

APPENDIX A.

Office of the State Drought Investigation Commission,
Union Buildings, Pretoria.

To.....

SIR,

As Chairman of the Drought Investigation Commission I take the liberty of approaching you on a matter of vital importance to the whole country and all its inhabitants, no matter what profession they may follow.

In the year 1919 the losses in the Union due to drought amounted to over £16,000,000 a figure approaching the entire contribution of South Africa to the Great War. And a sum of money large enough to construct a 2,000 mile new railway line. A loss of that magnitude cannot but affect the humblest as well as the highest citizen of the Union, and apart from the patriotic impulse which inspires the individual to save his country from a repetition of such a calamity, it is economically our duty to prevent, as far as possible, a duplication of this loss in the next drought, which, if past history can be depended on, lies not very far ahead.

It has pleased the Governor-General on the advice of Parliament to appoint my colleagues and myself as a Commission with wide powers to enquire into the matter and make recommendations.

My fellow Commissioners and I feel that the future prosperity of our country may be accelerated or retarded many years by what we do or leave undone, and we realize our responsibility so deeply that we desire to enlist the assistance of the best brains in the country to aid us.

I am accordingly approaching you with the request that you bring your trained mind to bear on the subject, and give the country the benefit of your opinion. It is the desire of the Commission to collect evidence of such a character that its report, with which will be published in full the papers put in by experts, will remain a document, to which, down the years of the future, posterity will be able to refer.

With a view to assisting you in crystallising your thoughts, showing you the ramifications of the subject, and giving you a rough guide as to the direction in which our investigations appear to lead, the attached summary of the main points has been drawn up. May I ask you to read through the whole of this very carefully even those paragraphs whose headings apparently have no bearing on your particular subject, and, having done so, to prepare a statement on such portions of the matter as, through your study and experience, you are especially qualified to deal with.

I desire particularly to impress upon you that the summary does not cover the whole field of our investigation, but only sketches it roughly as it were, and information, ideas, or suggestions you may wish to offer, or criticism you may wish to make in connection with any phase of this important matter will be thankfully received.

If you would prepare a written statement for the Commission and submit it before the end of October 1921, the members of the Commission could study it and subsequently arrange to meet you for the purpose of discussing it. It is felt that only by such a method can the full benefit be derived from your valuable evidence.

For your information I am enclosing a copy of my appointment including the terms of reference.

Thanking you in anticipation for the assistance which I feel assured you will lend us, as a Commission, and through us, the entire Union.

I remain,

Yours very obediently,

HEINRICH S. DU TOIT,

(Government Agronomist.)

Chairman : Drought Investigation Commission.

SUMMARY.

AFFORESTATION.

As a remedial measure in connection with soil erosion, afforestation of large areas has frequently been recommended, and the Commission consider it their duty to investigate this phase of the matter very thoroughly. The following questions will indicate roughly the range of expert evidence needed.

Have forests an effect on the quantity or method of incidence of rainfall? Do forests, for instance, "attract" rain in the same sense as zones of country on which rain has already fallen earlier in the season appear to do? Does the presence of forests decrease the frequency of thunderstorms and increase the proportion of rain falling in gentle showers? What is the effect of forests on the run-off of rainwater? How does this effect the strength of the underground water? What is the effect of afforestation on the erosion of soils? What is the effect of afforestation on the composition of soils? How would afforestation of river catchments affect the "life" (*i.e.* the period of usefulness prior to its silting up) of our storage dams? What effect has afforestation on the size of the maximum floods in our rivers and the damage done by them to arable ground on their banks, to artificial works in their valleys and to human life? What is the general effect of forests on our rivers when judged from the irrigation point of view? Would the benefits derived from systematic afforestation on a large scale in our river catchments—especially the steep upper reaches—be commensurable with the financial outlay? Apart from large State Schemes of afforestation, what can be recommended for promoting individual effort, and what form should this individual effort take? Can anything practical be done to reduce unnecessary destruction of trees in our natural forests during felling operations? Can anything be done to preserve our native trees and shrubs, to re-establish such forests as have already been destroyed, and to implant the love of trees in the hearts of the citizens of the Union? What is the effect different trees have on the available water contained in the soils? What is the effect of windbreaks on evaporation from soil and crops? Are any species of trees, suitable for sheepshelters, known which would grow on shallow Karroo soils under Karroo conditions? Would it be possible to employ poor whites on our afforestation works, bearing in mind the imperative necessity for educating their children? Would this compete with individual enterprise? If so, would the cultivation of our slower-growing indigenous trees, which make good cabinet-woods, overcome the difficulty?

AGRICULTURAL EDUCATION.

During its travels through the Union it has become manifestly apparent to the Commission that while combined action, *i.e.*, State action, is necessary in many lines to combat droughts, a great deal will depend upon the effort of the individual landowner. In a democratic country such as ours, this is equivalent to demanding that the voter and farmer must be educated up to the true significance of the problem. The question of the farmer who is farming to-day will be touched upon later, but with reference to the youth, the future farmer and voter, several questions arise.

Considering the large proportion of South African scholars who will become farmers, is our system of education satisfactory? Is for instance the "Nature Study" code in our schools drawn up in the best possible manner to serve as the foundation of an agricultural education? Do we have a sufficiency of elementary natural science in our primary schools? Should we extend the agricultural plots at our schools or does the time of vacation or other obstacle adversely affect the utility of such plots and render them of little value? Is the time available (*i.e.*, the period during which the majority of the youth of the country is available for education) too short to permit of an agricultural education sufficient for the future citizen? If so, should certain subjects now taught be removed from the syllabus, or should another year be added—*i.e.*, the standard of compulsory education raised? Is it to be recommended that every child in the Union up to Standard VI. or VII. take the same agricultural course irrespective of the profession he proposes to take up? If the shortage of suitable teachers is a serious obstacle to the carrying out of a scheme of agricultural education in our primary schools, what can be done to remedy this defect immediately? Would vacation courses and increased remuneration to qualifying teachers meet the case? Is there a danger that such a makeshift, stopgap system will bring agricultural education into bad odour, or could one expect it to be successful considering the large proportion of teachers recruited from rural districts? Is teaching of agricultural subjects in secondary schools as necessary as in primary schools, or may it be assumed that after the highest compulsory standard has been passed, the scholar (or his guardian) may be allowed individual choice, and if he desire, pass over to the agricultural schools; the latter forming separate units in exactly the same way as the agricultural faculty at our universities forms a separate unit? Should the schools of agriculture be further multiplied, or should they rather be extended in size with a view towards economy in staff, etc.? Do our agricultural schools and colleges do enough experimenting? If not, what is the reason?

AGRICULTURAL ADVISORY BOARDS.

It has been suggested by many farmers giving evidence before the Commission, that agricultural advisory boards be established in every district throughout the Union. It is felt that the member of Parliament for the district has so much to do that it is not possible for him to be absolutely *au fait* with agricultural conditions in his constituency. An agricultural board is suggested as a link between the farmer on the one hand, and the experts and the Minister of Agriculture on the other. The board could form the channel of communication for all matters not entirely individual. It could assist the farmers to get in touch with the correct sub-department, and assist the expert, when on tour, in obtaining or disseminating information. Such a board could register and transfer complaints and be of incalculable assistance when statistics have to be made up at short notice, as for instance in connection with crops available for export, etc., etc. In times of epidemics, of stock-diseases or droughts, too, they could be of service. The question arises whether, in the Cape Province where Divisional Councils are in existence, matters purely agricultural should not be removed from the councils and placed in the hands of such boards. Evidence with reference to similar expedients (whether with individuals or boards) in other countries, and suggestions as to additional duties which may be imposed upon such boards, and the limits of their sphere of activities is needed.

ALTERATION OF VELD AND FLORA.

In the dim past, when our coal was laid down the climate of our country and its vegetation must have been vastly different from what we have to-day, but the heading of this paragraph refers to more modern changes. In other parts of the world, interesting studies of the flora have been made, for instance, with a view to determining, by the width of the annular rings of tree-sections, the climate of past centuries; or again, by studying the special character of local flora to estimate, where historical data are lacking, the period which has elapsed since the last great climatic changes took place. The question of the rainfall of South Africa in the past (say 1,000 years) has an important bearing on many phases of the subject under investigation, and the Commission looks forward eagerly to obtaining botanical evidence on this point. We have, in our country a very diversified flora due to the difference in humidity, temperature, altitude and soil in different parts of the sub-continent. In raising drought resisting fodder-crops, and also other reserve fodder-crops for fighting droughts, the farmer is called upon to choose certain varieties among many hundreds, and frequently loses many years and much money in experimenting. It would be of great assistance if, for instance, it could be established that where certain indigenous plants grow, certain cultivated crops will grow, and if a series of indigenous plants could be used as frost or temperature indicators, it would be of more use to a farmer than tables of maximum and minimum temperature. Information along these lines would be of great value.

Besides the alteration in the flora due to cosmic causes, there appear to be other changes which have occurred during very recent times, such, for example, as the intrusion of the Karroo vegetation into portions of the Orange Free State Province. Is this due to decreased or altered rainfall, or is it due to MAN? Or has MAN'S effect on the earth, and his devastation of the natural vegetation brought about an altered rainfall? What effect has veldburning on the flora? What is the difference between sweet and sour veld? Why does drought, ploughing, or overstocking in many parts of the country "sweeten" sour veld? Why is the same plant (like bitterbos, saltbush, etc.) edible in some districts and not in others? With regard to re-establishing indigenous flora where it has been destroyed, what is known of their rates of growth, the best methods of propagation, etc.? Some farmers have erected "blind" camps (*i.e.*, paddocks without gates) on their farms to ensure a supply of seeds for the veld. Some, however, chose the tops of elevations, and others the lower depressions on their farms for these "seed camps," the former depending on running water to distribute the seeds, the latter, on the collected water to germinate the seeds and to make the adult plants prolific, while the winds must do the distribution. Are our indigenous seeds more dependent on water, wind or animals for distribution?

With reference to our native grasses, could any of them be improved by selective breeding, and if so, which, and along what lines?

DROUGHT RESISTING FODDER PLANTS.

While nature has provided, in the arid portions of South Africa, excellent drought resisting fodder plants, which, by careful grazing may be husbanded and made available in droughts, the advisability of planting certain drought resisting exotic plants for fodder direct, or for turning into hay or ensilage is very evident. The spineless cactus (different varieties) the American Agave, the Tamarisk, the three Australian saltbushes, the American saltbush, Kudzu, Soudan grass and the Mesquite bean are most frequently mentioned. Information as to the soils required

by them, best methods of propagation, best time to sow, districts in which they will thrive best, their drought and rust resisting qualities, best time to cut, best method of feeding, food values, etc., etc., will be useful, as also information about other similar crops not mentioned.

