REPORT OF COMMITTEE ON SOIL COLOR STANDARDS.

J. Gladden Hutton, In Charge of South Dakota Soil Survey.

When your committeeman suggested at the Chicago meeting in November 1926 that some steps might be taken to standardize color descriptions of soils he did not anticipate that he might find himself submerged in the ocean of color that seems to lie all about us both in the world of phenomena and the world of literature. It seemed then a comparatively easy matter to have some constituted authority decide upon color names and to have such colors reproduced in a convenient form for the use of soil investigators. He is aware of the fact that such a color scheme must include soils from many areas having different mineralogical and organic content, existing under varying conditions of temperature and rainfall, and occupying different positions in the cycle of soil development. He is aware of the fact that such a color scheme must be formulated by soil scientists who have access to soils from many areas.

It was suggested at the Chicago meeting that Ridgway's color standards and nomenclature might be used as a standard. Mr. Thomas D. Rice of the Bureau of Soils wrote me on March 18th that he had examined a large number of soils in the files of the Bureau and with Mr. Rice's permission I shall read from his letter:

"Since the discussion with you at Chicago, I have made some investigations of soil colors and some of the observations may be of interest to you. Ridgway's book was used as a standard, since it is by far the best publication we have found. This Bureau made efforts several years before Ridgway's book came out to get up a color scheme for soils, but the common color names being so at variance with the technical names and no satisfactory permanent color standards having been established, it was thought better to make up sets of soils to represent the common color names. The task of matching book colors is made much easier by Ridgway's large list. It is a matter of great difficulty, however, as you have no doubt found, to compare soils with printed colors. Light is not reflected with the same color values from soils, particularly cloddy soils, as from the printed paper. This is true of many substances, for example, metals have a color or lustre of their own. We may, however, be able by practice to make allowances and attain a greater skill in comparison. Before soils are compared with standard colors we must decide what state the soil to be compared should have. It is agreed by all that the official color must be based upon the air dried sample. A finely powdered soil may have a shade different from the cloddy soil, or even a smoothly cut soil section. In order to match at all, it is necessary to get a certain fineness, but in order to determine the field color it can not be pulverized too much.

"Still, I am hopeful that we shall get out some useful standards. The time has come when we can not depend upon the memory of the field man to compare a soil with one he saw last year in another area. Our color distinctions are getting too fine for that and we ought to be able to make comparisons rapidly and accurately.

"I have had the opportunity in our soil room to look at a great many series and compare these with Ridgway's colors. Nearly all the soils commonly designated as red are really brown, such as chestnut, auburn, and burnt sienna, according to Ridgway's nomenclature. Very few are really red. The reddest soil I could find was the subsoil of the Greenville clay loam from Alabama, and it registered between garnet brown and Morocco red. Most of our soils come nearer the official drab than any other established color, but when a number of these are compared with each other there is quite a variation. Many gray soils range around smoke gray, but here too there is a wide range in soil shades between these and the next color. The Pierre series in your state has a wide range as shown by our samples; the shades occurring are light grayish olive, light brownish olive, buffy olive, deep olive, dark olive, drab gray, and several others.

"It is plain, of course, that we can not use the standard color names since they vary so greatly from common usage. Names such as avellaneous or burnt umber would not mean much to the public. We could use these names among ourselves, or, as you suggested at the meeting, substitute a number for each color. These technical color names could also be put in parentheses in the reports after the common color names.

"I find that of the 1115 colors in Ridgway's tables less than 400 are possible soil colors. A great many of these are very rarely found and in most cases could not be considered colors of true soils as, for example, bright colors of partly weathered rocks. It is possible to get up a list of 250 colors that will cover the range of true soils, and I believe that 100 colors might be selected that would serve all practical purposes. I have found about 60 colors in the soils we have examined. If we could get these colors printed at a reasonable price and put in a form for use in the field, it might prove very useful. Dr. Marbut is looking into the possibility of getting these colors from A. Hoen & Co., of Baltimore, who published Ridgway's book. If we can get them we must devise some convenient holder for field and laboratory use.

"Have you any suggestions thought out by this time on this subject? We are glad you brought up the matter at the meeting, as some scientific system of nomenclature for soil colors is becoming very necessary".

