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RESEARCH AND METHODOLOGY NOTES

Agronomic Techniques for the Diagnosis of Farmers' Problems

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Introduction

The popularity of Farming Systems Research (FSR), among donors at least, has seen the implementation of not a few projects. Experiences from projects that attempt a description of existing systems and a test of research recommendations in the first year show that neither task is done properly. Description only extends to cursory lists of what happens that are of little use in the identification of farm problems. Tests of research recommendations, which are few and sometimes innappropriate, rushed in implementation rarely produce meaningful results. Such results fail to provide for the major research task of FSR, which is to develop innovations farmers can and will adopt to solve their main problems in food production. Diagnosis (defined as the identification of farmers' problems by means of understanding the existing conditions) is presented here as a method that will provide a sound base for research and in the short time available in the first year.

Still, several arguments against diagnosis are worthy of consideration here. The most forceful argument is that description takes time away from the 'real work of testing innovations, despite the fact that there is not enough time in the first year to test innovations properly. Prolonging descriptive work is disapproved of because its value as a sound base for research is underestimated, but this is not surprising given the current methods and the time allocated. Dismissal of these arguments, however, needs more than rhetoric; the purpose here is to persuade agronomists that diagnosis is worth trying.

The following arguments in favour of diagnosis attempt to do just that, persuade agronomists to add diagnostic 'tools' to their 'box'. Firstly, in describing the existing farming systems, diagnosis satisfies an important research objective. Furthermore, in the process of doing so - describing the existing systems - it achieves another important objective, that of getting innovations to come up from the farm. Remember Norman's 'bottom-up' approach to agricultural research rather than the conventional 'top-down' approach (Norman, 1980). Secondly, diagnosis identifies the farmers' most important problems, where agronomic manipulation could show measureable benefits. Finally, the close observation of biological processes forced by diagnosis generates ideas for innovations, which give the agronomist many more technical options for experiment. Impressive these claims may be, but what methods are required to achieve them?

The treatment here splits this subject into an outline of procedures and examples. Still, difficulties in treatment arise. The enormous variety of farm circumstances limits the value of detailed treatments of a particular circustance, but general outlines often lack enough substance for agronomists to mould the techniques to their particular circumstances. The treatment here errs towards the general, but two helps are provided. One is the indication of purpose which makes it easier to modify the details to achieve the desired ends. The second is to recount some experiences of how the problems in making some of the more common measurements were addressed. So this is no detailed recipe for a particular cake, indeed some of the obvious instructions (e.g. listing crop species; see Byerlee & Collinson 1980, and Zandstra et al 1981, for details) are not mentioned at all, but rather more explanation on purpose follows, after which examples illustrating the problems encountered in making some of the more common measurements are presented.

Outline of procedures

The first consideration in the outline of diagnostic procedures is setting-up the farms. Farm selection must fit with the designs of the socio-economic surveys; although the focus here is agronomic the research is multidisciplinary. Notwithstanding, clustering of farms does help enumerators cut down on travel and on recording. With clustered farms, enumerators need only record rainfall from one rainguage and only on the rain-days. Raingauges should be erected on two metre gum poles, away from obstructions such as trees, and to facilitate reading, near the field entrance. Prior to the onset of tillage and planting, the farmer should be supplied with wooden pegs for the purpose of demarcating the area of the days tillage or planting. Although farmers can mark the areas worked, enumerators may have to record (on the pegs and in the field books) the dates. Setting-up the farms, enumerators, and farmers, should be completed well before the ground is prepared for cropping.

The tillage and planting operations prepare the ground for crop growth. Diagnosis of these operations does not simply consider implements and dates; such lists are not very helpful in finding out problems. The purpose of diagnosis is to determine the conditions for crop growth wrought by the farmers operations; that is, to what extent does the tillage operation leave a suitable seedbed and rooting medium for planting subsequent crop growth. Similarly, to what extent does the planting operation leave the seed in a suitable environment for germination and emergence. Therefore, for diagnosis, the crucial issues in tillage and planting are: depth of tillage, soil tilth and compaction, soil moisture, soil fertility, type and amount of seed and seed placement. Now, it is easy to see how diagnostic work identifies problems: for example, the tillage operation may not loosen the soil to sufficient depth and consequently stunt root growth. This paper will elaborate on the problems of measuring depth of tillage and soil moisture.