ENSILAGE.

Ensilage will undoubtedly play a large part in providing against drought in the future. Questions which require answering in this connection are: what are the best crops to sow for ensilage? What weight per morgen may one expect from different crops? At what stage should one cut? Is it advisable to cut up the ensilage before ensiling? What are economically the best silos—stack, pit or tower silos? What precautions are necessary with the different methods? How long will ensilage keep when preserved in these different ways? Can frost-bitten mealies be used for ensilage? What type of ensilage is the best for each sort of stock? What weights may be considered a ration if there is absolutely no grazing? Can any indigenous plants be used for ensilage?

EROSION.

Is wind erosion a serious menace in South Africa as far as removing soil from the Union is concerned? Or is the soil merely removed from one place to another?

What is the effect of silt erosion on our underground water supply? What is the draining effect of a silt on the adjoining ground (apart from the removal of surface waters)? To what distance back from the bank of a silt can the draining effect be expected in different soils? Is there any geological (or other) evidence with regard to increased run-off since the advent of the white man in South Africa? From what time does silt erosion in South Africa date?

Presumably all erosion in modern times in South Africa has been caused by denudation of vegetation, aggravated by alternating droughts and violent thunderstorms. Denudation as the inverse of afforestation brings with it the same questions as afforestation, *i.e.* its effect on run-off, on the waterable, on the rainfall, on the composition of the soil, etc.

What is the effect of erosion on the composition of the soil? What is the proportion of silt in the waters of our rivers at their mouths? Is there much soluble plant food carried away by our rivers?

Would the State be justified in subsidising "ante-erosion" or "reclamation" works, other than by supplying expert advice and granting loans for checking erosion? What grasses, shrubs or trees are most suitable for planting to stop incipient erosion or to hold reclaimed ground? What properties have these different plants with reference to resisting frosts and droughts? How should they be planted, and when? Are they of use as stock food?

FARMING METHODS.

Under this head we must consider agriculture and stock-farming separately. Dealing first with agriculture: the question of droughts in this connection resolves itself into the economic use of water. Have detailed experiments been carried out in South Africa to determine what amount of water different crops need with varying degrees of atmospheric humidity? With our sufficient but late rains much can be done by the "dryland" methods if the water were stored in fallow lands and suitable deep-rooted crops sown the following spring. Information with reference to suitable crops, etc. would be useful. Data of similar nature for crops under irrigation are also required. Under storage and permanent water schemes, where water is limited and land usually unlimited, figures which may act as a guide to the farmer to make the most economical use of water are very necessary: that is, the determination of the optimum amount of water required by different crops on unit areas with varying atmospheric humidity, and also optimum area for maximum crop production with unit volumes of water applied. As part of the same problem naturally falls the question of the weight of seed to sow or the number of trees to plant per unit area for maximum production, and also the choice of the correct varieties. Figures, with regard to the reduction of evaporation from lands protected by windbreaks would be useful.

With regard to stock-farming, the problem is almost entirely a question of economic grazing of the veld. We are no longer dealing directly with water, but still, relative figures showing evaporation losses of different kinds of veld with control plots of bare veld week by week throughout the year, will be very interesting and may lead to useful results. There seems to be no doubt about the fact that comparatively small camps (small with reference to the fertility of the soil or abundance of vegetation, and the number of sheep in the flock) are necessary for the economic use of the indigenous grazing. Assuming that drinking water is obtainable in every camp, what is the best method of dividing up a farm? How should the camps be grazed? Will any of the usual bushes growing in the arid portion of South Africa, if heavily

grazed at long intervals, recover during a drought? If so, which? Does the correct method of grazing paddocks vary with grass and with Karroo veld? When should grass be cut for hay? Is veld-burning necessary for any grass veld? If so, for which? If not, what methods (if any) should be employed for removing the old grass?

Farmers have explained at length to the Commission the advantages of not kraaling sheep, but figures in connection with the weight of mutton or wool lost by driving sheep long distances daily to water or to kraals would be welcome, as also figures referring to the value of plant food removed from the farm yearly by sheep sleeping in the kraals and apparently depositing the larger proportion of their dung and a large proportion of their urine in the kraals.

The carrying capacity of open farms where sheep are nightly kraaled, as compared with those well divided into paddocks, is a feature on which a great deal hinges.

A matter which needs attention is the question of the correct time of the year to remove slaughter stock from the farms in order to save the huge tonnage of meat which yearly vanishes into thin air during the winter from our flocks and herds, and to save, at the same time, the veld from non-productive use. This naturally affects the entire organisation of the meat trade in the Union, and is linked up with the capacity of the available cold storage.

IRRIGATION.

Under the head of "farming methods" attention has already been drawn to the fact that the Commission is desirous of obtaining figures referring to the economic use of water. In addition, it is apparent that on our Karroo rivers heavy losses are sustained even under irrigation, owing to the precarious flow in the rivers. Storage reservoirs seem the only solution. Reliable figures in connection with silt, evaporation losses and losses of water in the river bed, effect of big storage dams on the underground water, etc., are needed in this connection. Afforestation would also appear to have a large influence on this phase and must not be lost sight of.

JACKALS.

The jackal is responsible for a large share of the incorrect farming practiced by our graziers, who, by jackal-proof fencing are now endeavouring to eliminate, if they cannot eradicate him. Unfortunately there are many portions of South Africa where this veld pirate will, for a great many years, be safe from danger as far as ordinary methods go. Perhaps our bacteriologists and zoologists will be able to devise some safe and sure method of destroying him and thereby save the country millions.

MACHINERY, IMPLEMENTS AND FENCING.

Whether jackal-proof fencing is to be erected, or whether we will be enabled to spread some epidemic among the jackals and be satisfied with ordinary stock-proof fencing, enormous quantities of fencing material will undoubtedly be needed in the country for reducing drought losses. At present, according to evidence submitted, we are paying three times as much on an average for our agricultural machinery and implements as any other country with whom we must compete in the world market. This causes one to enquire whether the State should not start working some of our iron mines, produce a large proportion of this material locally, and absorb a large number of unemployed whites.

METEOROLOGICAL.

Under this head the Commission desires evidence on the rainfall and climate in South Africa as far back as may be traced with the help of geology, botany and history, in order to determine whether, during recent times, there has been any change in our total rainfall or its incidence. Whether our country is large enough to contain its own circulatory system—for example, whether "repeated" rains brought about by reprecipitation of re-evaporated rainwater forms an appreciable proportion of our rainfall. What effect have forests on our rainfall? Why do rains so frequently follow the course of the previous rains during the same season? Would meteorological data from ships sailing in Southern Seas, together with Australian and South American data, not assist in the study of our South African weather? Is there not a marked similarity between the weather of the North-East of Australia, the South African Karroo, and parts of South America? Does this similarity not point to some prime cause lying outside South Africa? Is not this cause so big that it may be expected to cause phenomena in various parts of the world which would serve as indicators to us of coming weather conditions in South Africa, if we could but read them? Is it not the duty of the State to investigate this with a view of making *seasonal* forecasts a possibility?

Have any of the numerous rainfall "cycles" that have been "discovered" ever held true for any period after their "discovery"? Is there any definite connection between terrestrial weather and the number of sunspots visible, or the composition of the same as shown by the spectroscope? Has the solar observatory in South America been able to fix any connection between terrestrial weather and the intensity of solar radiation? Would the establishing of a solar observatory at some suitable site in South Africa be liable to assist in making seasonal forecasts? Are sufficient data compiled by our meteorological department to permit of the trajectories of our rainbearing air-currents being traced? Have the "parahails" been a success in France? Has the total rainfall been increased in their vicinity? Are scientists agreed as to the theory of their action? What is the generally accepted theory? Or have "parahails" proved a failure? Do cold currents from the South, and the presence of icebergs unusually far North coincide with abnormalities in our weather?

From the point of view of drought and the reduction of drought losses, the greatest practical assistance which the meteorologists could give, would be the drawing up of seasonal forecasts. The daily forecast is practically worthless to the man on the veld to-day, and of absolutely no use in the reduction of drought losses.

ORGANISATION.

The lack of organisation among the South African farmers for any but political purposes has become proverbial. The Commission feels that lack of organisation makes the whole question of drought-fighting, jackal extermination, and similar matters extremely difficult, and at all their meetings they have impressed the importance of organisation on the farmers. In connection with organisation, arises the idea of compulsory insurance against droughts, the premiums covering the expenses of removing stock, during drought, to better veld, etc. Experience of other countries in the matter of compulsory insurance will assist the Commission when deliberating on this point.

PROPAGATION OF AGRICULTURAL KNOWLEDGE.

As has been mentioned under the heading "Agricultural Education," it is necessary to enlighten the farmers of the country, and particularly those who do nothing themselves to come in contact with the Agricultural Department and its experts. One thing has been made painfully evident to the Commissioners during their travels, and that is the gulf existing between the Department as a whole, and the farmers. It is essential that this gulf be removed, and any practical suggestion calculated to have that effect will be eagerly received by the Commission and earnestly considered. One method already suggested is the district agricultural advisory boards mentioned above.

PLANT DISEASES.

Fortunately our indigenous plants have been free from disease, but during the last few years two parasites have made their presence felt in the Karroo, and possibly other parasites thrive elsewhere to the detriment of our useful vegetation. The caterpillar and a small black insect, presumably an aphis, are working havoc among the hardy Karroo bushes, and all our careful stocking, fencing and grazing will not avail against them. Here is a menace which bids fair to become as serious as the drought. The assistance of experts is particularly invited in this connection.

STOCK DISEASES.

From evidence submitted to the Commission, it appears that the losses are usually very much more severe in droughts than they would otherwise be, because the animals are suffering from some or other intestinal (or parasitic) disease. Further evidence from experts on the treatment of animals to prevent such diseases, and also in connection with the immunity against, or freedom from, certain diseases which run free is desired. If animals get into the habit of sleeping nightly under some one kraal or at the same spot on the veld, is not the danger from eartick and other parasites just as great as when they sleep in a kraal?

TAXATION.

