that no liability be incurred unless the instructions on the labels of sheep dip containers are strictly followed. In addition, the Ministry recommends that for the second dipping, half the prescribed strength be used, and it accepts this practice as conforming to the Order.

In Basutoland, a proprietary brand of arsenical and sulphur dip was used at full strength instead of half-strength for the second dipping. No untoward effects were experienced, and it was stated¹⁰ that "in practice where one employs a native staff this is an advantage, though of course it is not so cheap."

Arsenic, nicotine and cresol dips are used against sheep scab on the continent of Europe, the first being generally used in France, and the last most popular, apparently, in Germany. The use of arsenic dips is sometimes followed by poisoning, especially if the skin suffers injury during shearing; it is for this reason that they were displaced in some countries by other dips. In Prussia several cases of poisoning were observed as a result of dipping sheep in creolin dips, and it is stated in the American bulletin⁵ on "Sheep Scab" that "it is dangerous to dip sheep in some of the dipping preparations, especially lime-and-sulphur, if there are any fresh wounds on the animal." In America, it is the opinion of the authorities that the dangers inherent in arsenical dips should restrict their use to fields where, as in the eradication of cattle ticks, no safer dip is practicable.

In South Africa "losses have occasionally been encountered, especially in sheep and goats, after dipping in the so-called 'phenolic' or 'tar-product' dips."¹¹ On the other hand, the present satisfactory situation with regard to sheep scab in Basutoland is largely, if not entirely, due to a proprietary brand of arsenic and sulphur dip.

In England, dipping products are officially approved on the basis of chemical analysis, the number of approved dips being approximately 300¹²; the chemical works of nearly all provincial towns appear to produce dips. In the United States of America, dips permitted for use in official dippings are restricted to specific compounds of lime-and-sulphur and nicotine mixtures. Proprietary brands of both types may be used in official dipping only after specific permission has been issued by the Bureau. The regulations state that "No dip other than the lime-and-sulphur or the nicotine dip will hereafter be given department permission for use in official dipping of sheep for scabies, unless it has been shown to the satisfaction of the Bureau (1) that the strength of the bath prepared therefrom may be satisfactorily determined in the held by a practical, portable testing outfit; (2) that under actual field conditions the dipping of sheep in a bath of definite strength will effectually eradicate scabies infection without injury to the animals dipped."

In South Africa, the approved dips which have been sanctioned for the dipping of infected sheep under official supervision comprise home-made and certain registered proprietary brands of lime-sulphur which give a tank strength of 1.5 per cent. sulphide sulphur, tobacco extracts and nicotine products (which when diluted contain not less than 0.05 per cent. nicotine)—about 5 in number; two (with a third recently registered) powdered forms of arsenic-sulphur dips, three phenolic and tar distillate dips; and two containing other active ingredients.¹¹

inches from the bottom of the barrel. One hundred gallons of water are then added to bring to tank strength.

The quantity of water used with the paste for boiling is of importance, in so far that a small quantity of water affects the solution of lime, and the proportion of sediment, when the paste is not contained in a bag or cloth, is proportionately greater. If the paste is not covered, the boiling mixture can frequently be stirred to prevent the paste from settling and caking on the bottom of the vessel, and to assist the combination of the ingredients. When the mixture can be stirred in this manner, it would appear unnecessary to boil for more than forty minutes. But if it is held in a bag the period of boiling must be extended to two hours. It is interesting to note, however, that the American Bulletin recommends boiling the loose paste in thirty gallons of water for two hours, frequently stirring the mixture.

The final liquor should be of a chocolate or dark-amber colour, and should not contain any sediment, as this will injure the wool and the eyes of sheep.

Special mixing and sedimenting tanks can be constructed for dip-making; or the farmer may choose one or other of the more simple methods quoted above.

