

Enhancement of capacity in applied biometry in East and southern Africa

Proceedings of an ILRI workshop held at ILRI
Nairobi, Kenya, 7–9 December 1999



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editor

G.J. Rowlands

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ISBN 92-9-46-079-6

Correct citation: Rowlands G.J. 2000. *Enhancement of capacity in applied biometry in East and southern Africa. Proceedings of an ILRI workshop held at ILRI, Nairobi, Kenya 7-9 December 1999.* ILRI (International Livestock Research Institute), Nairobi, Kenya. 115 pp.

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Foreword

The papers included in this proceedings were presented at a workshop on the 'Enhancement of Capacity in Applied Biometry in East and southern Africa' covering Kenya, Malawi, Tanzania, Uganda and Zimbabwe (referred to as the 'region' throughout this proceedings). The workshop was financed by The Rockefeller Foundation and held at the International Livestock Research Institute (ILRI) from 7th to 9th December 1999. The papers have been grouped together against the different facets of the current status of biometrics both within and outside the region.

The first three papers set the scene by describing the **changing nature of agricultural research** in the region and its impact both on the biometric methods needed now and in the future and on the future role of the biometrician. The need for biometricians to be proactive and to get more involved in collaborative approaches with scientists is emphasised.

These three papers are followed by a series of papers from national institutions that **discuss the current status** of biometrics in the region. The situation in the different national research institutes researching in crops, forestry, livestock and medicine is highlighted in the first nine papers. These are followed by five papers describing the status of biometrics training in the Statistics Department of the University of Zimbabwe and in faculties of Agriculture and Forestry in Kenya, Uganda, Tanzania and Malawi. Each of the 14 papers concludes with suggestions on what is needed to enhance the capacity in biometrics in their respective institution. The final paper in this session provides an overview of the general situation in Africa, the Caribbean and Pacific countries and discusses the common factors underlying the lack of progress in the acquisition of appropriate biometric skills.

These papers may leave the general impression that current biometric capacity within national agricultural research systems (NARS) is grossly inadequate to meet the changing agricultural research scene in the region. Nevertheless, the papers that follow suggest that the picture should not be too gloomy. Two papers describe the **opportunities for advanced training** in biometrics in South Africa and Belgium for students from the region. These are then followed by a number papers describing various **new initiatives** within and outside the region. Two papers, for example, emphasise opportunities that have been made and the benefits achieved from linkages made between university departments in Nairobi and ILRI. Examples are also included of approaches for training in West Africa applicable to East and southern Africa, and their adoption in the improvement of teaching of biometrics to agricultural students at the University of Reading, UK. Looking further to the future the possibility of international agricultural research institutes in the region pooling their resources to provide more effective and structured capacity building to NARS is considered. The next paper proposes a collaborative approach among the various groups represented at the workshop in the development of training resources for use by biometricians and scientists within the region. The final paper describes INSTAT+, a computer statistical teaching aid developed by the University of Reading, that could play a significant role in the development of future training resources.

The need for **research networks** and better communication among biometricians is repeatedly emphasised throughout this proceedings. The last two papers describe, firstly an existing network in sub-Saharan Africa (SUSAN), part of the International Biometric Society, and secondly the possible formation of a steering group within the region to oversee the development of linkages between groups of biometricians and scientists in order to foster the enhancement of biometric capacity in the region.

A number of acronyms appear frequently in the papers that follow. These are: IARC—International agricultural research centre (These belong to the Consultative Group on International Agricultural Research (CGIAR)). Four of these IARCs are:

ICRAF—International Centre for Research in Agroforestry, Kenya

ICRISAT—International Crops Research Institute for the Semi-Arid Tropics, Niger

ILRI—International Livestock Research Institute, Kenya

WARDA—West Africa Rice Development Association, Côte d'Ivoire

NARI—National Agricultural Research Institute. A number of these are described, e.g.