The income tax in the past had the effect of encouraging overstocking, and thereby increasing drought losses. Fortunately this defect has been removed in the new law. The question of eliminating the disabilities under which the energetic farmer works as compared with the unprogressive man—that is, the old question of taxation of unimproved values still

remains. This question must again be thrashed out with particular reference to the encouraging of improvements designed to prevent drought losses, and erosion—such as irrigation works, damming of sloods, fencing, etc. In addition arises the question as to whether the funds required for State action in minimising drought losses should be drawn from the country as a whole, or from the farming community only.

UNDERGROUND WATER.

The adequate supply of good pure drinking water for stock at numerous points on a farm is of the utmost importance in the economic grazing of the veld. In a large proportion of cases the farmer is dependent almost entirely on underground water. Unfortunately, the water table appears to be continually sinking. Expert evidence in connection with the possible augmenting of the underground supply, the proper husbanding of it, the possibility of striking artesian water in different parts of South Africa, and other relevant points in this connection will be very valuable to the country.

POOR WHITES.

It will be seen from the terms of reference that the Commission must also report on the indigency arising among the farming community. Each drought leaves a certain number of casualties in its wake. Of these, a percentage is able by individual effort to recover, others, the weaker members or individuals, who by circumstances have been forced into the farming industry, an occupation for which they are mentally or temperamentally unsuited, remain poor and dependent. It would appear, therefore, that the State should take these people in hand and by some system place them back on the land, or on some other notch where they will fit, and remain or become worthy citizens and an asset to the State.

While this Commission is concerned mainly with potential poor whites, they cannot close their eyes to the men of European descent who have already sunk, for by studying them one can best realize the dangers one has to guard against and the natural psychological forces one has to deal with. For this reason the Commission would welcome any information in connection with the history of the poor whites in the different provinces, the causes which reduced them, etc.

It would appear that it is necessary to collect the indigents at certain centres to facilitate the education of the coming generation, as also to provide for that social company which man desires particularly when books are not available, or the ability to read them intelligently is absent. In order to give an opportunity to the individual to supply that incentive to work and revive that hope which is all but dead, or at the best dormant in so many of the unfortunate class, certain specially selected work is necessary. The work given should be of such a nature that piece work is possible, or an opportunity for extra private work of some other kind must be present so that the ambitious man may turn his spare time into cash, or some other device which can be calculated to have the desired effect should be thought out. The particular industry to be followed by such settlements or labour colonies is still naturally a matter of inquiry. Irrigation settlements have been suggested, also nurseries and plantations, state iron mines, cultivation of certain crops such as ground nuts, etc. Objection may possibly be offered against these suggestions on the grounds that the state is competing with the individual. On the other hand, it may be possible to start new industries (say for example beet-sugar or cotton growing) lead the country into new lines, and establish markets for the individual. A discussion of these points by our political economists will be much appreciated. It is assumed that such labour colonies would be arranged to act as sieves or filters permitting the men who have "graduated" as it were, and recovered their self confidence and additional experience, to leave and strike out for themselves while the remainder would be retained under supervision or as ordinary day-labourers. The experience of America with her "homestead laws" and similar expedients are of great importance in drawing up the report on this portion of the terms of reference. Some people consider that the so-called "spoonfeeding" and "sympathetic treatment" of poor whites is responsible for a lack of energy on their part, and suggest a stern treatment as being the natural goad. It has been suggested that begging and giving of alms be made offences. It is hoped by the proposers of this scheme, that if thieving and begging are stopped by law, the poor will be obliged to work for private individuals, come to the Government for employment on the labour colonies, or starve. Presumably the State will still maintain the aged poor, the chronic sick, lunatics, etc.

Most attempts at solving the poor white problem in the past have been confined to the economic side. It will be interesting to obtain information in connection with what may be called the biological phase of the question. What part does heredity and inbreeding play? What part does climate play? These are important questions when a decision has to be made on the locality of proposed settlements, and the transferring of paupers to prevent or reduce inbreeding.

XVII. RAINFALL AND SEASONAL FORECASTS.

230. It has already been stated that no alteration in the rainfall of South Africa has been proved (paragraphs 22 *et seq.*) Available records show that the average rainfall now is no different from that of a generation ago. Your Commission endeavoured to obtain information concerning past centuries as evidenced by the width of annular rings of old indigenous trees. In many other countries examination and measurement of these rings have established the existence of definite periods of supernormal growth. It has been possible to prepare diagrams showing variations in the rate of growth in certain countries for a period of as much as three thousand years. Since the rate of growth is dependent upon the soil, light, temperature and rainfall, and if it be conceded that the first two mentioned factors are, practically speaking, constant, then variations in the rate of growth should reflect variations in rainfall and temperature more or less closely, due allowance being made for the retardation of the effect of a larger or smaller rainfall in any one year. And since the width of the annular ring indicates the season's growth, these rings may be taken as a rough indication of the variations in weather conditions.

231. Your Commissioners had hoped that information concerning weather conditions of the past would have been obtainable from our old forest trees, but experts state that owing to the absence of strong seasonal contrasts in those areas where our old indigenous trees are found, the annular rings are indefinite and for that reason, incapable of measurement. There is the further difficulty that during periods of severe drought some of our indigenous species remain dormant and, for that reason, show no ring for that season. The Commission trusts that investigation along these lines will be continued by the Forest Service, the Botanical Survey or our Universities.

232. From a consideration of the rainfall of the past, we turn to the discussion of the rainfall of the present, and to one particular phase of it, namely, "rainmaking." The question has cropped up frequently in the press, and telegrams are published concerning reputed achievements of rainmakers in various parts of the world. Several gentlemen appeared before your Commission with ideas for "making" rain, or with suggestions for increasing the rainfall.

233. Of these suggestions some are based on ignorance, and can be thrown aside without discussion; but others demand consideration. While the Commission deems it advisable to mention these points, it does not consider it to come within the scope of its duties to report on them, since your Commission understands that any investigation, which Your Royal Highness may desire to have made into these matters, will be carried out under separate instructions. Several of the suggestions are the subject of so much discussion by farmers, that it would be well if Government took the necessary steps to issue an authoritative statement in connection therewith.

234. In a previous Chapter (Chapter IV.) the element of speculation or uncertainty in deciding upon the number of stock a farm can carry was mentioned, and the desirability of seasonal forecasts of the rainfall touched upon (paragraphs 21 and 53). The optimism of the farmer in normal times leads, and can only lead, to overstocking in times of drought. (paragraph 54) Should, however, seasonal forecasts of rainfall be possible, farmers would be able to conduct their operations with a great deal more certainty, although there would still be the uncertainty connected with locusts, caterpillars, hailstorms, early frosts and so on.

235. If, for example, a farmer be reasonably certain at the beginning of winter that the following summer will be late, or dry, he would immediately take steps to reduce the number of his stock. This done, he is left with a greater provision of fodder and water per head of stock, with the result that his reduced flocks stand a far better chance of holding out until rain comes. If, as at present so often is the case, the farmer at the beginning of the winter, has not been able to dispose of his surplus stock or, optimistically expecting an early and a good summer, keeps his flocks and herds intact, the end of the winter sees the last of his fodder and, with no rain in sight, he is forced to "trek" with his stock, or otherwise wait, hoping against hope, for rain every time a cloud shows above the horizon. Not only is every day of waiting a day of starvation for his stock, but each day sees a decrease in the strength of his animals, his lambing is a failure and he also loses many adult sheep.

236. It is thus evident that seasonal forecasts would reduce stock losses to a considerable degree. It would also reduce overstocking, overgrazing and attendant evils (see Chapter VI.).

237. Correct forecasts would also be of great assistance to the agriculturist as distinct from the stock farmer. They would guide the farmer in the drier regions in deciding whether he should risk the cost of ploughing and seeding or whether the drought would nullify his labour. In many parts of the country farmers have the choice between "lands" on high-lying, and "lands" on low-lying localities. The former are possibly excellent in wet, but not so good in dry seasons, while the latter yield good returns in dry, but fail in wet years. Here again then a good forecast would enable a farmer to choose correctly and thereby reduce his losses to a considerable extent.

238. In certain parts of the Union, witnesses informed the Commission that, in wet years, they look to their cattle for returns, in dry years to their sheep. With seasonal forecasts it would be possible for such farmers to make better selection when disposing of stock at the beginning of winter.

239. *These preliminary remarks are necessary to show the economic value seasonal forecasts would have in reducing stock losses, in increasing production and reducing soil erosion.* Forewarned is forearmed, and the enormous economic advantage that would attach to seasonal forecasts led your Commission to investigate the possibility of making such prediction.

240. Before proceeding with the discussion of seasonal forecasts, it may perhaps be advisable to state briefly the methods employed by forecasters. In the first place a large number of observers is required, well distributed over the area to be studied, and the area affecting it. These observers at a definite hour of the day, usually the early morning, make their observations of pressure, temperature, wind, rainfall, cloud and so on, reporting by telegraph to headquarters. At headquarters the forecaster plots all the information received on a map, and knowing that weather conditions—for example a condition of high pressure—move in a general easterly direction, he is enabled to forecast probabilities to the east of his known conditions. Naturally, in practice forecasting is not simple, and the forecaster needs much experience, not only general, but also of the particular area with which he is dealing, in order to be successful.

241. Forecasts made in this manner are usually for periods of from 24 to 48 hours, although in fairly settled weather, when for example the velocity of areas of high or low pressure is small, forecasts of over a week have been made with success. The essential of this system is a sufficient number of stations properly located, including many to the West of the area for which the forecast is to be made.

242. Forecasts for longer periods are frequently attempted by investigation of the probability that one meteorological phenomenon will follow on another. Thus, for example, in the Union it is well known that certain districts almost invariably get their first Summer rains long before rain commences in other parts. Suppose, for example, it be found over a number of years that a supernormal rainfall during certain weeks in one district is followed by copious December rains in another district and, further, that when the rainfall is subnormal there is invariably no rain in the other district before the beginning of February, it would be possible to forecast the weather for the latter district if the weather of the former were known. The work that would be entailed in the examination of records of various phenomena is prodigious, as a very large number of failures to establish correlations must result. Many correlations have however been worked out, and this is one direction in which the science of meteorology is developing.

243. Underlying the whole science of meteorology is the physics of the air. Air, whether in a bottle in a laboratory or drifting above the highest cloud, is governed by the same physical laws; and around the entire globe called the earth is *one* envelope of air, free to move in any direction, subject only to definite physical laws. Although accurate detailed study and routine observations are necessary for every place, it is futile to confine attention to one particular portion and hope therefrom to obtain a full explanation of the whole.

