LANDSCAN™ Practical Landscape and Soil Test Interpretation Workshops for Sustainable Farm Management

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Abstract
This paper discusses the scope and rationale behind a farmer workshop series called LANDSCAN. LANDSCAN was developed for graziers in the highly variable tableland environment in response to the need for a whole farm approach to specific degradation problems such as soil acidification, dryland salinity, soil nutrient deficiencies and pasture decline. Programs that focussed on single issues were not practical as many problems are inter-related and soil and landscape features affect options and responses. Soil tests were generally not well understood and under utilised in farm management decision making on most tableland properties. The aim of the workshop is to develop skills & knowledge to assess a farm’s natural resources (pastures, vegetation, soils & topography) and assist farmers and land managers to better match land-use to land capability.

Key Words
Landscape indicators, soil test interpretation, land capability, sustainable farm management, land degradation

Introduction
LANDSCAN is a practical workshop series developed for farmers and land managers by a group of experienced extension agronomists, soil specialists and livestock officers from New South Wales Department of Primary Industries. Participants pay for both the course and their soil tests. It is run on farmer’s properties and is a 50:50 blend of basic theory and practical outdoor exercises and demonstrations in their paddocks.

The majority of farmers, while aware of the need to run their property as a business and to focus on profitability, are generally good stewards of their land (their productive resource) and try to prevent land degradation. Farmers are also a very diverse group with a wide range of education. The course was written to provide basic principles and a process to help farmers make better decisions about complex, often inter-related issues such as soil acidification, pasture and nutrient decline etc that are occurring on their property in what is often an extremely variable landscape. It is all about helping farmers to use land profitably and sustainably, that is to use land within its physical capability while capitalising on its strengths for productive and financially rewarding outcomes. The course specifically avoids a highly technical, scientific approach to soil test interpretation.

LANDSCAN was designed for the high rainfall, temperate perennial pasture zone of the tablelands, coast and upper slopes. It has not been refined for cropping situations because it was felt that cropping farmers were much more aware of their soil fertility, nutrient status and other critical production issues.

Soil Sampling and Testing Rationale
Soil tests are only one, albeit important, factor that farmers need to consider when making decisions on the management of a given paddock and paddocks within a property. Participants must agree to soil sample and have tested a minimum of two paddocks at a NATA (National Association of Testing Authorities, Australia) accredited laboratory during the course. However, a soil test is not particularly useful unless it can be interpreted in conjunction with a whole range of other factors such as landscape features, soil type and topography, the enterprises that the owner is either carrying out or wishes to consider, and so on. The course aims to provide background information behind what they can see in any paddock and to discuss and demonstrate the limitations or opportunities that various soil and landscape features impose or provide.

A soil test is also only as good as the sampling procedure undertaken when the sample is collected. In the course participants are shown how to take samples that are representative of the paddock or the soil type.
and to avoid atypical areas such as sheep camps, shallow, rocky ridges, waterlogged areas etc. Because farmers are the ones who are most aware of the changes within a paddock and its previous uses and fertility history etc., it is preferable, that they take the soil tests. It is also important that they are shown how to interpret the soil test results. This is done using their own results which make the learning experience more pertinent. They can subsequently use soil tests to help them make better decisions for both sustainability and production outcomes.

The developers of the course believe soil tests cannot be interpreted based solely on the laboratory results. To give an example, many soils throughout the tablelands of NSW are highly acidic throughout the profile – that is they are naturally acid. Commonly soil tests from this region will have a pH of 4.2 in calcium chloride. Assessment based solely on the laboratory result would suggest that acidity is too low and the soil should be ameliorated using lime. However, not only is this the natural soil pH but many such tableland landscapes are non-trafficable (too steep or rocky to drive over) and Australian lime cannot be spread aerially. In addition, these landscapes often support native perennial pastures which are extremely acid soil tolerant. Therefore raising the soil pH would be neither possible nor effective. The landscape features provide over-riding limitations to what can be done and affect the management direction that must be followed. In such cases preservation of the native perennial pasture is the imperative because if these native pastures are lost they cannot be re-sown or re-established.

There are other, overriding physical limitations imposed by the landscape and soil type that determine best management practices in this environment. Many tableland soils for instance are slate-shale derived, naturally acidic throughout the profile and have very poor infiltration. Surface application of lime to such a soil, assuming it is trafficable and lime could be spread, may not achieve a useful result because the poor infiltration of these soils will combine to prevent the lime from moving into the profile. Even if the land were arable, incorporating the lime by cultivation is not an option as it would destroy the acid tolerant, native perennial pasture.