KARI—Kenya Agricultural Research Institute

KEFRI—Kenya Forestry Research Institute

KEMRI—Kenya Medical Research Institute

NARO—National Agricultural Research Organisation, Uganda

DRSS—Department of Research and Specialised Services, Zimbabwe

DARTS—Department of Agricultural Research and Technical Services, Malawi

LPRI—Livestock Production Research Institute, Tanzania

NARS—National Agricultural Research Systems—a collective term used to include both NARIs and university faculties of agriculture, e.g.

LUC—Limburgs Universitair Centrum, Belgium

UNP—University of Natal, Pietermaritzburg, South Africa

ICIPE—International Centre for Insect Physiology and Ecology, Kenya

SUSAN—Sub-Saharan African Network, a network of the International Biometric Society

At the workshop conclusion Professor Paul Janssen gave some observations on the outcomes of the workshop.

We have a mission, which can only be achieved through high quality work in teaching, consulting and research. By doing so we will be able to convince students and scientists that biometrics has a key role in supporting scientific research in agriculture and medicine. They will then understand and recognise that good statistical practice can give sound scientific grounds to their research. This is a way (or the only way) to help make biometrics popular. However, to realise this mission we must, as Dr. Hank Fitzhugh, Director General of ILRI, put it when he opened the workshop, 'sharpen the tools to increase the impact.' We must also revisit the way we work and find out whether ours is the most effective approach.

What practical steps can we take? First, we must build bridges; sometimes it is better to walk on a small bridge than to run out of breath on a long bridge; moreover a small bridge is cheaper. Indeed, many things are best done on a small scale, e.g. creation of small local working groups to study a new methodology or joint involvement in consulting/research problems. Second, we must put our activities into the picture through the quality of our



The participants of the workshop on Enhancement of Capacity of Applied Biometry in East and southern Africa.

teaching, consulting and through good public relations. We need to inform the scientific community of what we are doing—hence the reason for compiling this proceedings. We need to present a positive image in order to influence the policy/decision makers at our universities and institutes.

We need to revisit the target of the training at the university level by updating course content and giving convincing examples to demonstrate the usefulness of statistics (the paper by Allan and Stern provides an interesting new approach). We need to exchange expertise both within and outside the region and inform each other about opportunities. Small projects are possible, even at the international level (it is easier to find US\$ 3000 than US\$ 100,000). The region must clearly set its objectives. Progress goes step by step. If you go for big things (journals, books, software) act as a network. If you talk to donors and are thinking big then embed your proposal into a research or development project that clearly fits into the main objectives of the donor.

There is a lot of work to be done. To make progress the workload must be divided.

In conclusion, three quotations from this proceedings aptly describe the work to be done.

Janssen: 'Biometrics is an exciting field in which statistical practice and methodology go hand in hand with research in agriculture, biology, medicine etc.'

Riley: 'It is better to manage well a little knowledge than to mismanage a lot of knowledge.'

Coe: 'If we do not get involved we shall have only ourselves to blame. We cannot blame the customer if we cannot deliver the goods.'

Finally, the contribution of Joyce Chege, secretary to the Biometrics Unit of ILRI, Nairobi, is acknowledged, both for her assistance in the organisation of the workshop and in the typing of this proceedings. Dr. Rob Eley was facilitator during the workshop and his contribution to the smooth running of the workshop is also acknowledged.

G.J. Rowlands
Head of Biometrics
ILRI-Nairobi

Summary

Biometric skills in developing countries are inadequate to support the changing priorities of agricultural research compromising the quality of research aimed at increasing food security and alleviating poverty often because it lacks good statistical design (CTA 1997). It was on this basis that the workshop was planned, realising that not only do national scientists and statisticians (biometricians) need training in applied biometrics but they also need to be exposed to the range of problems and complexity of agricultural study design necessary for the developing world. Few courses in applied biometrics exist in universities in East and southern Africa. Training in biometrics provided hitherto by overseas institutions has been beneficial, but lecturers do not often have a full appreciation, or practical hands-on experience, of the special features of agricultural research and development in Africa. The subjects of experimental design, statistical analysis, interpretation and presentation of results are still recognised to be among the top priorities for training by national agricultural research system (NARS) scientists participating in collaborative networks co-ordinated by the International Livestock Research Institute (ILRI) and the International Centre for Research in Agroforestry (ICRAF). There is thus a major need to establish strong training programmes in the region itself with links to existing programmes abroad.