244. Meteorologists are rapidly coming to the conclusion that to understand weather it is necessary to take into account enormous areas. Although the air in the laboratory and the air in the atmosphere obey the same natural laws there are many natural factors affecting the weather, which are not easily ascertained or measured. This makes the problem of predicting what will happen in the atmosphere infinitely more difficult than predicting the result of a laboratory experiment, in which all factors are under direct control. Still, in spite of all difficulties the problem does not appear to be insoluble.

245. Marked similarities in weather conditions—in rainfall for instance—have been shown to exist in far-separated countries in the Southern Hemisphere, and it would appear that successful forecasting is merely a question of more observations and exhaustive study. In this opinion your Commission is supported by eminent meteorological and climatological specialists such as Dr. Simpson, Chief of the British Meteorological Service, and others whose views are recorded in Appendices Nos. 1, 2, 3, and 4.

246. Your Commission does not make definite recommendations as to the details of the investigations required to make such forecasts possible. A great deal more technical evidence than was submitted would be needed before it would be in a position to make such recommendations. In order, however, to give an idea of what might possibly be needed, your Commission may mention: (a) The establishment of a certain number of meteorological stations in the Antarctic—preferably with the assistance of other States in the Southern Hemisphere; (b) The study of currents and movements of icebergs in the Antarctic and Southern Oceans; (c) The establishment of more stations in Equatoria; and (d) The more effective use, for weather observations, of vessels sailing to and from the Union. These points, let it be clearly understood, are merely tentative suggestions showing possible directions in which the search for knowledge may extend.

247. In conclusion your Commission desires to point out that experts consider the chances of successful seasonal forecasts are ever so much more favourable in the Southern than in the Northern Hemisphere. At present in the Northern Hemisphere also, the movement among meteorologists is to establish stations as near the pole as possible. In a letter to our Commission Dr. Sutton, the well-known meteorologist, writes:—

“This country might be some meteorologist’s paradise. Our geographical position is so fortunate that we ought to be 50 years ahead of the rest of the world in successful seasonal forecasts.”

248. Your Commission cannot leave the question of rainfall-prediction without referring to the fascinating subject of “cycles.” The hope of establishing definite cycles of regularly recurring weather phenomena has stirred many breasts. South Africa too, has had its exponents of cycle theories, and some have been so plausible and have obtained such a hold on the public mind, that brief reference thereto is desirable.

249. A few of the many cycles which have claimed attention in connection with weather are Bruckner’s cycle of thirty-five years and others of twenty, eighteen, fourteen, eleven-and-one-tenth, nine-and-a-half, and seven years. In addition there is the variable sunspot cycle theory and the theory that the approach of lunar eclipses to one or other of the equinoxes is accompanied by certain changes in the rainfall: theories which also have their adherents.

250. When one bears in mind the large numbers of cycles that have been proposed and to the satisfaction of the discoverer, proved, it is evident that it is either merely coincidence that they have all more or less fitted the periods to which they were applied or, otherwise, that some or all of them are correct and should, with others yet undiscovered, be simultaneously applied to obtain the true resultant cycle.

251. Cycles of many kinds do, of course, exist in natural phenomena as, for example, the monthly waxing and waning of the moon. Others are more complicated, such as the tides of the sea which, depending mainly on the position of the Moon and the Sun relative to the Earth, give an instance of two cycles imposed one upon the other. Three, or even more cycles, may be imposed upon one another, and the more there are, the more likely that the “period” of the resulting cycle—that is the time from the occurrence of one phenomenon to the exact recurrence of that same phenomenon—will be extremely long. Also, with each additional factor or cycle imposed, the complexity of the resultant cycle is increased. Even two super-imposed cycles, with slight differences in period may have as resultant a cycle with a very much longer period than either. Take, for example, two regularly varying factors, one with a period of 999 hours, the other with one of 1,001 hours. The period of the resultant of these two cycles would be 999,999 hours, or over 114 years. That is, 114 years would have to elapse before phenomena, the resultant of the two mentioned factors, would begin to repeat themselves.

252. Man has not yet succeeded in tracing or weighing all the factors influencing climate, but that there is a very large number of factors, major and minor, is evident. And when one considers that many of these factors may themselves not be subject to regular cycles, the hope of discovering some simple regular cycle appears remote. This does not, of course preclude the possibility of discovering a complicated cycle or roughly regular minor variations imposed on major oscillations. But the simple cycles born of the examination of the rainfall of a limited number of years, and the urgent desire to push aside the heavy curtains shutting out the future, are doomed to early death when exposed to the test.

253. Your Commission finds that forecasts of seasonal variations would:—

- (i) Reduce losses due to periodic droughts,
- (ii) Reduce overstocking, overgrazing, and soil erosion,
- (iii) Increase production,
- (iv) Become possible as a result of an extensive continuous study of the climatology.

254. Your Commission therefore recommends that:—

- (i) The question be submitted to a committee of specialists to draw up recommendations as to the scope and nature of the necessary observations and study, and the best method of internationalising the investigation, if this should prove advisable.
- (ii) The survey of our coast, at present being conducted, should include the recording of observations which, though not necessary from a navigation point of view, may help to throw light on the climate of the Union.

XVIII. DETERIORATION OF VEGETAL COVER AND DIMINISHING POPULATION.

255. In Chapters III, IV, V, VII and VIII, faulty farming as practised in many parts of the Union, with the resulting deterioration of the vegetal cover and soil erosion, was discussed in general terms. It is proposed now to submit an analysis of the census figures, which was

carried out to ascertain whether any reflection of the conditions, described in the above mentioned chapters, could be traced in the variations of population.

256. The census returns since 1856 were first examined in general. Particular attention was then given to those districts which showed decreases. It immediately became apparent that every Census, since 1856, showed an increase in the European population of the different States making up the Union to-day. Naturally, the population of every district had not grown at the same speed, some having shot ahead far more rapidly than others; but from 1891, the returns show, not only varying speeds of growth, but also actual retrogression or decrease of the European population, in certain districts.

257. This, although it arrests the attention, is not in itself alarming until a further comparison of districts, showing decreases for each census period, brings to light that, with a few minor exceptions, it is the same districts which time after time exhibit a decrease. That a young country such as South Africa should exhibit large areas in which the white population is steadily decreasing, may point to an abnormal and unhealthy state of affairs in those districts which demands investigation.

258. The information obtained from the census returns has been plotted on a map (see Map No. I) for clear presentation. Every district which is tinted on the map is a district whose European population, at some previous census date, had reached a higher figure than the most recent one (i.e. 1921). The primary colours red, yellow and blue, and the red hatching indicate the census dates at which the population was greater. Where these colours are superimposed secondary colours—orange, green, or purple, or the tertiary, gray—or any of these colours under hatching may result. Such colours indicate districts for which at two or more census takings the population was less than at the 1921 census. The legend on the map makes the meaning of the colouring quite clear.

259. It will be seen from this map that the decrease commenced in Richmond in 1891 and spread during the following period until, at the 1904 census, a similar decrease is shown for practically the whole Cape Midlands. The affected area is roughly outlined by straight lines joining up the following districts: Hay, Willowmore, Albany, Albert and thence back to Hay. A few isolated districts to the North and East also show larger populations at 1904 than at 1921. In 1911 practically the whole area is again included, while to the West and the East new districts show up, and the Orange Free State, as far as Hoopstad, is affected. The following census shows further districts to have decreased between 1918 and 1921. The area of 1911, with the exception of the central portion, still shows a decrease, while to both North and West new districts are included.

260. Isolated districts in Natal and in the Cape Native Territories, not connected with the above main area, also show decreases of white population at certain periods; but in many cases the districts have so small a white population that the decrease is immaterial. In other cases again the decrease has been arrested. Impendhle is the only one of these districts which has consistently shown a decrease.

261. The reason for a decrease in certain districts at certain times is traceable to the removal of a military garrison, the completion of some large engineering work, the closing down of mines, or some similar cause. According to a census report some magistrates explain decreases in population by the amalgamation of farms, while others again suggest subdivision as the cause. It would not appear possible for both explanations to be correct. While a definite occurrence, such as the removal of a garrison, will explain an isolated decrease in population, a general continuous decrease over so large an area can be due only to some general widespread cause, which needs to be found. It should be mentioned here that, owing to the numerous changes in the boundaries of districts, it was necessary occasionally to estimate the population of certain areas. While this estimate may not be quite exact in the case of individual districts, it cannot affect the totals for the whole area to which we now turn.

262. For the purpose of further discussion, it has been deemed advisable to confine the attention to the main area showing the reduction in European population. This area is tinted on Map No. II and, as will be seen, is more or less the area enclosed within the lines joining the following districts: Hopetown, Willowmore, Peddie, Aliwal North, and back to Hopetown. *The Census figures for this area show a continuous rise until the 1904 census and a continuous drop since that date:*

Year.	European population.
1865	57,780
1875	69,491
1891	96,777
1904	120,941
1911	115,187
1918	108,268
1921	105,940

263. In connection with these figures it should be noted, firstly, that in 1904 the population of the Cape Colony had not yet returned to normal after the inflation caused by the war years, and that the reduction between 1904 and 1911 for the Midlands is therefore unduly exaggerated. But if that argument be true the average rate of decrease between 1904 and 1911 would be greater than at any subsequent period. Actually it was least during those years. The following table gives the actual decrease per year and the decrease per year per thousand of population during the specified periods.

Period.	Actual annual decrease.	Annual decrease per 1000.
1904-1911	822	6.8
1911-1918	988	8.5
1918-1921	776	7.2

But in interpreting these figures it must not be overlooked that the influenza plague of the Spring of 1918 was responsible for a greatly increased death-rate in this area as well as in the rest of the Union. Secondly, it may be argued that the reduction in population is due to the colonising of the Northern parts of the sub-continent which, to a certain extent, has always been a drain on the Cape Province.

264. In order to investigate this latter point, diagrams have been drawn comparing the actual population of the area under discussion with that of the whole of the Old Colony, and showing the relative decrease (Figures No. 1 and 2). The boundary of the Cape Colony in 1875 is taken as a basis, since that places not only the Northern Ranching Territories and the Witwatersrand outside discussion, but also the Diamond Fields, which have also acted as a drain on the population of the Mother Colony. We are thus left, for purposes of the comparison, with two portions of the Cape Province, in both of which farming is (or was until very recently) practically the one and only industry. In Figure No. 1, the population for the whole Colony (1875 boundary) is shown to have grown steadily until 1904, when the inflated abnormal figure (520, 882), due to the Anglo-Boer war, was reached, only to be followed by the drop occasioned by the exodus following on the post-war depression, 1904-05. The population seems to have returned to normal again in 1911 (512, 074), since when the growth has been steady and continuous to 1921 (613,766). But the Midlands Districts—the area with which we are particularly concerned—show no recovery, but continue to decrease from 1904, as shown in paragraph 262.