Liming by top dressing at economic rates is only likely to penetrate, even on soils with good infiltration, to about 10cms. If the soil is acidic to depth, what is the point? A “laboratory” recommendation to apply lime to soils that are acidic throughout the profile would only spend a lot of the farmer’s money for no productive benefit. The decision about liming will vary depending on one or more of the following:-

- whether the landscape is arable, non-arable but trafficable or non-trafficable
- whether the soil is naturally acidic throughout the profile or has agriculturally induced acidity
- whether the soil supports a valuable perennial pasture and has good infiltration (making surface liming a proposition)
- the property owner’s financial situation as liming is not cheap and there have been few productivity gains that can be attributed to liming pastures (just changes in soil pH and % Al).

Similarly recommendations for fertiliser usage should not be made in isolation of paddock use and the farm enterprise. Many native perennial grass pastures can tolerate somewhat lower levels of soil nutrition than the introduced grasses and still perform quite well. If the soil is also a low buffering soil where phosphorus fixation is low then maintenance rates of phosphorus fertiliser to support legume growth will be relatively low, depending on things like stocking rate and enterprise which are linked to the export of nutrients. Fine wool producers on the tablelands running a wether flock for instance, will export very little phosphorus from the paddock. Therefore, the target or critical phosphorus level for optimal pasture production will be relatively low and the amount of phosphorus that needs to be added to maintain this critical value will be reasonably small. However, another soil which may have a high phosphorus sorbing capacity, where there are introduced pasture species such as rye grass or phalaris and where the enterprise is second cross prime lamb fattening, will require a far higher phosphorus application due to higher plant requirements and export of nutrients to maintain pasture production.

Methodology – What is LANDSCAN?

LANDSCAN is presented as a group workshop series over 4-6 months, with 5 half day sessions and a final full day session. The course is structured to help farmers to appreciate the importance of the vegetation and landscape features they see everyday and to put these things into context with other
information that they can either learn or obtain through analyses, like soil tests. Each session builds on the previous one and presenters encourage group members to participate.

Session 1, “Reading landscapes” provides the basis on which the course is developed. The group lists landscape, soil, geological and vegetation features in the paddocks visited and discusses what they indicate, what features can and can’t be modified and implications for management.

Learning outcomes from session 1 are:
- recognise major land classes
- recognise important visual indicators of land capability such as slope, aspect and vegetation.
- understand that landscape features may exclude or limit management or development options
- appreciate those landscapes where the priority for management is to minimise land degradation rather than maximise production

Session 2, “Soils and soil sampling” is all about rocks, soils and soil profiles and emphasises an important soil property that is often overlooked – soil depth. Shallow soils hold less water, root growth is restricted and pasture production adversely affected. Importantly, it is something that cannot be changed. At the end of session two, participants are provided with soil sampling probes and bags, so they can sample some of their own paddocks. They are encouraged to sample a range of paddocks from their best to their worst, to provide a range of tests results to determine critical values for different landscapes, soils, degradation problems, enterprises, uses etc. Samples are taken from 0-10 cm depth for a comprehensive pasture soil analysis and from 10-20 cm to provide some information about the “sub-soil”.

Learning outcomes from session 2 are:
- relate landscape features to soil characteristics
- be familiar with soil descriptions & profiles
- understand physical properties such as texture and dispersion
- be able to take soil samples for meaningful diagnosis and monitoring

Session 3, “Soil fertility and soil test interpretation” attempts to de-mystifying soil tests. The individuals own soil test results are then used in session three to help them make sense of what to many is an incomprehensible page of numbers. The soil test result is first compared with another complicated form with lots of numbers with which participants may be more familiar. For example, a carcase grid for cattle producers or a wool test report for wool producers. Basic principles such as the Law of the Minimum, chemical properties of soils and soil nutrients required for plant growth are covered and a table of local benchmark data provides targets for various soil test parameters. Soil test information is subsequently sought from producers and used for all paddock visits and exercises during the remainder of the course.

