are replicated in the above sketch in eight randomized blocks. Note what a " bad " distribution chance often supplies; the chloride plots are all bunched together in the middle of the first block, while they form a solid band across the top block on the right; in the bottom block on the right, too, all the early plots are on one side, and all the late plots on the other.

The value of such large and complex experiments is that all the necessary comparisons can be made with known and with, probably, high accuracy; any general difference between sulphate and chloride, between early and late application, or ascribable to quantity of nitrogenous manure, can be based on thirty-two comparisons, each of which is affected only by such soil heterogeneity as exists between plots in the same block. To make these three sets of comparisons only, with the same accuracy, by single question methods, would require 224 plots, against our 96; but in addition many other comparisons can also be made with equal accuracy, for all combinations of the factors concerned have been explored. Most important of all, the conclusions drawn from the single-factor comparisons will be given, by the variation of non-essential conditions, a very much wider inductive basis than could be obtained, by single question methods, without extensive repetitions of the experiment.

In the above instance no possible interaction of the factors is disregarded; in other cases it will sometimes be advantageous deliberately to sacrifice all possibility of obtaining information on some points, these being believed confidently to be unimportant, and thus to increase the accuracy attainable on questions of greater moment. The comparisons to be sacrificed will be deliberately confounded with certain elements of the soil heterogeneity, and with them eliminated. Some additional care should, however, be taken in reporting and explaining the results of such experiments.

References.—(1) R. A. Fisher: *Statistical Methods for Research* Workers. (Oliver & Boyd, Edinburgh, 1925); (2) " Student ": *On Testing Varieties of Cereals.* (*Biometrika*, XV., pp. 271-293, 1923); (3) Sir John Russell: Field Experiments: How They are Made and What They are. *Jour. Min. Agric.*, XXXII., 1926, pp. 989-1001.)—*The Journal of the Ministry of Agriculture*, Vol. XXXIII., No. 6.

BOOKBINDING FOR THE TROPICS.

Sir ARTHUR E. SHIPLEY, G.B.E., F.R.S.

Since I wrote an article on " Enemies of Books " in the October and November (1925) numbers of *Tropical Agriculture*, I have accumulated a certain number of further facts as to the treatment of books in the Tropics. Dr. T. E. Snyder, Entomologist in the Bureau of Entomology, United States Department of Agriculture, has been good enough to send me the following paragraphs which are of considerable value in dealing with this difficult problem.

In 1908 a joint commission of the Bureau of Standards and the Library of Congress issued a memorandum in regard to certain experiments conducted by the Bureau of Standards, entitled, " Memoranda Relating to the Binding of Publications for Distribution to State and Territorial Libraries and Designated Depositories." This memorandum was published in 1908 by the Joint

Committee on Printing, giving the recommendations based on the results of these experiments. Certain binding materials were found to be superior to others. The results of the experiments with poisons are also to be found in this memorandum which was published unnumbered. It may be stated with reference to these results that they are by no means conclusive.

One of the principal types of serious insect injury to books and paper in the Tropics is that caused by termites or "white ants." These insects usually infest books and paper when they are piled on modern shelving, in wooden book cases, or on flooring. Hence, injury by them is secondary to the injury to the woodwork.

There are various references in entomological literature to solutions for preserving books in the Tropics from attack by insects. The following is said to be effective:—

1 oz. corrosive sublimate
1 oz. carbolic acid
1 qt. alcohol.

This solution should be lightly painted on both the outside and inside covers, especially along the margin and backs where paste has been used. It is reported to be effective in Jamaica for any kind of book cover and after the mixture has dried the books may be handled with perfect safety. Bookbinders in the Tropics are recommended to use a paste poison by adding one-half ounce of copper sulphate or blue-stone to every pound of paste.

It is reported that in Porto Rico protection for a year or more can be obtained by painting the books and covers inside and out with the following solution:—

1 oz. corrosive sublimate
1 oz. carbolic acid
1 pt. alcohol.

The books should not be handled until they are thoroughly dry.

In Cuba it is reported that books brushed lightly over the covers with

1,000 cc. methylated spirit
20 grms. bichloride of mercury
25 cc. phenic acid,

adding sufficient shellac to produce a slightly adhesive liquid, is an effective preservative against insect attack.

A strong solution of shellac in spirit has also been recommended for use in other tropical countries. A solution of corrosive sublimate and thymol is reported to be an effective preservative as is also the addition of alum to the paste.

The Bureau of Entomology has experimented with various poisons which are to be added in the manufacture of various wood pulp products, such as the various composition wood fibre boards. Crude carbolic acid at the rate of one gallon per thousand square feet has proved effective in preventing attack by termites. Bichloride of mercury at the rate of 00·49 ounces per square foot has proved effective against these insects. Copper sulphate at the rate of 0·113 ounces per square foot has proved effective against termites. Additional experiments are being conducted with sodium fluoride, chlorinated naphthalene and dead oil or coal tar creosote. This Bureau's results with the latter substances are not as yet conclusive.