265. While the actual decrease in the population in sufficiently apparent from Figure No. 1, the relative decrease, in comparison with the remainder of the Cape Province, is shown more clearly in Figure No. 2, where it is seen that these Midland Districts, which in 1865 supported 30.5 per cent of the whole European population of the Colony, in 1921 supported only 17.3 per cent. of the Europeans of the same area. Another point brought out by this diagram is that almost the entire reduction has taken place since 1891.

266. From this last diagram it is perfectly clear that the Midlands have lagged, and are lagging, behind the rest of the Province. The Diamond Fields, the Gold Fields, the Ranches of Rhodesia, the Coffee Plantations of East Africa all acted as lodestones, drawing settlers and adventurers from the Cape Province, but, apparently, the attraction was stronger in the case of the inhabitants of the Midlands than in the case of those of the Western Province. Generally speaking, it is the greater facilities in another district or country for making a living or money which induces a man to migrate. The decrease in the number of European inhabitants in the Midlands, therefore, leads one to the conclusion that it has become relatively, or actually, more difficult to make a living there than in the remainder of the Cape Province.

267. It must now be ascertained whether this reduction is actual or entirely relative. There can be no doubt that the advances of other portions of the Cape Province has magnified the relative decrease in the attractiveness of the Midlands. Through the establishment of factories, the increased export of fruit, jams and so forth and, generally, through vastly improved market facilities, parts of the Province have forged ahead, and can carry a very much larger population than they could a decade or two ago. This rapid improvement of one part would naturally, without any actual deterioration of the other, cause the latter to fall behind. Still there may be an *actual* retrogression in the backward districts—and actual decrease in the rate of production.

268. Even though the white population decrease, there is no reason why, if the productivity of the country remain the same, the number of small stock should decrease. In an agricultural district the total crop yield depends to a considerable extent on the labour and capital available, but in a small-stock area such as the Midlands of the Cape Province, the reduction in the number of small-stock should not follow a reduction in the number of white inhabitants.

269. Investigation shows that there has been a very considerable decrease in the number of small-stock in this Midland area, and since this reduction cannot have been occasioned by a reduction in the number of whites, it must have been caused by conditions disadvantageous to small-stock. The number of small-stock in each census year is plotted on Figure No. 1. By the use of two vertical scales it has been possible to show both the changes in population and changes in numbers of small-stock on one diagram. The vertical scale, on the left is the one used in plotting the population curves, the one on the right, for plotting small-stock data. On this diagram it is shown how the number of small-stock grew from 4,556,700 in 1856, to 9,558,940 in 1891, only to drop to 6,908,302 in 1904 as an effect of the war. In 1911 the number had reached 9,458,200—practically the same as in 1891. From the year 1911 the number dropped to 8,622,996 in 1918, and to 8,153,985 in 1921. It is necessary to add here that the small-stock figures and populations of paragraph 262 are for identical areas subsequent to 1891; but prior to that, the areas are slightly different as is shown by Map No. III.

270. It would thus seem clear that the productivity of the Midlands of the Cape Province has actually decreased in latter years: the lagging behind the remainder of the country has not been relative only. The commencement of this period of waning productivity is difficult to fix owing to the abnormal conditions brought about by the Anglo-Boer War.

271. While the decrease in production is certain, the reason therefor has still to be sought. It may be due to a decrease in the average rainfall of recent years, but even after making due allowance for the varying intensity of stocking, it is extremely difficult to trace definitely any reflection of the average rainfall in the number of small-stock. On the other hand, the decrease in productivity may be due to a decreased efficiency of the rainfall—that is to destruction of vegetal cover, spread of non-edible plants and soil erosion.

272. The statistical proof of large movements demands observations extending over a long period. In the present case the intervention of war conditions caused a break in the natural rise and fall of the number of small-stock, and the period which has elapsed since the first normal post-war stock census (1911) is too short to furnish by itself sufficient data for absolute proof. But with the evidence of farmers belonging to those districts before it, your Commission has no hesitation in stating that it is the deterioration of the vegetal cover and soil erosion that has caused this reduction in productivity. *In other words the declining European population of these districts is a first sign of that general deterioration of the country which is bound to follow the present prevalent methods of stock farming and is a warning to the remainder of the country.* The general though gradual improvement of stock is a factor tending to reduce the intensity of stocking, but experts inform your Commission that the reduction thus brought about is very small compared with the total reduction.

273. A point which deserves consideration in this connection is the comparison of conditions existing in the Cape Midlands and in other dry portions of the Union. Why should this decrease have taken place in the Cape Midlands and not in the Cape North-west, where the rainfall is less, the variations as great, and the drought as severe as in the Midlands? The decreases in population, where they exist, are of more recent date. Whence this difference?

274. Stock require water and food. Drought losses, as has been stated previously, are due directly to thirst and starvation and, indirectly, to disease, which more readily leads to fatal results in the case of impoverished animals. Where water is obtainable in reasonable quantity at reasonable distances during normal times, edible vegetation is the factor limiting the number of small stock which may be grazed, and as a result the veld is overgrazed. This overgrazing spells ruination of the veld and soil-erosion. *It is therefore to be expected that the veld, in districts where water is fairly plentiful, will, under present farming methods become more or less rapidly destroyed, and less and less productive. On the other hand, where drinking places are scarce, water becomes the limiting factor in the carrying capacity of the farm. In such a case as the latter, while the veld may suffer more from trampling than in the first case, and the vegetation in the vicinity of the drinking places be as badly overgrazed, the total damage done to the vegetation as a whole is less, the vegetal cover is not deteriorated to the same extent, and the productivity of the district is not decreased.*

275. When one examines the maps showing the number of drinking places in various parts of the Union (see Map No. IV), it is seen that these places are plentiful in the Cape Midlands and very sparsely distributed in the Cape North-West. Following the reasoning of the last paragraph, one would expect deterioration of the veld, reduction in the carrying capacity of the country and a declining population in the Cape Midlands, but not so in the Cape North-West. This actually is the case.

276. The same course which has been followed by the Cape Midlands appears to lie before the Southern and Western Free State. Overstocking in these districts was generally admitted by farmer witnesses. The signs are visible, the writing is on the wall: destruction of vegetation, spread of non-edible plants, soil erosion, and a dwindling population are all present. Only the fact that the Orange Free State has not been stocked as long as the Cape Midlands has saved it from exhibiting, for as long a period, the same unsatisfactory symptoms.

277. Your Commission :

- (a) **Has ascertained that the European population in more than thirty Midland districts of the Cape Province has steadily decreased, the decrease being 12.4 per cent. in 17 years.**
- (b) **Has ascertained that the small-stock in this area has also decreased, the decrease being 13.8 per cent. in 10 years.**
- (c) **Believes that this decrease is the result of a diminished productivity or stock carrying capacity of the veld, brought about by overstocking, overgrazing and the resulting soil erosion.**
- (d) **Desires to submit these facts in order to emphasise the disastrous effect of the prevailing system of stock-farming discussed in the Interim Report.**

XIX. THE GRAZING SURVEY AND POSSIBLE INCREASED WOOL PRODUCTION.

278. In the previous chapter the disastrous effect of the present system of stock farming was shown to be reflected in past censuses, and the magnitude of the evil already done was approximately described. Your Commission, however, considered it its duty not only to attempt to portray the present tendency, but also to estimate the economic possibilities of the application of its recommendations with reference to improved methods of grazing. With this object in view the grazing survey mentioned in paragraph 136 was carried out.

279. In collecting this information, the Sheep Division of the Department of Agriculture was most helpful. A long questionnaire dealing with many phases of sheep farming was circulated among the sheep inspectors. *Inter alia*, each was requested to estimate the average small-stock-carrying capacity of his area (a) under existing conditions, and (b) under improved conditions of efficient paddocking, comparing these estimates at the same time with the number of stock *actually* running to-day. In addition, each was asked to express an opinion on the size of paddocks required, to estimate the average distance that flocks are driven to water in times of drought ; and many other points were included, which demanded a thorough knowledge of local conditions.

280. Questions of this nature, dealing with averages over considerable areas which include many grades of farms, are extremely difficult to answer. It was, therefore to be expected that the replies, in very many cases, would be conflicting, the more so, when it is remembered that certain of the questions referred to conditions (such as the free grazing of small stock), which at present do not exist in many districts. Again in other parts, such as the Northern Transvaal, sheep farming is not carried on very extensively and the potentialities of such regions for this purpose are unknown. Notwithstanding, it is agreeably surprising to see the remarkable consistency of the data supplied by the inspectors, and the Commission heartily thanks them for the able way in which they replied to the questions.

281. Naturally, replies to questions, such as the stock-carrying capacity of a district, can only be approximations, because the capacity of the veld frequently varies greatly throughout a district. So, too, can replies regarding the most advantageous size of paddocks—which depends on the vegetation, the availability of drinking-water and the size of flocks—be subjected to criticism. But when the information is plotted on a map, the consistency of the data supplied becomes evident. The stock-carrying capacity of a district depends, to a considerable extent, on its rainfall and, therefore, any map which gives information concerning stock-carrying capacity may be expected to correspond roughly with the rainfall map. This is actually the case. Not only does the greater part of the data supplied by the sheep inspectors show *gradual* changes in magnitude as the rainfall varies from district to district, but many marked salients of the isohyets are reflected in the grazing maps. *All these points go to establish the value of the information supplied by the sheep inspectors.*

282. The isohyets, that is, lines of equal rainfall, exhibit considerable regularity (see Map No. V) ; yet a few marked irregularities appear. There is the high-rainfall area on the escarpment between the high and low veld of the Northern Transvaal ; then the spur extending due west from Pretoria. Another projection extends West-north-west from Bloemfontein ; another, to the South of Queenstown, extends westward. Finally, there is the high rainfall area around Knysna, and another in the Cape Peninsula-Paarl region. Everyone of these irregularities is reflected in the grazing maps, *with the exception of that of the Northern Transvaal (see Maps Nos. VI, VII, and VIII) whose potentialities for sheep farming are not yet fully known.* Similarly, a comparison of Map No. IX, showing the distance stock is driven to water (derived from reports of sheep inspectors) with Map No. IV, showing the number of drinking places in various districts (based on data obtained from other sources) indicates that the information on which this series of maps is based, is reliable.