Learning outcomes from session 3 are:
- understand basic plant nutrition & principles such as Law of the Minimum
- be able to interpret soil tests
- be aware of benchmarks for important soil nutrients
- identify the soil chemical limitations in paddocks

Session 4, “Sustainability and productivity” deals with the cause and effect of various soil degradation issues such as acidity, salinity and nutrient decline that have been highlighted by the soil tests. For example, the difference between the balanced nutrient cycles in a zero input, pre European natural system and a productive farmed system with harvesting and export of products from paddocks is covered. Importantly, the degradation caused by induced soil acidification is discussed along with the need to protect productive, previously non acid soils and use ameliorants to prevent acidity moving below the top 10 cms. The group learns about and discusses causes and effects of the various situations viewed in the paddocks visited.
Learning outcomes from session 4 are:
- understand the cause & effect of major soil degradation issues including soil acidity, dryland salinity, nutrient depletion, erosion and soil structural decline
- understand how these degradation issues are linked to water movement through the landscape
- awareness of the off-farm effects of these issues

Session 5, “Tools and strategies” deals with various remedies or “fixes” that can be applied for different production outcomes or to address different degradation issues. In conjunction with the landscape, the soil tests, the current enterprise and what the property owner wants to do with paddocks, discussion develops about what could be done to each paddock, including matching pasture types to different soils, landscapes and enterprises. This highlights the various issues that are important in terms of managing particular paddocks and the group attempts to fit the management of the various paddocks into the whole farm context. They consider things that can be changed, those that can be changed if money is no object and things that can be changed profitably.

Learning outcomes from session 5 are:
- match enterprise to soil & landscape features
- match pasture type to soil & landscape features
- select type & rate of fertiliser to manage soil nutrients
- manage soil acidity by a combination of reducing the rate of acidification, plant tolerance and the use of lime
- manage dryland salinity by a combination of improved water use, salt tolerant species and appropriate fencing and grazing

Session 6, “Making better decisions” is all about prioritising inputs for profitable and sustainable land-use. The final session is a full day and involves visiting 5 or 6 paddocks on 2 or 3 of the group member’s properties. As a group, the strengths and weaknesses, opportunities and limitations of each paddock are discussed and rated by each individual. Working then in small groups of 3 or 4, the participants carry out an exercise on the basis that the 5 or 6 paddocks visited are a farm, to decide which of the paddocks visited has the highest priority for expenditure, which has the lowest priority and the reasons why. This exercise is then continued and the small groups decide what management and inputs would be employed in each paddock if money was no limitation. Then a more difficult but more realistic exercise is carried out where decisions must be made and priorities assigned because finances are limited - only sufficient to fertilise 80% of their “farm”. Some hard decisions have to be made. Costs for a range of actions that could be carried out, such as sowing and/or liming pastures, fertilising pastures, fencing subdivision etc are all provided for the group based on current costs on a per hectare basis.

Learning outcomes from session 6 are:
- assess the strengths & weaknesses of each paddock to determine its potential productivity
- develop management strategies for each paddock
- prioritise inputs for paddocks on a whole farm basis

LANDSCAN was developed by a group of eight experienced field agronomists, livestock officers and soil specialists and the course has been able to capture this combined knowledge. To be run effectively it is necessary that less experienced staff have the opportunity to receive training and assistance with running their first course. While producers get a manual of notes that they can refer to, a comprehensive Power Point-based facilitators kit is given to presenters after they have completed a 2 day training course. LANDSCAN groups have between 12 – 15 people for each course and this requires 2 facilitators (at least one agronomist and if possible someone with livestock or soils experience as the other presenter). It is very much a course that relies on participation and the facilitators running the courses and those who developed the course originally, are very keen to encourage the farmer participants to share their knowledge and experience and thus improve the overall learning opportunity and experience.
Results – how useful is LANDSCAN to farmers?
Two years after LANDSCAN was launched, 12 courses with some 160 landholders and three facilitator training workshops with nearly 40 potential presenters have been completed. Both the initial pilot courses and later the producer funded courses, have included an evaluation both pre and post the course to see what level of knowledge change has occurred. Changes in the knowledge from the start to the end of the course were mostly positive. For example, 59% responded that Microlaena was tolerant of acid soils before the course and 100% said it was after the course. To the question “what is the enterprise that causes the most rapid soil acidification”, 53% said they did not know, 29% said lucerne hay production and 18% cereal grain production on the pre course questionnaire. On the post survey, 93% said lucerne hay and the other 7% said cereal grain production. These are actual comparisons but no statistical analysis has been carried out to date.