The focus of the workshop was thus to seek ways that African institutions can work together to improve their capacity in applied biometry. Participation was restricted to 36 persons representing national agricultural research institutes (NARIs), university faculties of agriculture and university statistics departments in Kenya, Malawi, Tanzania, Uganda and Zimbabwe, the international agricultural research centres (IARCs) of ILRI, ICRAF and the International Centre of Insect Physiology and Ecology (ICIPE) and research/academic institutions from England, Belgium and South Africa. The workshop reviewed initiatives and progress to date in enhancing capacity in applied biometry in Kenya through links between the University of Nairobi and ILRI and through the activities of the forum organised by The Rockefeller Foundation in the region of East and southern Africa. It went on to assess both the needs for training in biometrics and its application in the region and the opportunities for developing a framework of linkages between institutions to help strengthen institutional capacity in applied biometry.

The three goals of the workshop were:

1. assessment of the priority needs for training in biometrics and its application in agricultural research and development in East and southern Africa
2. agreement on the specific activities needed to address these priority needs and the partnerships that need to be developed to achieve them
3. agreement on a future plan of action and a time frame for achieving the necessary outputs.

The workshop began with a review of the current status of biometrics in NARIs and universities as described by participants from each of the five countries. Their papers are

included in this proceedings. Following these presentations participants were divided into four groups to undertake a strength/weakness/opportunity/threat analysis of the current status of biometrics. Predictably, the shortage of trained applied biometricians and poor availability of hardware, software and training material were identified as major weaknesses. It was also acknowledged that there is a general lack of appreciation by institutions of the potential value of biometrics in ensuring high quality research and this has led to poor career developments for biometricians. The need to sensitise policy makers and other stakeholders into the importance of biometrics was emphasised. It was also felt that opportunities should be made for sharing resources, including the licensing of statistical software, and for closer collaboration between NARIs and universities. It was agreed that there were many opportunities for local initiatives that are not dependent on major donor support. Where wider donor support may be enlisted it was important to appreciate that most donors are looking for opportunities to solve development problems, and it is up to biometricians, therefore, to ensure that they are part of these solutions. In achieving these goals it was recognised that there is a parallel need to strengthen the level of training in applied biometrics at university level. The existence of international organisations with experienced applied biometricians and of the Sub-Saharan African Network of the International Biometric Society (SUSAN) was an important asset. Nevertheless, it was recognised that biometricians have been slow to respond to the changing agricultural research focus in the region and they are in danger of being marginalised with the consequential misuse of statistical methods by scientists.

The prioritisation of the important needs for training in application of biometrics in universities and NARIs was then considered by a number of speakers, both within and outside the region. Working groups identified the following six themes as key factors required to improve the situation: improving the professionalism of biometricians, training scientists in biometric and database management techniques, developing university curricula to meet the research demand of the countries within the region, sensitising policy makers into the importance of biometrics, developing improved training materials in applied biometrics and arranging for improved linkages between institutions. Six recommendations are described below. On the third day four working groups each tackled one of these themes to develop activities that might be put together in possible future funding proposals.

Recommendations

1. A steering group should be formed comprising a member from each country, a representative from an IARC institute and a representative from South Africa to oversee initiatives arising from the workshop.
2. A demand-driven curriculum for a regional MSc degree programme in applied biometrics should be developed at a university in the region. The University of Nairobi was recommended since the Department of Mathematics was already in the process of developing outline curricula for new courses in applied biometrics at undergraduate and postgraduate levels. Two members of the department had also spent periods of

attachment at ILRI to expose them to the real world of applied biometrics and links had also been established with Limburgs Universtair Centrum, Belgium.