The growth of crops divides, in a useful way, into factors that determine yield potential, eg. number of plants, heads per plant, etc., and factors that reduce yield potential, eg. drought, weeds, pests, etc. Diagnosis seeks not simply to describe what happens; what number of plants there are or what yields there are, but to understand why; why are plant numbers low or why are yields low. This understanding is achieved, on the one hand by estimates of the yield potential through measurement of plant number, and number of yield producing organs and their size, and on the other hand by estimates of the factors that reduce yield potential. Later, examples are given of the estimation of plant number and of some factors that reduce yield.

The processes involved in transferring grain from the field to the table presents further opportunities for yield loss. The purpose here is to identify where losses occur and to estimate how large the losses are. This goes beyond the description of harvesting, threshing, winnowing, and storage techniques to a series of estimates of grain production. The losses in food value (nutritional and calorific) during food preparation and cooking, although not elaborated here may require investigation. A series of methods for the estimation of grain yield are given in the examples that follow.

Examples of Some Common Measurements

The following examples illustrate the estimation of soil moisture, depth of tillage, plant numbers, factors reducing yield potential, and grain yield. The examples draw from experiences in Botswana, a semi-arid country where animal traction is predominant (Lightfoot, 1982). The point of giving these examples is to show the kinds of problems that occurred and how they were addressed. So, this is not an exposition of 'the methods of measurement', but an illustration of how to go about the task of measurement. Indeed, as the first example (soil moisture at planting) shows, in some instances, only crude estimates were achieved.

Soil Moisture at Planting: Remember, diagnosis asks: was soil moisture suitable for seed germination and crop emergence. The components of soil moisture considered were water content and depth to wet soil. Initially, water content was determined gravimetrically, but this was abandoned because it was too laborious. A less laborious technique was developed. Water content was estimated by the degree of soil aggregation when squeezed in the palm of the hand. This method, however, was not without its problems as the degree of aggregation was confounded by clay content. The other component of soil moisture, depth to wet soil, was estimated by measuring the distance from the soil surface to the darker wet soil. This technique worked well except that colour differences were less pronounced in sandy soils. But, what really disadvantaged all these estimations was that enumerators had to be present during the planting operation; this was often impossible. On these occassions - when the enumerator was absent during planting - the soil moisture regime at planting was estimated from the rainfall data and the farmer's assessment. Farmers discerned three categories of soil moisture, little, enough and plenty, which correlated positively with rainfall data and gravimetric data.

Depth of Tillage: Farmers in Botswana till with mouldboard ploughs drawn by oxen. The depth of ploughing is crucial to root growth, so diagnosis sought to isolate the ploughing operations that were too shallow from those that were adequate. Depth of the furrow slice provided the obvious measure for depth of ploughing, but variation was high. Farmers lifted the plough over the tree stumps and anthills, and the plough sank in the wet patches. High variation meant more observations at each ploughing; more observations meant enumerator absence at some ploughings. Post-ploughing estimated depth was done with a ten millimetre diameter steel soil probe. The calibrated probe was pushed gently into the soil until the plough-pan was felt, then the depth read off from the calibrations. Two problems were encountered with this technique; one, the plough-pan of sandy soils was difficult to detect, and two, plough layers settled at different rates. On the occassions when direct measurements were impossible the farmers' estimation was used. Farmers estimated an 'average' depth of ploughing with an outstretched hand; half the hand corresponded to shallow ploughing (less than 100mm), and more then the whole hand correspondend to deep ploughing (more than 200mm). These estimations correlated well with

direct measurements of furrow depth, giving sufficient precision to isolate ploughing operations that were too shallow from those that were adequate.