The home manufacture of tobacco and sulphur dip seems to be a lengthy and tedious process, hardly practicable to the ordinary farmer. The nicotine and sulphur dip is a more convenient mixture. The nicotine solution and the sulphur should be mixed together with water before adding them to the water in the dipping tank, and it will be borne in mind that the dip should be heated.

These are the usual home-made dips, and many more proprietary makes are available to the farmer. There has been some controversy as to the relative values and efficiency of the home-made brands and proprietary products. It is not proposed to enter into this dispute. It will suffice to state that there is, for the farmer, a wide range of choice from home-made and proprietary dips which have proved effective in destroying the scab parasite. The cost of a dip will naturally affect the farmer's choice, but while it requires consideration there are other matters also to be taken into account. A product when diluted according to instructions should prove destructive to the parasite; it should also serve as a protection against re-infection to some extent, and to kill the larvae which might emerge from the eggs. With reasonable and proper care in its preparation and use, the dip should be safe to the labourers and to the sheep. The solubility of the concentrate is an important factor, as is also its penetrative qualities. It is obviously more desirable from a practical point of view that a dip be effective when used in a normal cold solution. Heating apparatus increases the costs of dipping operations. The dip should not discolour or affect the value of the wool. The portability of the concentrate or of the ingredients needs consideration where transport is difficult or costly. The question of labour, especially with home-made products, must be taken into account in estimating the costs involved. The quality of the ingredients must also receive attention as will be seen later in this article.

Experiments carried on under the direction of the Sheep-Dipping Committee in England in 1904⁷ demonstrated that lime-sulphur, arsenic and sulphur, carbolic dips, tobacco and sulphur, and others, were quite effective against the scab-parasite, and did not deteriorate the quality of the wool further than to discolour it to some extent. Since that period the preparation of dips has improved, the amount and proportion of ingredients in concentrates have been adjusted, and dilutions carefully studied and established so that, consonant with scab-curing properties, their injurious effect is practically negligible when administered properly.

In a pamphlet⁸ on Sheep Scab issued by the British Ministry of Agriculture and Fisheries, prescriptions for three home-made dips are given, and it is explained that the Ministry has not included in their Schedule any preparation containing arsenic. "It is not to be assumed, however, from this omission that the Ministry does not

concur in the view that arsenical dips are thoroughly effective against sheep scab. There is a possible danger to human beings, attendant upon the preparation of such dips, which renders it advisable that the dips should be compounded by qualified persons only. It is also important to note that a certain amount of risk may be incurred by dipping sheep twice, with a short interval, in a poisonous dip, and that when a poisonous dip is used for the first dipping, it is much safer that a non-poisonous preparation should be used for the second." The prohibition of the use, for the second dipping, of a dip containing arsenic in the Sheep Scab Order of 1928 was revoked in the Sheep Scab (Amendment) Order of 1928 (4634)⁹, and it appears that owing to pressure by the National Farmers' Union, the Ministry has recently waived its prohibitions of arsenic on the understanding that no liability be incurred unless the instructions on the labels of sheep dip containers are strictly followed. In addition the Ministry recommends that for the second dipping, half the prescribed strength be used, and it accepts this practice as conforming to the Order.

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The protection afforded against scab-infection by certain dips is shown in the experiments carried out by Bedford in South Africa (1915).¹³ A diagram illustrating his results shows that lime-and-sulphur gave protection for just less than 5 days; some brands of tobacco dips protected the sheep for a shorter period, while one was effective for a little over 5 days; another dip containing other ingredients prevented re-infection for about 11 days; and two arsenic-sulphur dips provided protection for about 14 and 16 days respectively.

To quote an American authority⁵: "The dip that is left in the wool after dipping will often serve for a limited period of time, as a preventive against re-infection. The length of this period of protection varies with the climatic conditions and the kind of dip used. If sheep are exposed to frequent, heavy rains after dipping, much of the dip will be washed out of the fleece. A dip containing sulphur acts as the best preventive against re-infection. Under average conditions such a dip will probably afford protection for a period of from 30 to 60 days and, under favourable conditions, for a much longer time."