3. A programme for sensitising policy makers in the importance of biometrics should be initiated. Activities proposed for such a programme comprised the production of a brochure highlighting the important contributions that biometrics can make in agricultural and medical research and preparing material to support seminars at different institutions. Both forms of publicity will illustrate by case study example the contribution made by careful statistical design and analysis to the success of a research project.
4. A survey of the needs of practising applied biometricians to improve the professionalism of their service to scientists was required. It was decided that SUSAN was well placed to undertake this survey, including the design of the questionnaire, its distribution, collection and analysis. The results of this study could then be used to identify the priority training needs.
5. Training courses in biometrics and data handling techniques for both agricultural and medical scientists were urgently needed. Following a needs assessment of the various institutions in one of the five countries a training programme should be designed for scientists in that country that could subsequently be adopted by other countries.
6. Training resources that provide biometric knowledge and information in interactive electronic form to teachers and researchers as discussed during the workshop were strongly supported. It was recommended that ILRI in collaboration with partners prepares a proposal for such a biometric training resource.

At the end of the workshop a steering group was formed from those present. Individuals also agreed to co-ordinate working groups to plan and develop, in liaison with the steering group, activities to support each of the recommendations.

Steering group	J. Jonazi, Malawi (Chairman)
	B. Chasekwa, Zimbabwe
	H. Mwambi, Kenya
	M. Nabasirye, Uganda
	C. Rweyemamu, Tanzania
	P. Njuho, South Africa
	J. Rowlands, ILRI (Secretary)

Co-ordinators of working groups

Demand-driven curriculum	J. Odhiambo, Kenya
Sensitisation of policy makers	H. Mwambi, Kenya
Survey of biometricians' needs	A. Odulaja, ICIPE
Training courses for scientists	E. Keogh, Zimbabwe
Training resources	H. Ibrahim, ILRI

Reference

- CTA. 1997. *Strengthening biometry and statistics in agricultural research. Summary report and recommendations of a CTA/University of Hohenheim workshop, 1996*. CTA (Technical Centre for Agricultural and Rural Co-operation), Wageningen, The Netherlands, pp. 1-20.

Changing nature of agricultural research

The changing nature of agricultural research in Africa

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Introduction

For many years agricultural research followed a standard approach of providing improved 'technologies' (germplasm and management practices) that maximised yield and/or profit. Research methods were also focused to meet these objectives. Now the nature of agricultural research is changing in many ways. This paper outlines these developments to help biometricians evaluate the extent of their support to scientists in keeping up with the changing needs.

Factors driving the change in agricultural research

Two factors are responsible for forcing the changes in agricultural research.

The first is a change in the way agriculture itself is viewed. Stakeholders now recognise that the role of agriculture is much more than food production. It provides income and employment and is an integral part of rural livelihoods. Agriculture is recognised as having impacts on the natural resources not only of farmers but also of others, both nearby and distant. No longer are stakeholders interested in simple relationships between inputs of, say, fertiliser and the resulting crop output instead insist on the complex relationships between the uses of a range of inputs, social and natural capital and outputs of diverse products and services—the production ecology of systems.

Secondly, processes of market liberalisation, democratisation and decentralisation mean research has to be client-driven, with farmers being the primary clientele .

Together, these changes made research to no longer be organised around the old commodity and disciplinary boundaries, but be based on understanding systems and problem solving using integrated approaches. The focus has moved beyond farmers' plots to households, villages and larger scales and social sciences have to be as important as biophysical sciences in understanding key processes. Scientists and farmers are becoming research partners, with participatory methods used at all stages of the research cycle. The old applied research methods, using empirical relationships to find optimal, are no longer adequate. Instead strategic research that aims to understand important principles which suggest options for broad investigation with adaptive methods are favoured.

Agricultural research

What research (the research agenda)?