A second letter from Mr. Rice under date of April 15th stated that the Bureau had taken up the matter of color reproduction with Mr. A. B. Hoen of Baltimore. But a subsequent conversation with Mr. Rice did not seem to indicate that the color chart could be speedily secured. In view of this fact, your committeeman endeavored to evolve an other plan which could be put into operation, if so desired, with a minimum of expense and delay.

It is suggested that the color wheel, familiar to all students of elementary physics, be equipped with standard color discs and that the combinations of colors be used to match the colors of the soils. A compact form

of this well known device is exhibited here and for the sake of convenience is termed a chromometer or color measurer. Soil colors may be duplicated by using combinations of colors with black and white. A sample of the soil to be described is placed near the disc and by the trial and error method a combination is found which will match the color of the soil. A graduated disc makes it possible to read the percentages of each color employed in duplicating a given soil color. The percentages of each color may then be recorded and reproduced on a similar color wheel or chromometer wherever desired. The one thing necessary is that a duplicate set of color discs shall be available. It may be seen that no attempt is made here to name colors but the device will make it possible to secure an accurate record of the color factors involved. Such a record is, of course, not practicable save where investigators are concerned.

That such a method may be reliable it is necessary that standard color discs equivalent to certain wave lengths of the solar spectrum be available. The question of securing such standard discs was taken up with the Bureau of Standards at Washington, D. C., but the Bureau was not in a position to undertake this work at present. The discs used on the chromometer are the Maxwell disc s furnished by scientific supply houses and are here used only for illustrative purposes.

Certain other standard factors must be employed if accuracy is to be attained. The illumination of the apparatus must be the same at all times. Probably the north light untinted by walls or vegetation should be employed and the light should not pass through glass as color values are changed by most kinds of window glass. This fact we have all observed while noting the color of the road as viewed through the wind shield of an automobile and comparing it with the observed color when no wind shield intervenes.

The condition of the soil as to moisture content and pulverization must also be agreed upon. Finely pulverized soil smoothed with a spatula will probably most closely approach the surface of the discs in the manner in which it reflects light. This does not, of course, agree with suggestions made by field men, but it might appear that if all soils were reduced to this condition the factors involved would be uniform. The color factors of soil in a moist condition, and in a cloddy condition, for the heavier types, might also be recorded.

When the records are made it may be possible for some competent student to sit down in a laboratory with a chromometer and evolve a system of color nomenclature adapted to soils. The color factors may be tabulated for each color and these may be reproduced by the chromometer. A few discs only are necessary, and these may be replaced by new ones at a moderate price. This would eliminate costly reproduction.

It may be said that Ridgway records that system of numbers and mechanical devices did not appeal to many of his correspondents as did color names. In the absence of definite color charts it appears that the factorial system here suggested may be far better than nothing.

It should be said that owing to the fact that standard discs are not available, your committeeman has spent little time in attempting to formulate definite suggestions for the use of the discs used on this experimental device.

Before concluding this part of the report, it should be stated that Dr. Marbut, In Charge of Soil Survey, Bureau of Soils, extended a cordial invitation to your committeeman to come to Washington and placed the files of the Bureau at his disposal for this work. Routine duties, however, made it impossible to accept the invitation.

-oOo-

Mr. B. H. Hendrickson, Scientist in Soil Survey, Bureau of Soils, has submitted the following for consideration:

"Working toward improvement in our present system of discerning true soil colors and tints, in the field, I have originated and used for the past six months a small, compact soil color chart adapted particularly for field use, consisting of soils of true solid or compound colors, mounted with glue and oven-dried on white paper.

"Messrs. M. H. Lapham, and H.H.Bennett, Inspectors of the Bureau of Soils, have both given me some encouragement, and Dr. D. S. Jennings of Utah thought well of it, and is getting up a set along similar lines. I will be glad to send to you a description of method used, and some duplicates of my prepared samples.

"The efficacy of this system is largely dependent upon comparison of colors in the air-dry condition, and has its limitations on that account. However, official recognition is given to soil color comparisons when made only in the air-dry state. While soil colors are sometimes described in a moist condition, I can hardly conceive of the weather conditions being so humid during an entire soil survey season in any locality as to preclude an air-dry comparison for the upper soil horizons, at least. I hope you will agree on this point, and emphasize it at the convention.