According to Verney,¹⁰ Green & Bedford report most favourably on nearly all the dips on the market, but as a prophylactic the arsenical dips appear to be the best.

In preparing the concentrate of a home-made type of dip it is not sufficient to guess the weight of the ingredients or the measure of liquid. All must be done with accuracy and care. It would be reasonable to ask—say in the case of lime-sulphur—which of the formulae quoted above should be adopted for dipping purposes. The proportions used in the English and New Zealand prescriptions is 1 of lime and 2 of sulphur; in the Australian¹⁴ and American dips the proportions are 1 of lime to 3 of sulphur; and in South Africa 3 parts of unslaked lime are used with 5 parts of sulphur. The quantities of both ingredients also differ. The farmer might easily become confused with these differences. It may be explained, however, that the composition of the dip depends upon the quality of the lime obtainable and its combination with the sulphur to form the necessary sulphide (or polysulphide) compound. The sulphur also must be of good quality and used for mixing in the form of a very finely ground powder or flour.

The equation of the chemical reaction of lime and sulphur is approximately a ratio of 1 part of lime to 2.29 of sulphur, but in practice the combining ratio is slightly lower—about 1:2.11. It is not proposed to enlarge on this aspect of lime-sulphur preparation beyond stating that researches¹⁵ into the chemistry of dips and the quality of local limes (when recommending lime-sulphur) is of economic and practical importance. Studies along these lines have been pursued in South Africa; but apparently they have not been completed.

Green,¹⁵ working in South Africa, states that in general practice it is highly important that the lime used be of a high grade. Although it has been shown that a dip much below the concentration obtained from a high quality lime is still effective in curing scab, the use of a low quality lime is uneconomical and liable to give uncertain results. The lime used in the manufacture of lime-sulphur dip should be of better quality than that utilised for ordinary liming of the land and should contain a high percentage of calcium oxide.

Failure to adhere to the directions in preparing the concentrate or the diluted dip may account for injuries to the sheep and discoloration of the wool. There have been several tests and experiments on the effects of different dips on the quality of the wool. They indicated that when carefully prepared and properly used the majority have little or no significant injurious effect. It is reasonable to suppose that dipping soon after shearing tends to affect the wool to a less extent than dipping when the wool is long and ready for shearing.

The experiment carried out on the influence of regular dipping on the merino sheep and its fleece at the Bathurst Experiment Farm in South Africa¹⁶ is of particular

interest. One lot of 30 sheep was dipped weekly for twelve months in arsenite of soda of a strength of 2lb. to 100 gallons of water; a second lot of 30 was similarly dipped in water; and a third lot used as control. The results showed that weekly dipping did not influence the condition of the sheep as reflected in body weight; all sheep dipped in arsenite of soda survived after a year's treatment, and were always free from ticks and blowfly trouble; arsenite of soda had no influence on fleece weights, fibre thickness, staple length or fibre contour. As regards colour, handle and appearance, the wools dipped in arsenite and in water deteriorated to some extent. Deterioration was practically of the same degree in the two dipped groups, and presumably due to the hardness of the Bathurst water and not to the arsenite of soda dip. As regards monetary value there was as much as 1d. a pound difference between the wool from the control and that from the dipped lots; and in the top a difference of 2d. a pound.

The frequency of dipping sheep as an anti-scab measure is dependent upon the existence and persistence of the disease. It may be taken that when the disease is diagnosed among the flock treatment should immediately follow. It is usual, however, for the farmer to consider the crop of wool and, if shearing time is near, to hand-dress any badly infested sheep and await the completion of shearing before resorting to dipping.