Changes in the research agenda can be summarised as:

- a. Moving beyond commodity based research. Research used to be organised around commodities such as maize or milk. Multidisciplinary teams aimed to improve production of these outputs. Now researchers recognise that much production takes place in multi-component systems—agroforestry, multiple cropping and integrated crop–livestock systems—which need to be studied as systems.
- b. Integrated approaches. The systems perspective means researchers look for integrated solutions to improve whole systems, rather than looking for fixes for each individual problem. This is the basis of, for example, integrated pest management and integrated nutrient management.
- c. Natural resources management (NRM). Research has to look not only at products, but the environmental services provided by agricultural systems. A natural resources approach to research requires evaluating these services at a range of time and spatial scales and determining trade-off between service and production functions. As an example, we need to evaluate how a change in landuse might alter water quality and quantity down stream.

Where research is done

There is a general change in emphasis in where experimentation should be done, with research stations becoming less important. Much research can be conducted in farmers' fields under the appropriate constraints faced by smallholders. Furthermore, it is necessary to carry out research along biophysical and social gradients which are not represented by research stations. Many research objectives are best reached using participatory methods in which trials are designed and managed by the farmers themselves. Researchers have to be aware and open minded about the range of possibilities and use an approach which will be most effective.

Evaluation of NRM aspects of agriculture requires looking beyond individual plots and farms. The 'benchmark location' approach uses sites chosen to be as 'representative' as possible of the type of environment or farming system they are intended to depict. These sites are used for cross-sectional characterisation and longitudinal monitoring studies with the expectation that the results they generate can be applied elsewhere.

How research is done

Firstly, the set of disciplines needed to tackle agricultural research problems is expanding. Social scientists, ecologists and systems scientists are gradually becoming part of the team, along with animal or crop scientists, economists etc. Secondly, the box of tools and

methodologies is changing. Research is continually moving on beyond the simple design of balanced experiments on-station or even on-farm. Spatial characterisation and analysis by geographical information system (GIS) are becoming important tools for identifying problems, targeting research and extrapolating results. Surveys (formal and informal) and studies that link surveys with multi-site experiments are becoming important tools. With the need to extend results from benchmark and farmer sites to other areas within the region that they represent, there will be a greater need for simulation modelling to demonstrate the extent to which research results can be extrapolated. Thirdly, the boundaries between research and extension are disappearing, with the specialists in communication and community mobilisation becoming part of research methods.

Concluding remarks

It is important that the changing nature of agricultural research in Africa described here is taken on board and is encompassed in any proposals that may be forthcoming to enhance the capacity in applied biometrics in the region. Both biometricians and scientists need to be equipped with the appropriate tools to allow efficient and effective project design within the new research agenda.

The impact of the changing agricultural research focus on biometric methods and the role of the biometrician

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Introduction

A biometrician provides support by helping researchers use methods that will be most effective and efficient in reaching research objectives. Traditionally this has meant helping with the design of experiments and surveys and with analysis of data. The research methods that are appropriate depend on the research approach used. For example, determining fertiliser recommendations requires different methods from development of integrated soil management strategies. The type of support needed by scientists depends on the methods used. These in turn determine the skills and training both researchers and biometricians need (Figure 1).

If the focus and approaches of agricultural research change so will the methods and support needed. The biometrician needs to keep one step ahead in anticipating and devising new methods to handle the different ways that agricultural research will be done. But is he? Are biometricians still providing the resource support that is needed?

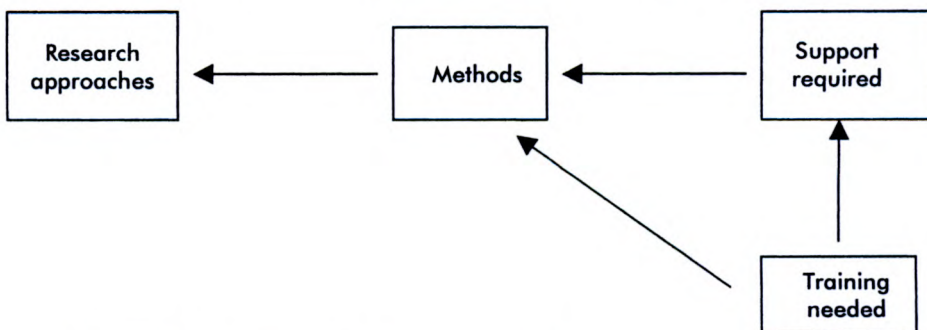


Figure 1. Are we as biometricians providing what is needed?