283. These grazing maps give no information concerning native territories, as conditions there are so different from those existing in European districts. Also, it is necessary again to state the information from the Northern Transvaal is not entirely reliable. Map No. VI shows the approximate grazing capacity of the various districts of the Union. Naturally, individual farms or even small areas, may have a larger or smaller capacity than shown by the map, which reflects the general present position. Map No. VII shows what the stock-carrying capacity of the Union would be if farms were properly paddocked and stock allowed to graze freely. A comparison of these two maps (VI and VII) clearly shows a shrinkage of the area of minimum capacity. There is a general movement of dividing lines to the West, indicating a general increase of capacity over the entire Union.

284. Map No. VIII answers the question—How large should these paddocks be? It must be remembered that Maps No. VII and VIII are based on estimates. In many districts the final effect of paddocking cannot be stated, as it has not yet been tested. For the same reason, too, the correct size of paddocks has not yet been determined. These figures, which represent merely the opinion of men who are daily among the flocks of their districts, are the best available information and will probably remain so until the investigations recommended in paragraph 227 have been conducted.

285. Map No. IX graphically shows the tragedy in the life of small stock in South Africa. In paragraph 63 *et seq* the question of driving stock to water was discussed. The Map indicates the extent to which this occurs. In the North-west of the Cape Province, the unfortunate animal cannot get water every day, but has to go alternate days without water—at such great distances do the drinking places lie from the grazing grounds.

286. Map No. IV, which is self explanatory, was prepared to check the information contained in Map No. IX, and in order to demonstrate the points raised in paragraph 275. It is of interest, while on the subject of drinking places, to analyse their character. Map No. X shows the distribution of drinking places, which derive their water from an underground supply, and a comparison of this with Map No. IX will indicate to what extent stock farmers are dependent on underground water. In Maps No. XI, XII and XIII, the analysis is carried still further, the number of boreholes, wells and springs used for watering stock being shown. From these maps the sparseness of boreholes in the North-Western Karroo becomes patent.

287. The maps discussed in this chapter show very clearly the general position in the Union at present, but a further investigation is needed to show what economic results may be expected if the proposed system of stock-farming becomes general.

288. The answers to the questions concerning the present intensity of stocking, the present and the estimated stock-carrying capacity under the paddock system, have been carefully studied. A few inspectors appear to have very optimistic ideas, for occasional estimates of an increased capacity, amounting to six hundred per cent., were received. This, of course, is due to the fact that many of the sheep-inspectors in the Union have hardly a nodding acquaintance with the possibilities of paddocking. In the case of estimates of over one hundred per cent. increased capacity the reduced figure of one hundred per cent. was adopted in making deductions from these data. Other inspectors of more pessimistic outlook, with probably no greater experience than their optimistic colleagues, do not think that the capacity of their districts would be at all increased by paddocking. Their figures, showing a zero increase, have been adopted. This method of treating extremes was decided on in order to insure a conservative estimate of average increased capacity.

289. In some instances inspectors reported their areas capable of carrying more stock even under present conditions and, with paddocks, still further increases. In these cases the difference between the estimated figures for farms fully stocked under existing conditions and the estimated figures for improved conditions, has been adopted as the amount by which the numbers can be increased. This, naturally, is smaller than the actual possible increase. On the other hand, there are districts which are so heavily overstocked, that the improved grazing conditions, which accompany paddocking, will enable them to carry safely little or no additional stock. In these cases the estimated increase, adopted for purposes of calculation, was not the increased safe capacity, based on sane stocking, but the excess, if any, of the estimated future capacity over the number now being carried.

290. Thus, a conservative estimate was made from the reports of the sheep inspectors. District by district was tabulated and, taking the latest figures available for woolled sheep, estimates for the increased capacity for each magisterial district were made. The table below is a summary of the results, and shows how, if paddocking were generally adopted, the number of woolled sheep in the Union could be increased without giving over any additional farms, or portions of farms, to the industry.

TABLE.

291. Showing estimated increases in the number of woolled sheep resulting from paddocking.

Area.*	Present number.	Estimated increase.	Estimated total numbers.
<i>Cape.</i>			
West	919,326	533,648	1,452,974
South West	992,386	542,023	1,534,409
South	608,215	337,810	946,025
Central	4,250,907	2,696,346	6,947,253
East	3,477,543	1,379,815	4,857,358
Bechuanaland	429,686	295,530	725,216
Griqualand West	580,284	465,633	1,045,917
Total for Cape	11,258,347	6,250,805	17,509,152
<i>Natal</i>	1,208,262	472,388	1,680,650
<i>Transvaal.</i>			
North	445,320	332,441	777,761
South	2,403,085	1,114,030	3,517,115
Total for Transvaal	2,848,405	1,446,471	4,294,876
<i>Orange Free State.</i>			
East	4,732,732	2,655,429	7,388,161
West	2,876,102	1,550,290	4,426,392
Total for Orange Free State	7,608,834	4,205,719	11,814,553
<i>Union.</i>			
Cape Province	11,258,347	6,250,805	17,509,152
Natal	1,208,262	472,388	1,680,650
Transvaal	2,848,405	1,446,471	4,294,876
Orange Free State	7,608,834	4,205,719	11,814,553
Total for the Union	22,923,848	12,375,383	35,299,231

This estimate shows that if all the areas at present given over to Sheep-farming were properly paddocked, they would be able to carry 54 per cent. more woolled sheep.

*The Magisterial districts included in these areas are :-

Cape West.—Calvinia, Ceres, Clanwilliam, Fraserburg, Kenhardt, Ladysmith, Laingsburg, Montagu, Namaqualand, Piquetberg, Robertson, Sutherland, Tulbagh, Van Rhynsdorp, Worcester.
 Cape South-West.—Bredasdorp, Caledon, Cape, Malmesbury, Paarl, Riversdale, Simonstown, Stellenbosch, Swellendam, Wynberg.
 Cape South.—Albany, Alexandria, Bathurst, East London, George, Humansdorp, Knysna, Komgha, Mossel Bay, Oudtshoorn, Peddie, Port Elizabeth, Uitenhage, Uniondale.
 Cape Central.—Aberdeen, Albert, Beaufort West, Bedford, Britstown, Carnarvon, Colesberg, Cradock, De Aar, Graaff-Reinet, Hanover, Hopetown, Jansenville, Maraisburg, Middelburg, Murraysburg, Pearston, Philipstown, Prieska, Prince Albert, Richmond, Somerset East, Steynsburg, Steytlerville, Tarka, Victoria West, Willowmore.
 Cape East.—Adelaide, Aliwal North, Barkly East, Cathcart, Elliot, Fort Beaufort, Glen Grey, Herschel, King Williamstown, Maclear, Molteno, Queenstown, Stockenström, Stutterheim, Victoria East, Wodehouse.
 Bechuanaland.—Gordonia, Kuruman, Mafeking, Taungs, Vryburg.
 Griqualand West.—Barkly West, Hay, Herbert, Kimberley.
 Transvaal North.—Barberton, Benoni, Boksburg, Germiston, Johannesburg, Krugersdorp, Lydenburg, Marico, Middelburg, Pietersburg, Pretoria, Rustenburg, Waterberg, Zoutpansberg.
 Transvaal South.—Bethal, Bloemhof, Carolina, Ermelo, Heidelberg, Lichtenburg, Piet Retief, Potchefstroom, Standerton, Wakkerstroom, Wolmaransstad.
 Orange Free State East.—Bethlehem, Ficksburg, Frankfort, Harrismith, Heilbron, Kroonstad, Ladybrand, Lindley, Rouxville, Senekal, Thaba Nchu, Vrede, Vredefort, Wepener, Winburg.
 Orange Free State West.—Bethulie, Bloemfontein, Boshof, Edenburg, Fauresmith, Hoopstad, Jacobsdal, Philippolis, Smithfield.

292. A similar analysis with respect to non-wooled sheep would show a similar result. As, however, the total number of all other small stock is only about one half of the number of woolled sheep, the case of the woolled sheep is more important and sufficiently convincing.

293. It follows from the estimated increased capacity of 54 per cent. that it would be possible to run 154 sheep where to-day only a hundred can be run. All witnesses, who have experience in these matters, agree a sheep is so much healthier, and grows so much better when allowed to run free, that it produces more wool. Assuming this increase to be at least one-sixth, the wool from 154 sheep would be more than produced by 179 sheep under present conditions. Not only do sheep, under free-grazing conditions, produce *more* wool, but they produce *better* wool and, owing to their not sleeping in kraals, the wool is much cleaner. The result is a higher price per pound for the wool. Assuming the increase in price to be only one-eighth, then the wool from 179 sheep would fetch as much as that from 202 sheep under present conditions. This is an increase of one hundred and two per cent. over present day production. In other words, given a stable market, *paddockocking will more than double the money annually received for wool in the Union.*

294. It is difficult, owing to the fluctuating market of the last eight years, to estimate the annual value of the woolclip of the Union, but one may assume that the amount of wool exported during the year 1922-23 (184,000,000 lbs., which is very nearly identical with the wool exported during 1913) represents a normal clip. The average price of the 1922-23 clip was approximately one shilling per pound, and assuming this price to be normal, we arrive at the globular figure of £9,200,000 as the normal annual value of the Union wool-clip. One hundred and two per cent. of this is £9,384,000, and this latter figure, therefore, represents the increased annual income from wool, which may be expected if paddocking be generally adopted. To arrive at a conservative estimate of the capitalised value of this annual income, we have calculated on a ten per cent basis, and reach the very satisfactory amount of £93,840,000.

295. The latest published total valuation of the Cape Province, exclusive of Bechuanaland and the Territories, is that for the year 1918, and it amounts to £156,266,346. The general adoption of paddocking will therefore result, on the basis of wool increase alone, in adding to the Union, without additional cost of administration, the equivalent of a New Province equal in value to over sixty per cent. of the 1918 valuation of the Cape Province.