The recommended interval between the completion of shearing and the dipping of sheep varies. Some authorities state that the sheep should have sufficient wool to carry away enough dip for future protection. Merinos should be dipped not less than four to six weeks after shearing, and long wools eight weeks after being shorn. Others maintain that sheep should not be dipped immediately after shearing, but that a period of at least ten days should elapse between shearing and dipping, in order that the shear cuts may heal. In early text-books, it was advised to dip three or four days after shearing. As a basic principle it may be accepted that short wool permits the dipping solution to penetrate to the skin—and the parasites—more quickly and uniformly; long wool, especially if thick and abnormally rich in yolk, may prevent the penetration of the dipping fluid or cause it to be unevenly distributed. On the other hand, the longer the fleece the longer may the dip deposit be stored on the sheep, and possibly exert its effect for a longer period.

In preparing the bath and estimating the amount of material, and the quantity of liquid which may be required for dipping, it is advisable to ascertain the capacity of the tank, and to allow for the amount of fluid which will be carried out in the fleece of the sheep. Sheep in full fleece will retain more of the dip in the wool than freshly shorn sheep, and short-wooled lambs will carry out, on an average, from one to two quarts of dip depending on the size of the sheep and the length and nature of the wool. An average-sized sheep with medium wool will take out about a gallon of dip, whereas a full-fleeced, fine-wooled sheep may retain in the fleece nearly two gallons. Wilken-Jordan and others¹⁷ state that the average quantity of dip lost is about 0.59 gallons per animal; the minimum and maximum amounts being 0.23 and 1.19 gallons respectively. Where there is no roof to the dipping tank an allowance should be made for evaporation if dipping occupies several days.

In some countries the lime-sulphur and tobacco or nicotine mixtures are used as warm dips. In the American bulletin, to which reference has already been made, it is stated: "The temperature of the dip should not be a matter of guesswork, but should be ascertained accurately by using a thermometer. If it is too high the sheep may be injured, and if too low, failure to cure will probably result. In field operations, when dipping is supervised by inspectors, the temperature of the dip is maintained at 100 to 105°F. Practices demonstrated that the lime-and-sulphur and nicotine dips should be used at these temperatures. The coal-tar-cresote and cresylic-acid dips should be used at slightly lower temperatures, the maximum for these being 95°F."

In Australia (New South Wales), Bruce¹⁴ recommended that when the fleece is short, the bath (tobacco and sulphur) should be administered at a temperature of 115°F. in winter, and at 110°F. in summer, at which it should be the endeavour to keep it throughout the dipping (the thermometer being tried every other dipful); and the sheep should be allowed to remain in the dip from 60 to 80 seconds, and as much longer as they can stand it; for with short fleeces they dry almost immediately after being put into the draining yards, and if the bath was not severe both as to temperature and duration, they would stand less chance of being cured than if they were in full fleece or nearly so, whereby they take out and retain more mixture. As the mixture cools it will be necessary to keep the sheep longer in it, say from 14 to 2 minutes altogether, but in no case should the temperature be allowed to fall below 105°F. When the fleece is long, the same writer stated, the heat of the mixture should be maintained at from 105 to 110°F. The use of lime-sulphur mixture should be similar to that of the tobacco and sulphur. In a footnote, it is further explained that while it takes only 30 seconds to kill the scab mite with the mixture at 90°F., it will live for 10 or 12 minutes in the same mixture at 45 or 50°F.* and that a high temperature will doubtless kill many of the eggs of the acarus. Hutvra and Merck¹⁵ remarked that cresol dips were used at a temperature of 96 to 100°F., and that the sheep were held in this bath for three minutes.

It is somewhat significant that lime-sulphur dip especially has been utilised successfully against scab at a comparatively low temperature, and thus without additional labour and expenditure on accessories for heating and maintaining a relatively high temperature.

While there may be advantages in using a warm dip, it does not seem to include a considerable reduction in the period for which the sheep are kept in the bath, for in the United States of America it is recommended that the time that infected sheep are held in the bath should in no case be less than 2 minutes. If the scab is not advanced, from 2 to 3 minutes in the vat is sufficient. But in well-advanced cases of hard scab on fine-wool sheep, especially bucks, better results are obtained if they are held in the vat from 3 to 5 minutes during the first dipping. If the hard scabs and crusts are broken up and soaked with dip before the sheep are dipped, it is not necessary to hold them in the vat longer than 2 minutes.* A warm dip would, of course, penetrate the fleece better, and no doubt it would more readily soften hard scabs and kill the parasites.

