# APPLICATION OF AGRONOMIC METHODS IN RANGE RESEARCH [1]

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In a brief discussion of the application of agronomic methods in range research it is not my purpose to formulate a set of hard and fast rules that may be followed to solve the major problems in range research. There are, however, certain similarities between the two fields of investigation, and I wish to call attention to some agronomic methods that may help to answer questions in range research as they have helped in the grazing work at the Northern Great Plains Field Station.

Investigations in agronomy are a simple matter compared to those in range research. This is true because in agronomic research the investigator has many factors under his control, whereas in range research few factors are under the control of the investigator. The agronomist starts out with his selected and pure seed, plants it at a uniform rate on land that has been prepared in a definite and systematic manner, and on soil that is uniform for the experiment. A large percentage of the crops grown by the agronomist are annual crops and thus are not subjected to the hazards of many years or centuries. The ecologist, on the other hand, must work with his crops, which are the native grasses and other plants, as he finds them on the range. The only control he has over them is to fence the range and shut out all livestock or to regulate the number of stock that are allowed on a specific area.

The agronomist in all his investigations is mainly seeking one thing, and that is the production of a given crop under certain conditions of soil and tillage. No matter how many years he may put into breeding a crop for disease resistance, for high quality, or other factors, the court of last appeal is the scales which show him its yield per acre in bushels or pounds. The ecologist does not have such a definite way to obtain a measure of production of his crops. His measure of production is obtained in an indirect and indefinite manner. He has to depend to a large extent upon the growth and density of his crops and the condition of the livestock on the range as his measures of production. If the stock come off the range in good condition, he assumes that they had plenty of feed; but if they come off in poor condition he is pretty sure that the range was overstocked. It may be well for the ecologist to look into this matter of a measure of production upon which the agronomist

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lays so much stress. While he cannot hope to realize the ideal of the agronomist, he can no doubt make valuable use of this factor.

When the dry-land field station was established at Mandan, North Dakota, in 1913, arrangements were made with the North Dakota State Experiment Station to conduct a cooperative grazing experiment on a section of land set aside for the purpose. In 1915 the writer was transferred to the Mandan station to take charge of the agronomic work and look after the grazing experiment, because he had more or less training along botanical lines. When the plans for the grazing work were formulated in 1915, the main object in view was to determine the number of acres of native range necessary to graze a 2-year-old steer during the summer, or for a period of 5 months. But, as the work progressed, this was found to answer only part of the questions in regard to pasturing problems in this area. The question of increased grazing capacity immediately came up along with others. In 1915 four pastures of 100, 70, 50, and 30 acres, respectively, were laid out and fenced, and grazing on them started in the spring of 1916. Each pasture was to be grazed with 10 steers. Here was a foundation somewhat following the agronomist's ideal of control methods. The pastures were small, the number of cattle was small, and there was no wide variation in native vegetation, as the total area was limited. The cattle could be handled much as they are in feeding trials. They could be weighed individually into and out of the pastures, and at regular periods throughout the grazing season. The cattle gains for the season and for different parts of the season, could be determined in relation to their pastures. Here was a method that corresponded closely with the agronomist's measure of crop production under different methods of tillage. It also served the ecologist with an indirect measure of the yielding capacity of his crop of native vegetation. This ability to determine the gains or losses of the livestock is one of vital importance in range research, and one that is too often overlooked as a measure of grazing capacity. It often happens that cattle will appear to be doing well on the range or pasture, but the scales show that they are making little or no gain. Here is a method that could well be adopted by the investigator in range research. Of course, with many thousands of animals, it would be impossible to weigh each one or all of them. But those carrying certain brands could be weighed when turned onto a range and when taken off. While this method would not be as desirable as some, it would be of much value to the range industry.

It should be recognized that the experiment at Mandan is conducted in an area of mixed farming, both grain and livestock being produced. In the range country our pastures would seem rather small, but throughout a large area of dry-land farming the question of farm pastures and the use of land unsuited to tillage, is a problem of no small magnitude. The results obtained from our small pastures can be applied to the larger range areas with the same degree of accuracy as the results obtained by the agronomist on his tenth-acre or fiftieth-acre plots can be applied to the larger farming operations in the same area.