The changing research focus

The agricultural research focus is changing, not just in this region but throughout the world. The research agenda now includes agro-ecosystem research, integrated approaches to

problem solving, natural resources management perspectives, participation of farmers and an increasing emphasis on providing information about alternative options rather than on optimal packages. With these changes what role is there for many of our traditional tools, typified by the randomised block design and analysis of variance?

The diagram below illustrates a typical design problem that is encountered in participatory and natural resources research. The study layout has several layers—villages, landscape positions on a gradient within each village, farms in each landscape position, different niches within each farm, plots within niches and trees in each plot.

Many questions arise in selecting an appropriate design for the study. For example, how many sampling units should there be at each level, which units and, if this is a participatory trial, who decides on the choice of units? What intervention should be tested at what level and what should be measured? The answers to these questions will not be found in a standard statistical textbook.

Layer	How many?	Which ones?	Who decides?	What intervention?	What is measured?
Village					
Landscape position					
Farm					
Niche					
Plot					
Tree					

Changes in what we do

The above example is a simple illustration of how research methods are changing, what biometricians will be expected to do and, further, what biometricians must train others to do. There are no recipe books of designs for these new problems. We cannot expect to find classical designs which match researchers' requirements. Instead we will have to apply design principles to each new problem. We shall need to balance theory against practical possibilities in applying these principles.

There will be an increasing emphasis on data management and processing as an integral part of the research process. As biometricians, therefore, we need to develop our skills in designing appropriate data management strategies. We need to increase our range of analytical methods and be prepared to learn from ecologists, economists and sociologists on the techniques they use. We need to see beyond the statistical model and classical significance testing. There will be uncertainty in everything and it will be important to develop our skills in interpreting this variation and make balanced judgements on what conclusions can be drawn.

We also have to change the way we get involved. If we wait for a scientist to come along with a query then it is unlikely we will understand the complex situation sufficiently to be able to contribute much. The biometrician has to be a member of a scientific team. We must make scientists appreciate the contribution that we can make to a team effort. Thus, we must expect the arrows in Figure 1 to point in both directions and to be able to respond

when the arrow is pointing back at us. Biometricians are trained to be objective, unbiased thinkers who are able to stand back and judge on probabilistic grounds the likelihood of a scientific result as being genuine or not.

If we do not get involved we shall have only ourselves to blame. We cannot blame the customer if we cannot deliver the goods.

Biometric support to biometricians and scientists in developing countries— Approaches needed now and in the future

J. Riley

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Introduction

The preamble to the final report of the Technical Centre for Agricultural and Rural Cooperation (CTA) study on 'Strengthening biometry and statistics in agricultural research' (Riley 1998) describes the changing needs in agriculture as follows:

Traditional agricultural research has involved detailed biophysical studies in well-controlled conditions. Issues of global changes have resulted in emphasis moving to broader, but less precisely controlled, studies and surveys to assess environmental change and the effects of technology intervention upon the natural environment and the population at large.

The design and analysis of agricultural studies have necessarily become more complex: the whole research spectrum needs to be addressed from basic laboratory and station research through adaptive and applied multidisciplinary research on farms and within communities to farmer impact assessment. Research at each of these stages can benefit from the rigour introduced by professional biometric input which ensures clear planning, appropriate information collection, information summary and interpretation and its presentation in appropriate formats to all involved stakeholders.

Biometric skills have traditionally been taught to deal with straightforward studies such as those for single-species on controlled research stations. Yet biometric needs for multidisciplinary and impact-assessment studies are greater—to cope with the informality of designs, large variability in data and variety of data types. To maintain rigour, strong biometric input is essential—professional input consisting of powerful, flexible computer-based methods. Training of agricultural researchers in the use of such methods is rare; training of professional biometricians in the use of such methods, and skills in consultancy techniques, are therefore essential to underpin the work of agricultural researchers.

