Challenges and possible solutions in running long-term trials

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Long-term ecological trials have provided valuable data for understanding dynamics of rangelands in response to fire, grazing, climate perturbations and other manipulations (Morris and Tainton 2002). However, long-term trials include many logistical and scientific challenges in addition to the usual challenges of running effective research trials. The Kokstad research trials illustrate many of the problems associated with long-term trials. These problems, and possible solutions to them, will be detailed below. Like any project, long-term trials require careful management and dedicated supervision to ensure their success.

Frequent staff turnover with inadequate documentation

In the twenty years since the establishment of the trials, there were four scientists and at least two technicians responsible for the trials (three scientists in the last ten years). In 1998, the scientist and technician were replaced simultaneously, meaning that there was no effective handover (for nine months, the trial was run by an experienced research labourer). One consequence of this frequent staff turnover was an unplanned change in the grazing regime on one of the trials.

In order to ensure that trials are effectively continued, it is absolutely essential that every detail of the trial procedure is covered in the trial protocol. While the project design for the Kokstad trials were detailed and more than adequate for setting up a trial, there were many small details that were not included in the project design document. For example, the exact date of burning, and the procedure for deciding when to place animals on the trial and when to remove them, were not clearly detailed in the original documents, with the result that the start dates and lengths of the grazing seasons varied substantially.

A proper handover protocol is also essential to avoid errors like the altered grazing regime. The grazing regime was clearly outlined in the protocol, but was somehow still changed. Unfortunately, it is very difficult to hand over a project when the previous project manager has already left the institution months before a replacement is appointed. Therefore, an institutional protocol of going through every detail of the project documents must be enforced when new staff is appointed.

Inadequate data management protocols

The data from the two-camp trials alone take up one drawer of a filing cabinet at Cedara. Given a few more years, additional draws will be required to store just the raw data. Backup copies will require another filing cabinet elsewhere.

It is not sufficient at the beginning of a trial to create one file labelled “two-camp trial” if masses of different data are planned to be collected for years. Every file and folder, both of the original data and of copies of the data sheets, must be created at the initiation of the trial. The protocols for handling the data must be outlined in detail. Copies of the data must be kept separately from the originals, in a different filing cabinet in a different building.

It is crucial that every data sheet is copied for backup. One simple method to copy the data is to use technology that has been in existence for decades – carbon paper. If two or three identical data sheets separated by carbon paper are used in the field, the copies will be created instantaneously.

The highly effective but now neglected system of White Label, Blue Label and Green Label files should be revived (ask any retired government researcher how the system worked).

Detailed data sheets for every variable measured must be included in the trial protocol document. If these data sheets are updated, then the project protocol document must be updated. The protocols for how the data is collected, where it is copied and archived, and how it will be analysed, must be included in the trial protocol.

Poor electronic data management

A major problem with the data from the Kokstad trials has been frequent changes in software over the years. The early data were captured in customised databases programmed in FORTRAN, but the programme has since become corrupted and the data is now inaccessible. Several spreadsheet programmes have emerged and, in turn, become obsolete over the past decade alone. Each scientist or technician captures the data in different formats on different programmes, under meaningless filenames and archived apparently randomly on the hard drive of computers which themselves quickly become corrupted or obsolete. The management of electronic data requires as much care as the management of the paper datasheets, yet generally receives the least attention.

Internationally, protocols and procedures for capturing, archiving, securing and backing up electronic data have been developed (see, for example, Kruger 2007). It is crucial that these international standards for data management be adopted by research institutions. There is no longer any excuse for creating Excel spreadsheets entitled “Kok1” saved under “My Documents” on the hard drive of a scientist’s computer.

The electronic data management systems for long-term trials must be established at the same time as the trial is designed. For existing trials, sound data management systems must be established to archive previous data and capture all new data. The systems must take into account the fact that the software and hardware used will be obsolete within 18 months, and therefore must be “future compatible”.

The data must be captured immediately after collection in the field. If it is left to later, the accumulated data sheets will become buried under a pile of administrative priorities and if they are eventually captured, they may be done so hastily and shoddily.

Data capturers must be properly trained in the programme and in the vagaries of the type of data they are entering. For example, a secretary unfamiliar with entering veld condition assessment data into a customised database swapped the latitude and longitude coordinates of several sites, so that the sites were apparently located in the Eastern Cape rather than in KwaZulu-Natal.