296. In addition to the increased value of the annual wool production, there is the increase in mutton production and sheepskins. In the same manner as the increased woolclip was estimated, so may the increased mutton production and the increased skin production be estimated. A conservative estimate would give an increase of 70 per cent. for the former, and 50 per cent. for the latter. No figures for the annual mutton production in the Union are available, but assuming the weight to be in the neighbourhood of one-hundred-and-eighty million pounds, and the value £2 per hundred pounds weight—during the years 1916-20, inclusive, the value of imported mutton was £2-12-6 per hundred pounds; of mutton exported, £3 9s. 11d. per hundred pounds—we have :—

Annual value of present production of mutton	..	..	..	..	£3,600,000
70 per cent. increase	..	..	..	..	2,520,000
The average annual export of sheep skins 1916-20	..	..	..	..	1,762,642
50 per cent. increase	..	..	..	..	881,321

297. The case of angora goats is somewhat different. Mohair has a limited market, and an increase in annual output will not necessarily increase the total value. Possibly areas at present devoted to producing mohair, may later be used for grazing woolled sheep; but many such districts, through the nature of the veld, are unable to carry sheep. For these two reasons it is not proposed to include in these calculations the financial betterment that paddocking will bring to the angora goat areas.

298. A larger number of goat skins of all kinds will however be produced as the result of paddocking. Assuming the increase to be 50 per cent. of the average annual value of the exports for the period 1916-20, which was £627,760, the future increased annual value of goat skins will be £313,880.

299. The estimated financial improvement in small-stock farming resulting from the adoption of paddocking is thus summarised :—

Increased annual value of wool	..	..	..	..	£9,384,000
sheepskins	..	..	..	..	881,321
mutton	..	..	..	..	2,520,000
goatskins	..	..	..	..	313,880
Total	..	..	..	..	£13,099,201

say £13,100,000 which, capitalised at 10 per cent. as in paragraph 294, is £131,000,000. This figure is 84 per cent. of the 1918 valuation of the Cape Province. (See paragraph 295.)

300. In addition to the above gains, the adoption of the paddock system would result in considerable savings. Scab and diseases, generally, would decrease and the money now spent in fighting them be saved. The toll paid directly to the jackal and droughts, and the cost

of an army of shepherds would be greatly reduced. The number of Europeans supported directly and indirectly by the small-stock areas would increase and, as a result, the cost per capita for education, railways, and administration generally, would decrease. Soil erosion would become less. All these savings are definite enough but difficult to estimate. The figures tabulated above are sufficient to indicate the economic value to the whole country of the system of paddocking, described in general and in theoretical manner in the Interim Report.

301. There are, of course, parts of the Union where the veld is so poor that it is doubtful whether paddocking is economically possible, but the total number of sheep in these areas is relatively so small that their existence does not appreciably affect the argument of the preceding paragraphs.

302. Your Commission, as a result of an extensive investigation of the possibilities of the paddock system, finds that, apart from various valuable advantages difficult to estimate, the annual income of the Union from small-stock alone will increase by an amount of £13,100,000 if the system becomes general. A fuller realisation of what this means, is to be found in the fact that, capitalised at even 10 per cent., the increased annual income is 84 per cent. of the property valuation of the Cape Province for the year 1918.

XX. WATER, FENCING, JACKALS, STOCK THEFTS, ETC.

303. *Although the matter was dealt with in detail in the Interim Report, it cannot be too often re-iterated that the adoption of the paddock system depends on cheap fencing, a supply of water in each paddock, control of the jackal and prevention of stock-thefts.*

304. In the Interim Report (Chapter XIV) your Commission recommended that the State should encourage farmers in every way possible to improve their facilities for watering stock. Wherever practicable, dams are to be recommended. There are, however, areas where the topography, the nature of the soil and the rainfall make dams unsuitable for providing a reasonably certain water supply. In such cases wells and boreholes must be relied on. Even small dams are a valuable asset, provided the paddocks containing them are grazed before the water has percolated or evaporated. Paddocks containing larger reservoirs, or permanent supplies, should be reserved until the water supply in the others has given in.

305. In recommending dams as desirable sources of drinking water, your Commission wishes it distinctly to be understood that it strongly recommends that stock should not be allowed access to such open water; neither should they be given direct access to springs. The water from all such sources should invariably be piped to suitable drinking troughs. Not only does such an arrangement make for healthy stock, as described in paragraph 62, but it also economises the water-supply.

306. Boring has proved a big boon to South Africa in rendering large areas capable of being grazed which, without boring, would not have been able to carry any stock. At the same time boring has not proved an unmixed blessing. It has been shown in paragraphs 274 and 275 how the presence of many drinking places may lead to overstocking. Boring, being easy and cheap, has replaced the more expensive dam-building. This means that the ground-water is continually being tapped, and dams which, to a greater or less extent, tend to strengthen the ground-water, are not usually constructed.

307. In certain parts, particularly Bechuanaland and Bushmansland including also Namaqualand, it is obvious from the evidence submitted that the losses in time of drought are caused by thirst and not by starvation. (See evidence of Mr. Melville, Appendix No. 33.) In those regions dams are a practical impossibility, owing to the flatness of the topography and the porosity of the soil. Large volumes of water flowing in the rivers disappear in the porous sand in the course of a few miles. Here boreholes are necessary, but it is to be hoped that the settlers in these newer districts will not, when they have sunk more boreholes, so stock their farms as to bring about the same lamentable destruction of the vegetal cover, observable in so many of the older districts.

308. Many were the complaints of witnesses about the costliness of government drilling. It is not necessary to discuss the question here, but what does demand notice is the land settlement attempted in some parts, where men with limited capital have been put on desert farms, whose water potentialities are quite unknown. Frequently such men have been ruined in their fruitless search for water, and the attempts at settlement have proved a ghastly failure.

309. A general shortage of drilling machines was noted throughout the whole Union. Not only do witnesses complain that they have to wait years before effect is given to an application for a government drill but that in many districts private machines are unobtainable, and in connection with the latter there is the further drawback that the owner refuses to drill through hard formations. Your Commission is, however, informed that the number of government drills has been increased recently.

310. The underground water that up to the present has been tapped by the South African farmer lies comparatively near the surface. Our knowledge of the water, existing at greater depths, is still very slight and is limited to information derived from mines, and from one

or two deep holes sunk by private capital. It is highly probable that considerable quantities of water exist at great depths in most parts and possibly this water may permit of economic development. Many witnesses throughout the country have touched on this point, and your Commission urges that the boring of a number of deep holes at suitable points should be undertaken by the State to obtain further information concerning our deep-lying underground water.

311. Quite apart from food considerations, drought resisting succulent plants are to be highly recommended as auxiliaries to the ordinary water supply of the farm. The succulent species which your Commission particularly has in mind are the Prickly Pear and American Aloe (Agave). Experiments conducted at the Grootfontein School of Agriculture have shown what an extremely valuable reservoir the former represents and, in illustration of this point, your Commission refers to the fact that sheep were kept in perfect health at that institution for nearly two years with no other source of water than Prickly Pear.

312. In order further to emphasise the vital importance of an adequate water supply for stock, your Commission cannot do better than quote from Australian experience. It is well known that the droughts of Australia are of greater severity than ours and, doubtless, the sheep farmer of that country has learned through the mill of bitter experience what his South African fellow farmer appears not to have realised so well, namely, that water alone is capable of keeping sheep alive for many days, provided they are properly handled, whereas food with inadequate water is not. Australian experience is summed up in the following passage taken from the authoritative publication "Management and Diseases of Sheep in Australia." (Butterworth & Co., 1920) :—

"In times of drought long stages have often to be travelled with sheep over country devoid of all feed. To accomplish this it is necessary that the sheep should be in a fairly strong condition. Only a tried and experienced drover should be entrusted with this task, as special care and knowledge is required. He should have a good understanding of the sheep's powers of endurance, its digestive system, etc. Under extreme conditions a sheep in fair to moderate condition can exist for 30 days without food, if water is obtainable when required. A drover, knowing this fact, should not hurry his sheep over long stages to get to feed in a few days. Get water for them every day if possible by some means, but let them have their own time to travel along. The leaders should be steadied and the flock should not be harassed in any way, and it will be found that everything will go satisfactorily. If timber is available a few trees can be lopped for sheep, provided they are in good condition and their digestive organs strong, but not otherwise.

If sheep are in poor condition, before it is decided to move them a long distance to fresh country, and if grass or artificial feeding cannot be provided to help them along it is better to let them take their chance at home rather than send them on the roads to die."

313. In outlying parts of the Union, near large cattle ranching areas and near game reserves, sheep farmers complain of the lack of interest shown by cattle farmers in the eradication of the jackal, or they complain that their attempts to eradicate the jackal are useless "while the Government breeds carnivora in the reserve." To cope with this difficulty it was suggested by witnesses that these areas be fenced off and patrolled at the cost of the State, and that legislation be enacted and strictly enforced to make cattle farmers assist in eradication. Your Commission does not consider the time ripe for such action. When the small-stock farmers of these areas have taken steps to commence jackalproof fencing on their own, the State can again consider the problem. The Fencing Act of 1922 is already showing gratifying results, and these areas, sooner or later, will doubtless adopt its provisions for compulsory jackalproof fencing. When this happens, or when the farmers of such areas take other efficient steps to deal with the jackal, the State will be bound to assume its responsibilities in connection with these "jackal-breeding grounds."

314. Your Commission feels that this is an opportune place to refer pointedly to the desirability of an efficient control of insect and other pests, whose depredations may have the effect of seriously lowering the stock-carrying capacity of the farm. It is unnecessary to refer to the locust menace, since Government is fully alive to its seriousness, except to say that if ways and means of destroying the locust could be devised which would leave it as a fodder asset on the veld rather than as at present a potential danger to stock through poisoning, a great advance would have been made towards taking the sting out of locust invasions. From time to time during its journeyings in the Karroo areas, your Commission had brought to its notice the destruction of grazing caused by other insects, and while the depredations due to any of them may not yet have assumed large proportions, it is possible that the total damage done by all such pests may constitute a serious handicap to stock-farming. For this reason, as well as for the reason that it is possible that a presently comparatively harmless pest may at some future date become a serious menace, your Commission is of the opinion

that methods of control should be worked out in respect of all pests that injure grazing in any degree whatever.

315. A conspicuous factor, reducing the grazing yield of many parts, is inedible vegetation. Your Commission has already dealt with this question, particularly with respect to the causes that have led to the spread of such plants (see paragraphs 85 and 92). Under the paddock system the tendency will be in the direction of the suppression of such growths, provided they are not totally repellent in flavour; but there are others which it appears stock cannot be driven to eat although starving. Such are the Rhenoster Bush, the Harpui Bush, and the Jointed Cactus. There is no doubt that efficient economic methods of eradicating these growths are needed and would prove a boon.