Having touched upon the period sheep should be kept in the dipping fluid, the apparent discrepancies in recommendations may briefly be discussed.

In the Sheep-Scab Order of 1928 "dipped" and "dipping" mean a thorough immersion in the dipping-bath of the whole sheep (including the head and ears), and keeping the sheep (excluding the head and ears) in the dipping-bath for not less than one minute. In Leaflet No. 61, where prescriptions are given for the preparation of three home-made dips, there is included a note "The period of immersion in these dips should not be less than half-a-minute." The opinions expressed in the American bulletin are quoted above. It will be seen that sheep can often withstand much longer periods of immersion than one minute. Sheep in poor condition, of course, cannot tolerate such a long period as those in good health. In South Africa, as in Basutoland, the period of immersion is stipulated as being not less than two minutes.

As the interval between any two dippings is established in accordance with the period taken by the scab-mite to complete its life-cycle, it would appear that unless the development of the mite-varies, in time, with the seasons in any particular country, or the peculiar climatic conditions in different countries, there should be unanimity in the recommendations as to the most suitable and effective interval. Yet this is not so. In Britain, the second dipping should be carried out "not earlier than the

eighth day, and not later than the fourteenth day after the last dipping." In Australia, the recommended interval was from ten to sixteen days; and in New Zealand and America ten to fourteen days. The regulations in the Union of South Africa provide that the second dipping shall in every case take place within not less than eight nor more than ten days after the date of the first dipping. Bedford¹⁶ in South Africa advises that the second dipping should always be given nine or ten days after the first. In Basutoland, it is customary to hand-dress and dip twice at an interval of nine days, non-infected fleeces being dealt with also at ten-day intervals.

While all these different intervals may be accepted as effective in the countries to which they apply, it would seem that a more precise recommendation, based on the minimum number of days for the completion of the life-cycle of the mite, would be more effective in practical eradication of the disease. A reasonable latitude provides for inclement weather, or other pressing duties on the farm which may disturb the normal interval of dipping; and it may allow for delayed hatching of the acarine eggs under adverse conditions; but these differences do indicate the need for further research into the biology of the scab parasite under various conditions, and in different countries.

Preparation of Sheep for Dipping.

When arrangements have been made with regard to the material for the dip, and for the procedure of dipping, the flocks to be treated on the appointed day should be gathered together near the tank several hours before the actual dipping. If they are allowed access to water and food three or four hours before immersion in the dip, they will probably be in the best condition for the operation. They should not be too full of food and water, however. On no occasion should the flocks be driven hurriedly from the pastures to the dip without providing water for them and sufficient rest to permit cooling off. By looking-over the sheep, and preferably by re-counting, it is easy to detect any animal which may not have been marked, or which may have joined those previously hand-dressed.

It is advisable that the rams should be dipped separately; and as they succumb more readily than ewes or hoggets, it is necessary to give them careful attention. Frequently the rams are put into the dip before the other sheep. In such cases, the bath dilution should not be too freshly mixed, and it is important to stir the dip frequently. Verney¹⁷ in Basutoland states that in his campaign "no sheep are allowed into the tank until fifteen minutes have elapsed after well mixing the dip in the tank." He also observes "that goats stand dipping better than sheep, and if there are goats with the sheep (a common condition in this territory), then the goats are put into the tank before the sheep."

Because of the large horns and the size of the body, rams should be allowed plenty of swimming space; and in addition to immersing completely two or three times, the head, ears and horns should receive special treatment by lading-up the dip in a bucket or tin and pouring over the head to ensure a thorough soaking of the wool around the horns and ears.