Systems for capturing data must be standardised and simple to use, and allow for the “double-entry” system of data capture (where every datum is entered twice by two different people, and the two datasets automatically checked against one another for inconsistencies).

Inadequate supervision

The Kokstad research station is located 250km away from Cedara, where the responsible scientists have been based for at least 15 years. A simple misunderstanding at the beginning of the season can result in several months’ worth of useless data being generated if the scientist does not join the technician and his staff on site and assist with the management of the trial.

Alternatively, a procedure outlined by the scientist may be logistically difficult, or require a disproportionate amount of time and effort from the technician in relation to the value of the data generated – a sure way to result in disgruntled field staff. For instance, the cover data on the runoff plots appeared to take an inordinately long time (about three weeks) to collect every season. It was only after three years that the scientist joined the field staff to help them collect the data, and found that the Levy Bridge that they were using was lacking nine of its ten pins. The field staff, having never been trained in the use of a Levy Bridge, was using the one remaining pin in each of the ten holes in the frame of the Levy Bridge. Had the scientist joined them for the very first season, the problem would have been solved immediately and a great deal of wasted effort on the part of the technician and his staff saved.

Inadequate trial management, such as poorly functioning water troughs and poorly maintained fences, can have a much greater effect on results than the actual treatments applied. If trials are regularly inspected by outside staff, the responsible officers will be motivated to maintain high standards of management. Such a system was implemented successfully at Cedara, where the Animal and Grassland Science staff toured the station once a month to inspect one another's trials and facilities in a spirit of friendly cooperation.

Frequent priority changes

Research institutions frequently change management, who in turn change policies and priorities for the institution. For long-term research trials to survive changing policies, it is important for project managers to carefully examine the objectives of the trial and decide where within the overall objectives of the institution the trial fits.

Long-term trials, while expensive to establish, are often relatively cheap to maintain. It is important for research managers to sell the importance of the trial to senior managers and policy makers. However, in order to be convincing, the trial must be genuinely important, which brings us to our next point.

Figure 1: Long-term sheep grazing trial at Kokstad Research Station

Inadequate research
Long-term trials can be incredibly valuable research resources, yet many of them are inadequately used. Routine measurements are conducted on the trial, which may or may not be reported in regular progress reports (more about that later), but often no real, imaginative analysis of even the routinely collected data is conducted and published.

Many long-term trials have great potential for answering additional, specialised questions in fields completely removed from the purpose of the trial. Examples include Martindale's (2008) survey of plant diversity at Kokstad, Manson et al's (2007) survey of soils and landscape functioning of the Brotherton Burning trial, understanding competition and soil carbon on the Ukulinga long-term trials (Fynn 2003, Fynn et al. 2003), and invertebrate diversity at Brotherton (Uys and Hamer 2007).

Such long-term trials must be marketed to other researchers and research institutions. Trials should be used for farmers' days, training, workshops and other forms of technology transfer. They should be reported in the popular press such as the Farmers' Weekly. Responsible officers should regularly report interesting results and key questions to peers for discussion and to generate new ideas.

The first criterion for a trial to be recognised as important is good trial design and reliable records of treatment application and data collection. Many trials have been poorly designed (O'Connor 1985, Barnes 1992, O'Reagain and Turner 1992). Considering the decades of experience in establishing and running long-term trials in southern Africa, and the many critical evaluations of their effectiveness, there is no excuse for new trials to be poorly designed and maintained.

If the trial is widely recognised by the broader research community as important, the trial will be more likely to survive policy changes and budget cuts.

Poor analysis and reporting of routine results
The deadline for the annual report is approaching. The responsible officer, having reported all his other activities, suddenly remembers that he must report on his long-term trial. He quickly opens the spreadsheet of the year's data (assuming that they have actually been captured – see above), and draws a graph and a table of the change in relative abundance of *Themeda* and the cumulative weight gain of the livestock respectively. Satisfied that he has completed his report, he closes his document and moves on to more important things.

Routine analyses can be standardised and included in the electronic data management system, so that routine reports can be generated at the click of a button. This does not preclude the need for thorough and imaginative analysis and interpretation of results, but at least can help to ensure that the annual reports are themselves professional and meaningful.