Since the 4 original pastures were established, others have been added to help answer further questions in regard to pasture problems. A pasture for "rotation and deferred grazing" was added, and others for cultivated or "man made" pastures have been included. The question of cultivated pastures is continually coming up, especially in areas of mixed farming. Here of course the agronomist, with his knowledge of tillage methods and forage crops, will dominate the field. And what an advantage he has over the ecologist who deals with the native range! Should the cultivated pastures be overgrazed and badly injured, all the agronomist has to do is to plow up the field, reseed it, and in a year or so he has a new pasture made to order. But what happens to the native range when it is overgrazed? Yet the agronomist, no matter how good a pasture he can make or how quickly he can make it, cannot entirely fulfill the grazing needs of livestock; at least we have not been able to do so at Mandan. Our cultivated plants make their maximum growth in too short a period to afford a pasture that will carry the stock throughout the season. The plants soon become hard and woody, and when they reach maturity the stock will not readily eat them. Cattle in our trials have lost weight or made light gains with plenty of matured forage or feed in the pasture. From recent trials we have found that a combination of a cultivated pasture and a native one work exceptionally well together. The cultivated pasture is grazed heavily during the fore part of the season to utilize the vegetation while it is in prime condition for grazing. The stock are then turned onto the native pasture for the remainder of the season. From our few trials the cattle have made more gains by this combination, for the season and for the period on the native pasture, than those on the regular native or cultivated pastures for the same periods. Of course the acres required have been less than for native pastures. The native pasture is also maintained in better condition, as it is not grazed until much of the vegetation has matured.

The agronomist has much room for the improvement of his cultivated pastures for the dry-land areas. The value of a mixture of different species needs to be worked out. He can learn much from the research on native ranges in regard to grazing requirements and the management of his made pastures.

The agronomist is constantly subjecting to trial new grasses and trying to develop others. He is a valuable individual for the range research man to cultivate and consult frequently. Some day the agronomist may discover or develop a grass or other forage plant that may be able to establish itself on the range in competition with the native vegetation. Such a plant would be of inestimable value to the range industry. Within the past few years crested wheatgrass (*Agropyron cristatum*) has been shown by the agronomist to be of value for early spring pasture. The early growth can be grazed before other cultivated species or the native grasses are ready for pasture.

In his forage crop work the agronomist recognizes the fact that the crops must be harvested at the proper stage of development in order to secure the

maximum yield and the best quality of hay. Some plants can be cut 2 or 3 times during the season, but others will produce only 1 crop. In the case of alfalfa, the agronomist has learned that if he allows the first crop to go too long before it is cut, he will get a reduced yield on the second crop without much increase on the first crop. In the case of the one-crop plants, if the harvest is made too soon a reduced yield will be the result without a chance of another cutting. In his search for a measure of production of the different range grasses, the ecologist can well take a lesson from the agronomist in his hay making. Some grasses can be cut or grazed several times during the season, and will thus produce their maximum amount of feed. Other grasses, if cut or grazed early in the season, will soon stop growth, and will not produce their maximum or normal amount of feed. If the ecologist in his search for a production factor, allows all species to come to the same degree of maturity before he makes his measurements of leaves and stems and obtains their unit weights, some species will show a factor too high, while others will be too low. Of course this would furnish the proper data upon which to estimate the feed for a winter range; but the same data, if applied to a summer range, would be too low or too high, depending upon the relation of the species. Yield factors of this nature for a certain species should be based upon cuttings made at different periods of the season and for several seasons. Such seasonal production factors would more nearly determine the grazing possibilities of a given range.