Particular care should be exercised in handling the sheep when they are put into the dip, and while they are in the bath. Overcrowding should be avoided, and the number of sheep in the bath at a time should allow sufficient room for movement without crushing. The attendants should see that the animals are properly arranged, and prevent them from climbing or raising themselves out of the bath at the sides or ends of the tank. Native labourers habitually take periodic rests, and hold a sheep, with a crook, so that its head and shoulders are well above the surface of the dip for a considerable time. It is essential that at every stage of the operation close supervision by a capable and reliable person be provided.

* Temperature of dip at Naivasha.

Ewes and lambs should not be dipped together. The former can usually withstand dipping better than rams, hoggets or lambs, and it is surprising how much even young lambs can tolerate when dipped separately and permitted plenty of room for swimming. Sheep in weak and poor condition—those scouring, and infested with internal parasites—should receive special attention. They should always be assisted through the dip, or segregated for special treatment prior to dipping. On no account should they be returned to the flocks without first having been dipped.

Draining and after-dipping Treatment.

When the sheep emerge from the dipping tank, a quantity of dip taken out in the fleece drains away fairly quickly. It is desirable that this should be saved and returned to the tank. The draining pens should be constructed to allow all the surplus amount to flow back to the tank. Dirt and excreta will also be carried in the drainage, so provision should be made to collect all solid material in a sedimenting pit. Excreta and dirt will find a way—by the exit—to the dip which necessitates a periodic skimming of the dip. The cleanliness of the bath and of the sheep will depend to some extent on the state and arrangement of the pens around the tank. The draining pen, in particular, should be a bare yard (preferably with a cement floor) and with no grazing or food which may become contaminated and thus provide a source of poisoning.

After the sheep have been dipped, they should be allowed to rest and dry in the shade for not less than two hours. The lambs should be kept apart and not allowed to suckle their mothers until the ewes have dried. Rams also should be kept separate until drying is complete. If the sheep are driven quickly, and far, immediately after dipping and when wet, they may suffer from chill. Mortality after dipping is not infrequently due to hurrying the sheep back to the pastures.

A further check of the number of sheep dipped, and an examination of the state of the animals after dipping should be carried out. This procedure involves little extra labour and trouble, but gives the satisfaction that the work has been done thoroughly, and arrangements can be made for nursing those animals which may have suffered during the immersion and thus reduce losses. It is well to extend the observations on dipped sheep for several days to estimate the effect of dipping, and periodic inspection should be carried out for several months to ascertain whether the disease is reappearing.

Effects of Dipping.

A sudden or drastic change in the treatment of sheep may be expected to cause some constitutional set-back, especially if any of the animals are suffering from poverty or sickness. Dipping in water alone may result in the further weakening of sheep in poor condition, and may cause mortality through chill or exhaustion. When sheep are properly immersed in a reliable dip, practically no losses or damage follow—at most comparatively little, though ignorance and negligence are often responsible for heavy losses. There is no doubt that a brand of dip is sometimes blamed for deaths when the real cause may be more correctly ascribed to faulty procedure. Deaths after dipping are not necessarily due to the composition of the dip. Reference has already been made to the experiments at Bathurst on the frequent and regular dipping of sheep in arsenite of soda, when it was shown that such dipping did not affect the constitution of the sheep as reflected in body-weight, etc. Arsenical poisoning may result from the absorption of an arsenic dipping fluid through broken skin. Sheep dipped in an overheated condition may suffer from scalding, and then absorb the arsenic through the inflamed skin. Similar trouble may arise from the use of a dip made stronger than that recommended. Poisoning may also follow the dipping of sheep with fresh wounds in a lime-sulphur dip. This is a form of blood-poisoning, apparently caused by micro-organisms entering the open wounds and the sealing action of the dip excluding the air and stopping natural drainage.