Failure to achieve such flexible biometric skills in any country will result in a decline in research quality, the generation of non-representative research results, the rejection of research publications and their exclusion from the research debate. This will be detrimental to global development and the conservation and sustainability of natural resources.

This shows very clearly how biometricians must be aware of the changes they need to make to provide professional support to their scientists as they respond to changing research

directions. Failure to be flexible and make these changes may well result in loss of financial support for biometric posts.

The situation is not unique to Africa. In Nepal there are three main agricultural research stations and there is no biometricians employed in them. The same is true in Papua New Guinea. The number of biometricians in the regional agricultural research network in the Caribbean has been reduced from three to one. In one of the national agricultural institutes in Colombia there were three biometricians. Now there are only two and there are threats of more cuts. In Europe agricultural institutes are in decline, many have closed and biometricians are disappearing to industry. And there are many more examples of cuts to agricultural research in many other countries. What must be done?

Ways forward

Institutional management must be persuaded to recognise the importance of biometrics both in the maintenance of research quality and in the decision making process. Additionally, the management structure must encourage interdisciplinary studies to maintain funds for all scientists including biometricians. This will require an understanding by the scientists and the biometricians of biometric methods for multi-component studies and skills development in this area. How is this best achieved?

Training for scientists

Most scientists have received training in routine methods to handle well-balanced statistics designs and straightforward, well behaved analyses. To handle multi-component studies and irregular designs a greater appreciation is needed of variability in location, material, samples collected at different times and so on. Understanding of correlation and the complexities of repeated measures demands newly-available methods to adjust for the dependencies between sets of data. Participatory research demands an understanding of qualitative data such as farmer responses and impact assessment.

In biometric training for scientists do we retain the simple design approach or do we baffle the scientists with the complexity of more advanced methods? It would be appropriate to take a middle road adapted for individual needs and abilities. This would be demanding on time and resources but would ensure that appropriate methodologies are available to the relevant disciplines.

Training for professional biometricians

Updating in new techniques is essential; this can be done through short courses and also through material accessible on the Internet. Awareness of new methods must be combined with a confidence building process to ensure that communication of the new techniques to scientists is unambiguous and non-technical. Writing skills are essential and often require improvement (everywhere in the world!). Biometricians need to have the same knowledge as

scientists in new techniques but need to understand them in more depth so as to be able to adapt them to unusual situations and programme them efficiently.

Personal management is very important. The biometricians must be proactive and develop collaborative approaches with the scientist and take the initiative to seek funds. In particular he/she must identify research priorities and respond to the need to understand the statistical techniques required to underpin them. He/she should manage time well to ensure time to read about new methods and software. Much is available free on the Internet. An appreciation of a wide range of statistical packages and their limitations is necessary to ensure flexibility of programming for new methods.

How should this delivery of new skills best be done?

New university syllabuses need to be designed to incorporate more flexible methods in a clear, non-theoretical way. This is essential for those commencing training as a scientist or as a biometrician, although biometricians can benefit from further theoretical training in these areas.

Short courses will be crucial for scientists and biometricians qualified already and may be provided by biometricians from outside the country. However, short courses for scientists may not be appropriate for biometricians as they may start at too basic a level. Two types of course should be designed:

- a. those for biometricians should be detailed with a substantial degree of the underlying theory, although practical examples are also essential and
- b. once these are achieved, the courses for scientists should be designed in collaboration with the local biometricians and he/she should be involved with the training.

Increased input to the training should be made by the local biometrician, until his/her confidence is such that he/she can provide it himself/herself. The biometricians from outside the country should make a gradual withdrawal from the training programme at each stage to ensure institutional development. The local biometricians should continue to monitor the uptake of the teaching material by the scientists and ensure that updates and explanations are given to encourage continued use of the material.