"I will be greatly interested in your findings, and will welcome any suggestions you may offer. Mr. Carter, of the Texas Soil Survey, will bring to Madison my little exhibit."

A SOIL COLOR CHART ADAPTED TO FIELD USE.

By

B.H.Hendrickson, Scientist in Soil
Survey, Bureau of Soils, U.S.
Dept. of Agriculture.

This soil color chart method of field comparison and determination of soil colors consists essentially of a number of small soil samples mounted on a white paper background, with common glue used as the adhesive material, and oven-dried immediately after mounting in order to prevent change of color due to hydration. Assembled in a folder or notebook, after having been carefully named as to color,

they provide a convenient color comparison with air-dry soils met with in the field.

This method was devised as a possible means of overcoming in some measure, the difficulty of accurately determining soil colors in the field. Change of color vision of the individual field man, from day to day, as well as the variation between soil color concepts of different individuals, have long been recognized as troublesome sources of error. Similar inaccuracy due to inexperience on the part of new men in the Soil Survey can be largely obviated by use of the color chart.

In preparing the chart, small samples of soil were sifted through cheesecloth or gauze to remove lumps and foreign matter. Strong white paper was prepared by coating with Lepage's glue, diluted with water in the proportions of 1:1, 1:2, 1:3, and 1:4, by volume, depending upon color of sample to be mounted. Thinly diluted adhesive material has proven best for the lighter colored samples, and thicker dilutions for the darker ones. The sifted soil material is sprinkled over the glue-coated paper, the excess shaken off, and the sample at once oven-dried for five to ten minutes at a temperature just below the point at which the paper will discolor. The samples are then carefully compared, named, and pasted in a cardboard frame in such a way as to prevent friction between samples. They are then arranged alphabetically, or in some other convenient manner, and bound together in a folder or notebook, and are then ready for use.

Soil colors are compared in the field by placing a pinch of air-dry soil directly on the mounted samples, until a close color comparison is noted. With a little experience in the use of the chart, very nearly accurate color distinctions can be discerned quickly.

Among its advantages might be mentioned the fact that regardless of the apparent color-changing effect of the slanting rays of the early morning or late afternoon sun, the chart will give the true color. The same is true in any light. Its use will also prevent any great variation in the color descriptions, by different persons, of a soil series of known color range, occurring in widely separated parts of the country. It will also assist in studies of the color-moisture relation in soils. The method is exceedingly simple, and a useful chart can be easily prepared by any field man, to cover the range of soil colors in any particular area.

Among the disadvantages, the outstanding limitation consists of the well known difficulty of comparison between any air-dry sample, and the commonly encountered moist soil conditions met with in the field in soil survey work, particularly in humid sections. Considerable difficulty was experienced in getting the finished samples to exhibit the identical color of the original soil sample. Some of the compound colors, those combining red and brown tints in particular, have a tendency to become a shade or two darker in the chart samples. It should be noted, however, that if correctly named, these altered samples are just as useful for color comparison purposes.

This suggestion of Mr. Hendrickson is of great practical interest. The question as to how generally it may be applied may arise. For a definite area,

at least, it has many points to recommend it.

-oOo-

The following letter indicates the general interest in the matter of color standards:

Gwalior, India.
April 19, 1921.

Mr. J. G. Hutton,
S. D. Experiment Station,
Brookings, S. D., U. S. A.

Dear Sir:-

I was much interested in your letter regarding soil color standards in the February 18th number of Science. I assure you that there have been many of us who have been much in need of color standards for soils work in the field. During my soil survey field work experience I was very strongly impressed by the need, for I found that some of the men that I worked with saw a predominance of a certain color in a soil, and I would not see that color, but another one.

I have discussed the matter with Mr. Macy H. Lapham, Inspector of the Western Division of the Bureau of Soils survey work, and with other old soil survey men. They tell me of various efforts along the line of standards, where water colors were made up and where other colored substances were taken as a basis. But none of the schemes were a success.