Feedback is also collected via a mail questionnaire, a month or so after the course has finished, to try to get a better, more honest response from people when they’ve had a little more time to reflect on the course. Nearly all participants responded that they could visually assess the strengths & weaknesses of paddocks & prioritise them for inputs. Over 90% said they would revise or carry out a farm plan. To the question “Would you use skills gained in this course to develop a farm plan?” 100% said yes in a recent mail survey after a course at Armidale. To the further question, “How?” nine of the 13 people completing this workshop wrote responses as follows:-
1. The farm plan will now be based on better informed assessment and evaluation and on opinions derived from information rather than gut feelings. Some areas proposed for early development will now be relegated to possible development (in the future) - and the type of development amended to suit.
2. Better able to prioritise paddock developments.
3. Map farm, soil test key paddocks, identify best uses for each paddock. Identify fertiliser needs for each. New pasture development plan.
4. I would like to utilise my paddocks better
5. Better lambing paddocks. Treating problems spots (eg acid and sodic paddocks)
6. We already have a farm plan and individual paddock summaries/plans. We will revise these to include the new information.
7. Consider changes in soil type, topography, aspect etc when planning position of new fence lines. Manage some areas for conservation and others for production – rather than trying to do both in all areas.
8. Prioritise paddocks for inputs such as fertiliser and the best type of fertiliser to use. Prioritise paddocks for pasture improvements.
9. Develop long term property plan and pasture benchmarks.

Comments from other groups included:
“I found the format of the course, with the formal talks re-inforced by paddock visits to illustrate points made was terrific. The well written take home notes ..... gives the course a SUSTAINABLE nature.”
“The sequence of sessions was excellent – each building on the previous ones. (I) did not feel left behind.”
“My ‘poorer’ paddocks that I thought needed sowing with pasture, I now find would be a waste of money. Will (now)..... put money into better soil type paddocks.”

One of the most interesting things to come out of the post course feedback from the LANDSCAN workshops is the comment by several producers that they had always wanted to spend money on their ‘worst’ paddocks, to try and raise the productivity of those paddocks closer to the average for the farm. By participating in the exercises in session six with decisions having to consider cost and having to justify why various options were being considered to other members of the group, it came home to them that it would be better to spend their limited finances on paddocks with a higher potential. For example, paddocks with a run-down perennial grass pastures on reasonable soil that were low in a legume. They were being invaded by low fertility annual grasses such as vulpia and have had irregular fertiliser applications over the last few years. Such paddocks could be re-sown but that would be very costly. In most cases they were likely to respond positively to better management and appropriate inputs. Potentially an increase in stock carrying capacity from 7 dse/hectare to 12 dse/hectare would be possible.
By comparison, fertilising or subdividing country with less potential on shallow, acidic soils with native pastures and large paddocks may only result in an increased carrying capacity from 3 to 5 dse/hectare.

Another issue that came up with the producers was that quite often they would have spent a lot of money on new pastures rather than look after the sown pastures they had. In many groups, soil phosphorus levels in pastures that were 5 to 10 years old and still supporting a reasonable level of sown grass, were deficient in either phosphorus or sulphur or both. One of the principles the course tries to emphasise is that if graziers are going to spend a lot of money on sowing pastures, there needs to be a plan and finances available to fertilise in subsequent years. This would ensure phosphorus levels in particular are adequate so that the pasture, especially the legumes are retained and the grasses remain vigorous and productive.

**Conclusion**

LANDSCAN is based on a whole farm approach to sustainability & productivity issues. It recognises that natural indicators and soil tests provide a guide to paddock potential, that good management cannot be driven by single issues and that financial viability is essential for sustainable land-use. It examines the myriad of factors that need to be considered when managing individual paddocks and placing them in a whole farm context. This can also be scaled up to a sub-catchment/ catchment level to manage potential off-site effects and regional issues. At this level the course addresses many of the soil, water and vegetation targets identified by Catchment Management Authorities in NSW as priorities for land and natural resource management.

In terms of communicating and utilising soil information, comments by farmers after the recently completed workshop at Armidale where nearly 50% of respondents said that the most valuable session was the one about interpreting soil tests, while the final session (or “all sessions”) were rated as most valuable by over 50% suggest LANDSCAN is an effective way to help farmers understand and utilise soil test information.

**References**


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