It is not uncommon for sheep which have been driven hurriedly to the dip to arrive in a thirsty condition, and when they enter the dip, they swallow some of the liquid. Or the animals may receive hasty and rough treatment in the bath, and in the midst of the turmoil take in an overdose of dip. Poisoning may result from eating food or tufts of grass in the draining-pen, and from several other minor causes. Suffocation or nicotine poisoning may occur by the use of too strong and too hot a dip containing nicotine.

As to the effect of dips on wool, it may be accepted that the sooner dipping is carried out after shearing, the less effect the dip is likely to have upon the wool. Unnecessarily high polysulphide concentrations in a lime-sulphur dip would naturally involve risk of damage to the wool and probably render it less amenable to scouring and cleaning processes in general. Under normal conditions, damage to the fibre soundness of the wool is due rather to the process of dipping than to the ingredients used in the dip. The results of the most recent experiments in South Africa indicate that arsenates and arsenites tend to protect the fibre rather than to cause damage, as the yellow film staining the fibres impedes the penetration of the destructive ultra-violet rays of the sun.¹⁸

Records of casualties during and after immersion in an arsenical dip in Basutoland show that 75 per cent. of the losses occurred at the second dipping, and amongst sheep that were put into the tank first after mixing a fresh tank-full of dip.¹⁹ This suggested that the dip had not been properly mixed, and we are now very careful to train our native dipping supervisors in this direction. In addition to thoroughly mixing the powder into a thin paste in a bucket, all this has to be passed through a grain bag, and no sheep are allowed into the tank until fifteen minutes have elapsed after well mixing the dip in the tank.

In an experiment in Kenya with a dip prepared from an arsenic compound and one prepared from lime-and-sulphur mixture, it was observed that mortality was greatest after the second dipping, and least after the third dipping. The percentages of casualties after the first, second and third were 0.66, 0.75, 0.09, respectively. In each case the dip was prepared most carefully on the evening previous to the day of dipping. The results indicated that the first dipping adversely affected the weakest animals, and the second dipping took a toll of those sheep not in so poor a condition as the first lot, but which could not withstand two immersions at a short interval. Some old native sheep soon collapsed in the lime-sulphur mixture, but recovered after a short rest.

Kraals, Homes and new Pastures.

It was held by early writers, and believed by farmers until recently, that the scab-mite or its viable egg was able to exist for some considerable time apart from the host; and that mites and their eggs in tags of wool torn off the sheep by wire, left on rubbing-stones, fences, gates, etc., accounted for the reinfestation of dipped sheep. It was particularly stated that the mites retained their vitality on cast-off scabs in moist places, under manure in a yard or field, or other places which afforded shelter and moisture. The stated period of vitality, under these conditions, varied from one or two months to as long as a year. Ranges or pasture-lands near watering-places exposed to sunlight were believed not to remain infectious longer than thirty to sixty days.

The experiments carried out in South Africa by Shilston²⁰ and Bedford & Du Toit give valuable, exact information on this point, and finally explode the old vague theories. Du Toit²¹ states that his experiments with infected sheep and kraals have shown that the possibility of scab infection originating in a kraal is very small indeed. One experiment proved that if a grossly infected kraal be left empty for seventeen days, clean sheep can be put into it with perfect safety, and another experiment

showed that even this period is unnecessary provided that the sheep have been dipped properly.

Although Du Toit concludes that a thorough dipping is the only thing necessary for the complete eradication of scab from a flock and that it is not necessary to worry about the infection of a kraal, it seems not to be a troublesome precaution to treat moveable night bomas which may be utilised to pen the sheep immediately after dipping, especially if measures have not been taken to ensure that no strange or undipped sheep has joined the flock. These night bomas usually consist of a length of netting wire supported by long, narrow poles; they are easily pulled up and rolled; they can be carried to the dip and left in the bath for a few hours before being used on a new site.

Disposal of the Dip.