In our study of the native vegetation at Mandan we have applied ecological methods such as mapped quadrats, list quadrats, photographs, and clipped quadrats. The clipped quadrats were started in 1917, and were based on the agronomist's desire for a measure of production. Some of the quadrats are cut frequently, some once a year, and others once in 2 years. These clipped quadrats later suggested our "mowing experiment," which is purely an agronomic method applied to range research. It was prompted by the agronomist's desire for something specific as a measure of production upon a plot or field basis. The plan of the experiment follows closely one in crop production. Nine acres were laid out, and each acre was staked to be cut and raked as a unit. Six acres are cut each year. The 3 acres through the center are cut each year, and the 3 acres on either side are cut in alternate years. For the 9 years that the agronomist's measure has been applied, we find that the units cut each year have produced an average of 331 pounds of air-dried hay per acre, whereas the units cut in alternate years have produced an average of 772 pounds per acre, or 2⅓ times as much. This purely agronomic method helped us to answer a purely range research question—Why can we graze 1 steer to 5 acres under a system of rotation and deferred grazing, and have him gain 275 pounds in 5 months, while a steer on 5 acres under continuous grazing will gain only 240 pounds, and the pasture lack a few days of carrying him for 5 months? The answer is clarified by the agronomist's measure of the yield of hay. We get a greater production of feed in the ro-

tation pasture because of the rest periods for different divisions of the pasture, which helps to produce stronger and larger plants the following season, just as they do in the mowing experiment. Some may think that the increased yield of hay in the units cut once in 2 years can be accounted for by the addition of the growth of the previous season. This is not true, because the ecologist with his methods has come along and measured certain plants as an index of growth and vigor. Quadrats are laid out in the mowed area so that the same plants are measured from year to year. In the units cut each year the plants average 1.4 per unit area, 157 mm. high, and 2.5 stalks per plant. In those cut once in 2 years, the plants average 4.7 per unit area, 210 mm. high, and 3.6 stalks per plant. The ecologist has also determined that the old growth accounts for only about 35 per cent of the total production for the season in the 2-year units. Of course we cannot get the same increase in production in the rotation pasture, because the cattle graze the growth of the current season, and thus the moisture conditions are not so favorable as in the undisturbed mowing experiment.

In our cooperative grazing experiment we have found the agronomist's methods, and especially his desire for a measure of production, extremely useful. In our grazing investigations the agronomist has always been willing to fade into the background and allow the ecologist to go ahead with his wild ideas, but in justice to the ecologist he has always been just as obliging when the agronomist wished to perform. In fact I have a most kindly feeling toward both of them, and in our range research I am sure there is plenty of room for a great many agronomists and ecologists.

## Summary

There are certain similarities between the fields of investigation of aggronomy and range research. Some agronomic methods help to answer questions in range research.

The agronomist has many factors under his control, while in range research few factors are under the control of the investigator. In the latter field the investigator must work with conditions as they exist. The agronomist is interested mainly in the production of field crops in bushels or pounds per acre. The ecologist has no direct measure of production, but must depend upon an indirect measure such as the condition of the range and the livestock that feed upon it.

In the grazing experiment at the Northern Great Plains Field Station the pastures are of definite sizes and are grazed with a definite number of cattle. It is possible to weigh the cattle when the grazing experiment starts and throughout the season. This affords an indirect measure of the yielding capacity of the native vegetation which corresponds somewhat closely with the agronomist's measure of crop production. The ability to determine the gains of the cattle on the range is of importance and is too often overlooked.

The question of cultivated pastures is one that frequently comes up in an

area of mixed farming involving both grain and livestock. In this case the agronomist with his knowledge of tillage methods and forage crops will dominate the field.

In forage crop investigations the agronomist recognizes the fact that crops must be harvested at the proper stage of development in order to secure the maximum yield and best quality of hay. The same facts hold true for the native forage crops on the range. Grazing can be so arranged that the plants produce their maximum amount of feed and have it utilized at the proper stage of growth.

In the grazing experiment at the Mandan station both the methods of the agronomist and those of the ecologist have been applied. Agronomic methods applied to problems in range research have been found to be an aid in answering questions of pasture management.