Since coming to India I have been doing some soil mapping along the lines of the work by the Bureau of Soils, and as I am able to do only a little work at odd times, I find it very difficult to keep the colors in mind from one time to the next. Some satisfactory means of obtaining satisfactory color standards would be a great help.

It has occurred that perhaps a tint photometer of the Hess-Yves type would be the thing most suited to the work, but to be entirely satisfactory it would have to be adapted to use it to determine field color as well as the color of a small sample.

Of course, one comes back to the main question as to what is the value of color? The Bureau of Soils has been making very fine distinctions in color, or has been attempting to, on the supposition that color was intimately connected with some other properties of the soils. But as far as I know the significance of small color variations has yet to be determined. Of course there are certain colors of soils that are associated with very definite properties, and about this there is no doubt.

Personally, in my work here, I am endeavoring to map as fine variations as possible, going on the usual supposition of the Bureau that it is easier to map variations in the field, and then combine, if necessary, than to subsequently

separate soils originally mapped as one sort.

I hope that I may have your views at length on the subject, as for a number of years I have been very much interested in the matter.

I am

Yours very truly,

ROBERT L. PENDLETON.

A FEW SUGGESTIONS ON SOIL COLOR AND THE NEED OF STANDARDS IN MAPPING.

By A.M.O'Neal, Jr., Iowa Soil Survey.

The Soilist in his work of classifying and mapping soils is constantly confronted with color problems that are difficult to solve, and are a constant source of worry. The descriptions as furnished by the U.S. Bureau of Soils are excellent, but in the interpretation of these by the various field men is the difficulty. Different men interpret colors differently, so a soil that appears yellowish brown to one may look different to another. The Tama series is described as having dark brown to black soils and yellowish brown to light brown subsoils; the Clinton series as having gray to dark gray soils underlain by light brown to yellowish brown subsoils; and the Ruston as having brown to grayish brown soils and yellowish red or reddish yellow subsoils. Will different men recognize and map these soils alike without a uniform sample with which to compare their findings?

Along county boundaries I have often had occasion to observe different mens ideas of the same soil type, and found that their interpretation of soil color is often quite different. It is difficult to hold a type true to color no matter how conscientious the field man. His ideas may change as the work progresses with nothing but a soil description, which he carries in his mind, to check against.

Realizing these difficulties I undertook the study of a number of soils collected from different parts of Iowa, to see if a definite relationship existed between types as mapped in the same or different localities. These soils were compared not only with each other but with the color descriptions as furnished by the various field men in their reports. It was found that though these descriptions were identical the actual sample showed marked variations in many cases. Further it was noted in a few cases that even though the actual samples were similar the color descriptions, as given by different field men, were unlike.

Moisture influences soil color and the field man must carefully consider this factor in mapping. A soil after a rain will look different from what it does during a dry spell of weather. Just how much effect moisture has on color has not been determined, but it should be worked out for use by the field man.

Since different men interpret color descriptions differently it would seem that more uniform work could be done and the chance of error reduced to a minimum if color standards were prepared for general use in the field. A large amount of soil work has already been done in various parts of the country and these standards should only be prepared after collecting and comparing a large number of samples of each series and type. In this way the most typical can be decided upon. However when once selected all future work can be compared and held close to these standards. When new series and types are established the color of soil and subsoil can be decided upon at the beginning. Since soil types will always show a certain amount of color variation it would seem well not only to give the typical but also the two extremes. Further it would be a great help in mapping to show, if possible, the effect of moisture on color. Color plates might be made showing the color

after a certain amount of moisture had been added.

The color standards should preferably be in the form of charts giving the color of the 3 foot soil section. These charts could be prepared for each type and furnished to the men. They should be in loose leaf form and small enough to be carried in the pocket. The field man after a few trips over his county knows about the soils he may expect. He can therefore select the plates needed without carrying the entire number.

Soil colors are difficult to reproduce, and this probably has discouraged work along this line. However since the publication of Mr. Ridgways book on Color Standards and Nomenclature the problem has been simplified and it is hoped a system of soil color standards can be worked out and perfected. The writer feels that through such a system the status of the soil work throughout the country can be greatly improved.