After completing the dipping operations, it is customary to dispose of the liquid by transferring it to a deep pit in the vicinity of the tank. In some countries, the authorities have thought it necessary to advise farmers not to dispose of it in such a way that it may pollute rivers, or streams or other water supplies. Amongst civilised people, it may not be necessary to remark that the sediment left in the tank is impregnated with arsenic, and the "dumping" of this mud on the surface in a place accessible to any stock is liable to cause poisoning of animals. Cattle, in particular, are readily attracted to these "dumps" and consume inordinately large quantities of the earth, or grass growing on it. The result, as some know from experience, is a heavy death-roll.

Prevention of Scab.

The precautions to be taken to prevent the introduction or re-occurrence of sheep scab include the periodic inspection of the sheep and immediate treatment when the existence of the disease is confirmed. It is advisable always to examine closely all newly purchased animals, and those returning to the homestead from outside and distant pastures. These sheep should not be permitted to mix with the other flocks until it has been ascertained that no disease exists among them, or until they have been treated thoroughly.

If the sheep are kept in good condition and free from worm infestations, they are less liable to succumb to severe scab infection than sheep in poor condition and diseased. The former can also better withstand immersion.

Many farmers in Kenya, at any rate, keep isolated "hospital" flocks, which comprise sick animals set apart for special treatment and nursing. It is an excellent system contributing to effective control of all diseases and worthy of adoption by all farmers.

Efficient fencing of the farm—and the keeping of fences in good repair—is essential to effective control. In some instances, however, it is a costly undertaking and thus frequently impracticable. Where a number of large, unfenced sheep ranges exist in a district, the alternative to fencing appears to be an agreed policy of simultaneous dipping, supported by a rigid control or prohibition of movement of sheep into that district. There are several practical difficulties in this alternative method, especially where surreptitious movements of native sheep (often moved at night) take place, but determination and zeal might surmount these difficulties.

A scab-eradication campaign cannot be successful without the provision of funds, as it needs an efficient organization to enforce an agreed policy over a protracted period. In most countries the cost of treatment and the responsibility of keeping scab at bay devolve upon the sheep-owners. Expenses incurred in administrative assistance and pressure are borne by the Government concerned. In Basutoland, dipping is free; but in order to defray the costs, a tax or export duty of one farthing or halfpenny a pound is imposed on all wool exported from the territory.

As the onus of controlling sheep scab falls upon the farmer, he should be thoroughly conversant with every practical aspect of the disease, its treatment and its prevention. The research worker may be able further to enlighten him on several important points which may arise under the particular local conditions. The chemist especially may continue investigations into the question of dips, their preparation and use, their adequacy as a protection against reinfection, and their effect on the wool and the processes in preparing the finished product.

Legal provisions should afford some measure of protection to the zealous farmer from the possible negligence of less progressive neighbours, and, finally, legal safeguards should be provided in as simple a form as possible or made more clear by explanatory leaflets.

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EXPLANATION OF PLATE II.

- Fig. 1—Indicating by arrows the lachrymal or infra-orbital pouch and the deeper cavities of the ear. In both sites mites may lurk, and possibly escape the effects of treatment.
- Fig. 2—Showing the "scabs" in the lower part of the ear where many mites were found.
- Fig. 3—Section of a piece of skin and wool, as shown in fig. 4, taken from the back of a sheep which died from a chronic infection of "scab" and emaciation.
- Fig. 4—Section of a piece of skin and wool.
- Fig. 5—Showing a "tag" or "tuft" of wool to which adhere several layers of scabs, and under which were found (at arrow end) a cluster of eggs and live mites.



Fig. 1



Fig. 2

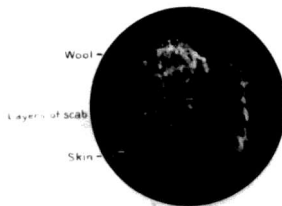


Fig. 3

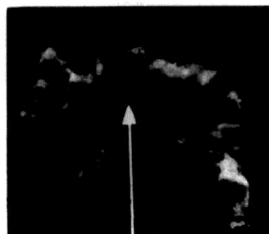


Fig. 5



Fig. 4