Too much data
Scientists like to collect as much data as possible from a long-term trial – or rather, to expect their technicians and students to collect them. However, if the data are not going to be used to address a specific question, then a great deal of time and resources are wasted. The chances of data being incorrectly recorded by inexperienced personnel increases and data management becomes a nightmare.

Long-term trials should be designed so that the minimum data required to address the core questions are collected, and that a hierarchy of data priorities is incorporated into the design of the trial from the start. Additional questions can be asked of the trials in specific, short-term studies. In institutions where frequent changes in personnel are a major problem (such as government institutions), then it becomes even more important that the trial protocols are kept as simple as possible.

The principle of simplicity applies to the actual experimental design. A complex, split-split-plot design with multiple levels of treatments is almost guaranteed to suffer from incorrect treatment applications in the long term. The layout of the trial should be kept simple, so that , for example, fire treatments are less likely to jump to the neighbouring unburnt plot (Zacharias 1994). As Krebs (1999, p. 2) memorably put it "if you ever find a dichotomy of purpose [between the statistical and ecological requirements of the study], achieve your objectives, answer your question, and ignore the statistician".

(For a thorough and readable discussion of the basics of conducting ecological research, I heartily recommend the first chapter of Krebs).

Conclusion

The basics of sound project management – careful planning, documentation of procedures and results, regular reporting and so on, apply as much to long-term trials as to any project, but with additional challenges. Frequent changes in personnel, budget cuts, and frequent changes in computer hardware and software, are amongst the most common challenges that can upset the smooth running of a long-term field trial. All of these challenges and more can be addressed by assuming from the start that the initial project manager and field staff will not be there next year, which the office where the data is archived will burn down, and that the computer will become obsolete shortly before it is stolen. By building simple, effective data capturing, backup, archiving and reporting systems into the project design from the start, many of the problems afflicting long-term trials can be avoided. Most importantly, like any project, all the staff involved in the management of a long-term trial should have a clear idea of the objectives of the trial, and be an enthusiastic part of the running of the trial.

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References

Barnes DL 1992. A critical analysis of veld management recommendations for sourveld in the south-eastern Transvaal. Journal of the Grasslands Society of Southern Africa 9(3): 126-134.

Fynn RWS 2003. Determinants of community composition and diversity in KwaZulu-Natal mesic grasslands: evidence from long-term field experiments and pot and plot competition experiments. PhD thesis, University of KwaZulu-Natal, Pietermaritzburg. 208 pp.

Fynn RWS, Haynes RJ and O'Connor TG 2003. Burning causes long-term changes in soil organic matter content of a South African grassland. Soil Biology and Biochemistry 35: 677-687.

Krebs CJ 1999. Ecological Methodology. Addison Wesley Longman, Menlo Park, California. 620 pp.

Kruger J 2007. The Kruger National Park data repository. Grassroots 7(2): 27-30.

Manson AD, Jewitt D and Short AD 2007. Effects of season and frequency of burning on soils and landscape functioning in a moist montane grassland. African Journal of Range and Forage Science 24: 9-18.

Martindale G 2008. Influence of livestock grazing on plant diversity of Highland Sourveld Grasslands of KwaZulu-Natal. MSc. thesis, University of the Witwatersrand, Johannesburg. 80 pp.

Morris CD and Tainton NM 2002. Long-term rangeland trials in an African grassland offer insight on the role fire, fertilizer and rotational grazing play in management of tall grasslands. Rangelands 24(5): 8-12.

O'Connor TG 1985. A synthesis of field experiments concerning the grass layer in the savanna regions of Southern Africa. South African National Scientific Programmes No. 114.

O'Reagain PJ and Turner JR 1992. An evaluation of the empirical basis for grazing management recommendations for rangeland in southern Africa. Journal of the Grassland Society of Southern Africa 9(1): 38-49.

Uys C and Hamer M 2007. The effect of long-term fire treatment on invertebrates: results from experimental plots at Cathedral Peak, South Africa. African Journal of Range and Forage Science 24(1): 1-7.

Zacharias PJK 1994. The fire/grazing interaction on Döhne Sourveld. DSc. thesis, University of Fort Hare, Alice. 155 pp.