316. Your Commission recommends that:

- (i) Dams should be more generally constructed where possible, instead of only sinking boreholes and wells.
- (ii) Stock should not be allowed access to dams, the water of which should be piped to suitable drinking troughs.
- (iii) Settlers in the newer districts, where water has not yet been fully developed, should be warned against the evils of overstocking which, though at present impossible, may become so through the sinking of more boreholes.
- (iv) A number of boreholes should be sunk by the State with a view to exploring deep-lying water.
- (v) The value of succulent plants, such as the Prickly Pear and the American Aloe (Agave) as an auxiliary water supply for stock, should be borne in mind.
- (vi) Methods for control of pests, which reduce the grazing yield, should be devised.
- (vii) More attention should be devoted to the prevention of the spread and eradication of growths known to be useless for fodder purposes and detrimental to the grazing yield.

XXI. COLD STORAGE AND ECONOMIC GRAZING.

317. It was shown in the Interim Report that paddocking would increase the carrying capacity of the veld. In this, the Final Report, an attempt has been made to estimate the financial value of this increased capacity. Owing to the fact that the capacity of the veld depends on climatic conditions it is impossible, without seasonal forecasts, to determine the capacity of a farm for a season ahead. Your Commission has shown that a big advantage would accrue from seasonal forecasts because they would warn the stock farmer to remove, at an early date, unnecessary "eaters" from the veld and thus leave more fodder for the remainder.

318. In a similar manner the establishment of a large number of cold storage depots would favourably affect the position. Conditions to-day are such that at the end of a good season a farmer has a considerable number of fat stock for disposal; but unfortunately, owing to a limited demand, the markets become glutted and prices fall. This leads those, who can, to hold over their stock, which loses weight throughout the winter, and it should be observed, the surplus stock consumes fodder and water, which should have served for the other animals.

319. To some extent the difference in incidence of rainfall in various parts of the Union acts as an equaliser, for fat stock becomes available only as the result of rainfall. For example Namaqualand—an area of winter rainfall—can supply slaughter stock before the veld of summer rainfall areas is green. Generally speaking, however, the greater portion of the slaughter stock of the Union is ready to be removed from the farm at the beginning of winter. Thus, although the demand for mutton is fairly uniform throughout the year, the supply of fat stock is not.

320. Were the farmer assured a uniform price throughout the year, he would be able to direct his farming operations with an eye only to the fatness of his sheep and the state of his veld. If cold storage were available he would dispose of his slaughter stock at the beginning of the winter. Thus would the weight the animal now loses in winter be conserved, and the veld it now consumes in the winter be saved. This would tend to reduce the fluctuation in the price of slaughter stock—an advantage to all concerned—and obviate the necessity for importing mutton which, since 1918, has again been on the increase.

321. An examination of the figures, kindly submitted by the Superintendent of the Bloemfontein Municipal abattoirs for the period April, 1919, to February, 1923, shows that the stock slaughtered there during the latter part of the winter is considerably lighter than the average at any other time of the year. The figures show the decrease during the winter very clearly but the magnitude of the decrease does not reflect very well the state of the stock on the veld. In Summer or early Winter, when the stock is in good condition, the butcher has no need to pick and chose. During that period, therefore, the stock slaughtered approximates more or less closely to the average animal on the veld. In late Winter and Autumn, however, only the best are fit for slaughtering and the abattoir figures are far in excess of the average on the farm.

322. The best months in the period under consideration were January, February and March 1921, when the monthly average weights for sheep slaughtered were 38·4, 38·4 and 41·0 lbs. respectively, and the worst, August, September and October 1922, with monthly averages 31·7, 32·2 and 30·9 lbs. The difference between maximum and minimum monthly means for the period 1920-21 was 5·4 pounds. The two following years give 3·6 and 5·7 lbs. respectively. These figures, as explained above, are considerably lower than the annual alteration in the average sheep; and probably also lower than the loss suffered during the winter by the picked animals actually slaughtered.

323. The average weights for the twelve months, commencing with November 1921, are particularly eloquent of the effect of drought on the slaughtered weight of stock. During this period the rainfall was considerably below normal. In the following table, for purposes of easy comparison, the rainfall of Bloemfontein is placed in a parallel column alongside the weights. Naturally all the stock slaughtered did not come from the Bloemfontein District, nor was the drought as severe in all parts of the Orange Free State as in that district, but nevertheless the Bloemfontein rainfall figures will serve to indicate the severity of the drought.

324.

Year.	Month.	Average weight of stock slaughtered at Bloemfontein Abattoirs.	Rainfall, Bloemfontein, in inches.	Average rainfall, in inches.	Accumulated deficit in inches.	
1921	April	—	2·05	2·06	0·1	
	May	—	2·91	0·80	2·01	
	June	—	—	2·73	0·72	
	July	—	—	0·56	1·28	
	August	—	—	0·21	1·49	
	September	—	0·60	0·68	1·57	
	October	—	0·49	1·70	2·78	
	November	40·2 lbs.	1·36	1·75	3·17	
	December	39·3 "	2·96	2·73	2·94	
	1922	January	37·8 "	1·85	2·48	3·57
		February	38·3 "	1·09	7·83	10·31
		March	36·6 "	0·11	2·74	12·94
April		35·4 "	—	2·06	15·00	
May		34·1 "	0·80	0·80	15·00	
June		32·5 "	2·05	2·73	15·68	
July		32·2 "	—	0·56	16·24	
August		31·7 "	0·16	0·21	16·29	
September		32·2 "	0·06	0·68	16·91	
October		30·9 "	0·65	1·70	17·96	

During the following month rains commenced in Bloemfontein, and the average weights jumped to 34·3 pounds.

325. Your Commission has not attempted to investigate the best method of establishing cold storages; it merely desires to point out their enormous advantages. As long as the storage is well and economically conducted it matters not whether it be carried out co-operatively by farmers (as in the case of creameries), by private enterprise, or by the State, provided that, if it be run by private enterprise, the State or the producer have sufficient control to insure that the results described above are obtained. *Cold storage will increase the productivity of the country, will reduce drought losses and the deterioration of the veld, including soil erosion.*

326. Objections may be raised as to the saleability of the frozen meat. In the first instance your Commission would point out that it is unnecessary that all the meat be frozen. A considerable portion, namely that intended for earlier consumption, need only be chilled. As far as the remainder is concerned, judging from the annual imports of mutton from other countries, there is already a considerable market for frozen meat in the Union.

327. Your Commission endeavoured to ascertain cold storage costs, but its attempts were not very successful. Cold storage, such as that proposed, has not been practised in the Union to any great extent, and the charges quoted to your Commission evidently do not reflect the actual cost, seeing, that with equal facilities for obtaining coal, the charges vary nearly 100 per cent.

328. A more general making of biltong has been suggested as a means of reducing the number of grazers during the winter. Canning and turning into meat extract are likely means of establishing an overseas market for surplus stock.

329. Your Commission.

- (i) Finds that an enormous waste of flesh occurs every year through slaughter stock being kept too long and allowed to decrease in weight through want of food.
- (ii) Believes that cold stores distributed throughout the Union would increase the supply of prime meat in the country, stabilise the market, and reduce veld deterioration.
- (iii) Desires, without discussing how these cold stores should be established, merely to point out their extreme desirability.
- (iv) Considers that the drying of meat, the production of meat extract, and so on, would in a similar manner tend to a more economic use of the veld.

XXII. OTHER PHASES OF OVERSTOCKING.

330. The effect of overstocking both on veld and animal has been treated in detail. It is necessary, however, to refer to certain other phases of the matter.

331. It was suggested by several witnesses that the farmer should be prevented by legislation from putting too large a number of stock on his farm. Other witnesses went even further and suggested that farmers be forced to rest portions of their farms in rotation. Your Commission had made it sufficiently clear that overstocking is detrimental to the country and should be stopped. If this could be done by the mere enactment of legislation, that would unquestionably be the correct procedure; but a law of this nature could not be enforced. A fixed ratio of area to number of sheep could not be laid down for the whole Union not even for a single district. Each farm and farmer would have to be gauged individually, and even then the approved numbers would automatically become more or less than the farm could carry owing to varying seasons.

332. Your Commission cannot, therefore, recommend the legislation suggested, but with the same object in view recommends the less militant measures mentioned in this report in order to lead where driving will not avail.

333. In spite of the enormous ravages of wars, the population of the world is increasing and areas now used for sheep farming are slowly being taken up for other purposes. South Africa, in so far as most of its territory is concerned, will, however, remain a sheep country, because of its greater suitability for this than for anything else, and its importance among the wool-producing areas of the world cannot but increase. At the present time the economics of sheep farming turn about the question: "How many sheep can be carried per morgen?" and this to a large extent depends on the nature of the farm. Soon the question will be: "How many pounds of wool are produced from one morgen annually?" and the answer to that question will mirror not only the capacity of the farm and the quality of the sheep, but also the ability of the farmer.

334. The wool-production of the Union should be increased. On the one hand the area available for grazing is limited, but its carrying capacity can be increased by the methods described in this report. On the other hand there is still considerable room for improvement in the average yield of wool per sheep, and this could be achieved by improving the breed.

335. A very pertinent question which arises, is whether the precarious system of farming at present practised is comparable with the keeping of really good stock. Only after the farmer has taken the necessary precautions against drought losses, dare he consider the purchase of first class stock, for without such precautions the risk would be too great. Thus soil erosion, veld deterioration, lack of foresight in providing for droughts, and resulting stock losses act against the improvement of breed.

336. Extensive areas (mainly in the Transvaal) in possession of Land Companies and absentee land lords, appear to be occupied mainly by native tenants. The communal system of farming, as carried on by the native, is fundamentally bad, but this leasing system, according to witnesses, is even worse. Your Commission endeavoured to ascertain the extent of the areas; but unfortunately statistics were not available.

337. Although overstocking was fully discussed in the Interim Report, there remain a few points which deserve mention:—

- (i) The impossibility of preventing overstocking by law.
- (ii) The detrimental effect of threatened drought losses on the improvement of stock.
- (iii) The destruction of property leased to natives by Land Companies and other absentee landlords.

XXIII. RUNOFF AND EVAPORATION.

338. Water which falls from the sky upon the earth has four possible courses open to it.

- (1) It may run off the surface and find its way into the water courses.
- (2) It may be evaporated from the surface of the soil before it is absorbed or even thereafter, provided it has reached a depth too great for surface tension (capillary action) to draw it to the surface.