Plant Number: Knowledge of land use efficiency - can more plants be grown on the same area - was the main diagnostic value of plant number. Plant number was determined when the crops were easily distinguishable. Although cereal crops (sorghum and maize) dominated most of the area, other grain crops (legumes) were also included in the plant count. When other crops, such as melon, sweet-reed and pumpkin, were present they were noted but not included in the plant count. The measurement involved counting the plants that fell inside a meter square quadrat. The quadrat was placed between ten and fifteen times in each planted area; the size of the area and the plant distribution determined the exact number. Observations were selected by walking diagonally across the area and placing the quadrat at a pre-determined number of paces. The mean of the counts was taken as the plant number of the area. Subjectivity in the decision of how many observations to take was the only disadvantage with this otherwise quick and easy technique.

Factors Limiting Yield Potential: Weeds and particularly drought severely reduce yield potential in Botswana. The purpose of assessing these factors was to understand why yields vary. For this purpose the following assessment methods were designed to be used by enumerators on their weekly farm visits. Weeds were assessed using a simple rating from 0 to 5, where 0 was no weeds and 5 complete weed cover up to knee height. 1 was then a few small weeds, 2, 50% ground cover of small weeds, 3, 50% cover of small and knee high weeds, and 4 complete ground cover of small weeds and 50% cover of tall weeds. In addition, some assessment of the presence of parasitic weeds was thought necessary because these weeds, particularly Striga on sorghum and Alectra on cowpea, are important in Botswana. The difficulty in seeing these weeds (they are short and hidden at the base of the plant), however, made accurate assessment of infestation level so time consuming (each weed must be counted) that it was abandoned in preference of rating presence or absence. The duration of drought spells was assessed from the rainfall data. This assessment was found, on direct observation, to be inaccurate presumably because it ignores the all important soil-plant relationships. A more accurate estimation of drought duration was counting the number of days that the crop exhibited intense leaf-curl. Another important consideration of the effect of drought on yield was the growth stage at the time of stress. Water stress during flowering and grain filling reduces yield much more than stress during vegetative growth.

Grain Yield: In the Botswana study grain yield was not estimated because severe drought destroyed the crops. Still, readers may find the methods proposed to estimate grain yield useful. Farmers normally plant mixed crops and harvest them at different times. Underestimating yield occurs when only one crop is considered and when only one harvest is considered. The following series of estimates were proposed to reduce the chance of gross underestimation. Visual assessment estimates the yield potential prior to harvesting. The number of legume pods and their size, and the number and size of cereal heads or cobs are estimated. With these and consideration of the weight of grain produced, an idea of potential production is gained. In addition, the presence of other crops, such as melon, squash and pumpkin, is noted. A more accurate estimate of grain yield is obtained by the weight of sample harvests. Using the same sampling procedure as described for plant number, all grain crops (cereals and legumes) falling in the metre square quadrat are harvested. The sample harvest is threshed and weighed, and a correction factor applied to estimate the production for the whole planting area. Estimates of grain yield for a

specific crop is obtained during the farmers' harvest operations. Here, the farmer harvests the crop and the unthreshed crop is weighed in the field. Finally, an estimate of the total farm production can be obtained by counting and weighing the bags containing the harvested crops. These bags will contain threshed and unthreshed crops, therefore threshing percentages need to be computed. Remember, this figure will underestimate production because some of the products will have already been consumed by the family.

Conclusion

Of course, many of these techniques are known to agronomists and the diagnostic purpose (understanding why things happen rather than simply what happens) is appreciated and practiced by many. This paper, however, was not written for these experienced people, but for agronomists who for the first time are faced with foreign farming systems, or for the first time are faced with working on farmers' fields. For these people, diagnostic work can describe the existing farming system such that the major problems are evident, and provide ideas to assist in the design of innovations. This, it is argued, is not only a sound base for research, but also practicable in the short time available for field work in the first year. Although the first year has been the focus here, the stages of FSR being iterative encourage researchers, perplexed by lack of adoption, to find new ideas through diagnostic work.

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