Agro Services International

Agricultural statistics: Do we need really need it?

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Growers who regularly attend agronomic seminars would have heard a lot about statistically valid field designs, complete randomized blocks, t-tests, f-tests, LSD (not the drug), confidence levels and a lot of other strange statistical terms.

You would have heard some say that this is absolutely necessary in scientific studies. You would have also heard others (like me) me say that scientists often waste time using these methods. What is this all about and why should a grower be interested?

Let us imagine that we planted the same crop on two plots next to each other and gave both of them the same treatment. We would expect that the yields from both plots would be similar, but it is unlikely that they would be ***identical***. No matter what we do, we will almost always get some variation between plots in the same field. All growers know this; some areas in a field produce better than others, no field is perfectly uniform.

Now let us conduct a field trial testing two different fertilizers. We established two plots next to each other, one with fertilizer A and the other with fertilizer B. If plot A produced 100 lbs and plot B produced 99 lbs, we would be reluctant to accept that fertilizer A is really better than B, the 1 lb difference is probably due to the natural variation in the field.

However, if fertilizer A produced 100 lbs and B produced 10 lbs, it appears that fertilizer A is really better than B. But what would we say if the respective results were 100 and 90 lbs? Or 100 and 95 lbs? How much difference should we get before we are confident that the result from A is truly better than from B and not due to natural variation?

This is where statistics comes in. Statisticians have developed a number of reliable mathematical methods that are used to make these decisions. There are many different techniques that are used depending on what is being tested, but idea is to repeat the experiment several times and calculate how consistent the results are.

These calculations are very complicated and based on probability theory, something that most field scientists including myself do not really understand.

Fortunately, these methods are usually easy to use as the statisticians have done most of the work for us. We need to lay out our experiments in certain patterns (which always include repetitions of the treatments), collect the data and calculate the results using equations developed by the statisticians.

In fact, today we do not even need to do the calculations ourselves as modern computer programs can do them for us. At the end, the calculations indicate how certain we can be that the treatments are truly different.

It is generally accepted in science that we must be at least 95 per cent sure before we accept the results as being different. This often expressed by saying that the difference is significant at the 5 per cent level (we are 5 per cent certain that the treatments are the same or 95 per cent confident that they are different).

In a really good experiment, we may find that difference may be significant at the 0.1 per cent level, meaning that we are 99.9 per cent confident that the treatments are different. (Statisticians are never 100 per cent confident about anything).

A word of caution. I once reviewed a trial where the author claimed that his "miracle" product increased crop growth and that the increase was significant at the 0.5 level. We immediately think that we can be 99.5 percent confident that the treatments were different; his product did increase crop growth. However, he said the difference was significant at the 0.5 level, not the 0.5 *per cent* level. This means that we are only 50 per cent confident that the treatments were different.

By scientific standards, the treatments were not different; his product did not work. The report was misleading.

There is another important requirement for a good trial; it must be a *controlled* trial. Put simply, we must be sure that if we get differences between treatments, we know exactly what caused the difference.

I reviewed a trial done with yet another "miracle" product, this one applied to bananas. The product was applied to a new banana field. This was compared to an old field that was given a different fertilizer.

Was the increase in production due to the product, or was it because the untreated field was several years old and no longer productive? Could it be that the fertilizer program used on the treated field was better than on the other?

We really don't know so it is not correct to say that the product worked, nor can we say that it did not work. Because the trial was not properly designed, we can draw no conclusions other than that the experimenter wasted time.

The solution is to ensure that the treatments are done under the same conditions. We want to compare two fields, one with a new product and another without the product. The two fields must be planted at the same time with the same variety on the same soil in the same area, and treated with the same fertilizer and irrigation.

We must ensure that there is only one difference between the fields, that is the product. (Remember that we must repeat this comparison several times). If we get a difference between the fields, it could only have been caused by the product.

There are many different trial designs that can be used, the most common is the "complete randomized block" which is a quite versatile tool. I do not usually use it, but prefer to establish a pair of plots on a farm comparing the old and the new methods.

For example I may have one plot with the traditional fertilizer and another with an improved fertilizer. Other than this, the plots are managed in the same way and this pair of treatments is always repeated on several farms. This method is referred to the "paired t-test".

Why do I use this approach in most of my trials? The biggest advantage is that it is one of the most farmer-friendly research methods. Several growers can actively participate in the trial and determine for themselves if the treatments work and if they are easy to implement. In addition to being a valid research method, it is an extremely good extension tool.

Should all research be done using the paired t-test approach? No. There are many types of trials that cannot be properly done this way.

For example, a researcher may be trying to find out if different varieties require different amounts of nitrogen. He may have three varieties and treats each of them with four different amounts of nitrogen. In this case, the paired t test cannot be used, the complete randomized block is suitable.

Now, the big question. Is all of this really necessary? That depends on what we are doing.

When we are investigating anything that is truly new, we MUST use this approach. We need to be confident that our assessment is valid and this is the only way to do it. For example, if we are testing a new variety that has never been grown before, or a new pesticide that has never been used before, we must use a statistically valid method.

However, if we are trying to introduce technology that has already been proven using this approach, conducting more statistically valid trials is simply wasting time and resources.

I sometimes establish "trials" to illustrate the use of balanced fertilization to growers. In these cases, I may not establish scientifically valid trials, but concentrate on demonstration plots that can show growers how to improve efficiency

The principles of plant nutrition have been known for one hundred and fifty years and have been authenticated with hundreds of statistically valid trials conducted all over the world. While there are certain aspects of fertilization that still require research, I do not need to establish trials to determine if we should apply nutrients to nutrient deficient soils.

We have to avoid the two extreme approaches, one where we believe that we must constantly be conducting statistically valid trials to rediscover what we already know, and the other where we recommend and promote products and techniques that have never been scientifically tested.

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