We would suggest that it may be found advisable to use binders made of asbestos as covers for books and paper in the Tropics and that these be bound together by metal—either spring or clips. If this is not practicable, we suggest that you use covers made of a wood fibre board treated with a chemical preservative, following the suggestions as outlined above.

I have also heard from Mr. Frank Cundall of the Institute of Jamaica to the following effect:—

"With regard to Mr. Dunlop's experience that French and German bound books are absolutely immune, it may interest you to know that in the binding of books for the Institute of Jamaica the preparation referred to by Dr. Thorpe has been in use for upwards of thirty-five years. It was efficacious until recently. When I complained to the Institute's Agents they sent me the astounding reply from the binders that whereas before the War they obtained their ingredients from Germany they had since obtained them in England, and they could only assume that they were less efficacious."

He further informs me that he is preparing a memorandum for the next issue of the *Handbook of Jamaica* on the "Preservation of Books in the Tropics" which will undoubtedly be of great value.

Finally, Mr. Cedric Chivers read a most able and helpful paper before the Royal Society of Arts on 22nd April of last year. Mr. Emery Walker, F.S.A., who was in the chair introduced Mr. Chivers as the most important binder outside London and a binder who had more to do with library binding than anyone else in the trade. Mr. Chivers does not deal with binding for the Tropics but his paper is full of interest. He has investigated all the qualities of papers used in binding, and it is sad to reflect that these have been steadily deteriorating. He has experimented with the tearing strain of papers and has made many improvements in the actual method of binding; these are fully illustrated in the Journal of the Royal Society.

Some of the results regarding the actual binding are most surprising, and one fact becomes quite evident—that Nigerian leather is in every respect (with the solitary exception of vellum) the most capable of resisting the strain of various usages. The high value which is shewn by the Niger leathers is not a little surprising, when it is remembered that these leathers have been tanned by the natives of Nigeria. The Nigerian tanner, in his so-called ignorance, has been working along the lines of least resistance, allowing atmospheric conditions, temperature and time to operate, with results which give a more satisfactory result than can be obtained under civilised conditions. Further, severe tests under extreme conditions of heat, dryness and moisture have demonstrated that the native tanning of Nigerian leather more effectually preserves it from injury under bad conditions than any European tanning. Under conditions in which

Cowhide and Calf	Lost	99%	of its original strength
French Levant Morocco		87%	do
Persian hard grain Morocco		83%	do
Thin Pigskin ...		75%	do
Morocco		70%	do
Thick Calf		50%	do
Thick Hogskin		27%	do
Niger Leather		12%	do

vellum comes out first as having the highest resistance to tearing strain, but after that Nigerian un-pared comes second. Nigerian sheep skins third, Nigerian goat skins fourth, pared Nigerian leather fifth, soft Nigerian leather sixth. Pigskin comes twelfth, cow-hide and calf-hide come eighteenth. There is no doubt that Civilisation has much to answer for—at any rate in the preparation of leathers used for book-binding.—*Tropical Agriculture*, Vol. III., No. 7.

THE RELATION BETWEEN FORESTS AND RAINFALL.

COL. SIR HENRY G. LYONS, R.E., F.R.S.

The occurrence of dense forest growth in regions of heavy rainfall; and the humid atmosphere and damp soil which prevail in many forest regions suggest a relation between forestation and rainfall which has often been constructed to mean that forests cause the quantity of rain falling in their immediate neighbourhood to be larger than that falling on a corresponding area on which no trees are growing.

Proof of this is difficult to obtain and even the records provided by rain-gauges exposed within and without the forested area need care in their interpretation; the trees reduce the velocity of the wind blowing over the forested area and tend to cause the amount collected in the gauges to be larger than on treeless and more wind-swept land. Again, when rain falls on trees a proportion, estimated by some at 25 per cent., is temporarily held on the surfaces of leaves and branches where the drops evaporate more freely than on the ground, thus making comparison more difficult.

The relation of forests to climate, and especially to rainfall, has been investigated on many occasions and in many parts of the world without any satisfactory proof being furnished that they influence materially the rainfall of a district. Even where reliable measurements of rainfall are available, these vary considerably from year to year, and a long series of observations is necessary before they can be expected to furnish reliable evidence of climatic change.

The Government of India carried out an exhaustive enquiry during the ten years from 1906 to 1915 in order to ascertain whether there was evidence of any relation between forests and atmospheric and soil moisture in India. The results were published in Forest Bulletin No. 33 (Calcutta, 1916) where it is stated that the influence of forests on rainfall is probably very small, the Director-General of Observatories giving as his opinion that probably it did not reach 5 per cent.

In 1910, Dr. W. L. Moore, then Chief of the United States Weather Bureau, published a report on the influence of Forests on Climate and Floods in which he and Professor Cleveland Abbe record their opinion that forests have little or no effect on the quantity of rain falling. Similar conclusions have been reached by other investigators working other regions.