Short attachments to institutes in the north or to local institutes with experienced biometricians to analyse their own data, with the daily support of practising biometricians, may be more beneficial than short courses for the local biometricians. However, attachments for PhD's typically lead to too great an amount of specialisation and theory. Additionally, they cause the biometrician to be away from his/her institute for too long a period and support to the scientist may suffer.

Requirements to achieve upgrading of skills

As shown above, a good deal of initiative is needed on the part of local biometricians. This must be underpinned by multilateral support from universities, institutes, professional

societies and publishers to provide access to the necessary new material. Indications are that this support is beginning to emerge.

And money is essential to support all new schemes. But there are lots of opportunities to find funds. All northern funding schemes are accessible to biometricians both in the north and in developing countries. There are large numbers of regional and national groups in developing countries that have funds unavailable to those from the north but readily available to those who reside in the region and who have the energy and enthusiasm to access them in the appropriate way. Seek and you shall find!

Reference

Riley J. 1998. *Strengthening biometry and statistics in agricultural research*. Study Report. CTA (Technical Centre for Agricultural and Rural Co-operation), Wageningen, The Netherlands. 27 pp.

Current status of biometrics in the region

A survey of the current status of biometrics in the National Agricultural Research Organisation, Uganda

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Introduction

The mandate of the National Agricultural Research Organisation (NARO) in Uganda is to undertake, promote and co-ordinate research in all aspects of crops, fisheries, forestry and livestock and to ensure dissemination and application of research results. Research is conducted at the centre and eight research institutes. There are 195 research scientists with varied disciplinary backgrounds and experience throughout the organisation. These are supported by 168 technical support staff. Having myself recently moved to Makerere University there are currently no biometricians on the organisation's staff.

A recent survey conducted throughout NARO showed that research was carried out either on station (15%), on farm (15%) or both (70%). More than 200 on-farm trials were conducted during 1998 and 1999 with an increased emphasis on studies involving farmer participation and impact assessment.

History of biometrics support

Prior to 1980 there was good access to biometric expertise with each research institute having its own biometrics unit, which offered advisory and analytical services and training to newly recruited scientists. During the 1980s, however, most biometricians left the research system and units became virtually non-functional.

NARO was established in 1992. However, the role of biometrics was not explicitly defined resulting in a major decline in the quality of biometric input in research compared with earlier years. Results of a survey on the state of biometrics in NARO carried out in 1997/98 justified institutionalisation of the discipline. The lone biometrician within NARO was given responsibility for biometrics in 1998. But, given the minimal ratio of biometrician to scientist (1:194) with no supporting staff, this initiative has obviously had very little impact.

Computer use for data entry and statistical analysis

A survey of current computer use shows that the majority of scientists are using spreadsheet software for data entry and management prior to statistical analysis (Table 1). Many also rely on Mstat. The use of statistical software is illustrated in Table 2. The table illustrates the variety of packages used. However, scientists have very limited access to manuals. The use of major statistical packages, such as SAS and Genstat, is limited by the inability to purchase software and inadequate skills in their use.

Table 1. Percentages of scientists using different software packages for data entry and management.

Software package	Use by scientists (%)
Lotus	42
Excel	38
Quatro-pro	26
Access	2
Mstat	32

Although there are currently 156 computers with 486 and above processors in NARO, not all are accessible by research scientists. Only a limited number of computers have appropriate statistical software installed, and scientists are required to share these computers. Scientists have varying levels of statistical expertise gained through training courses, some of which date back to the 1970s (7%) and 1980s (50% of scientists). Thus, there is a major need for training courses in biometrics, both at the introductory and advanced level.

Table 2. Percentages of scientists that have been trained in the use of statistical packages, use a statistical package and have access to a manual.

Software package	Have received training (%)	Used by scientists (%)	Access to a manual (%)
Mstat	32	72	24
SAS	25	50	13
Genstat	14	27	7
SPSS	8	20	7
Statgraphics	6	9	6
Minitab	11	9	1
Other	14	19	12

Requirements

There are important requirements for improving levels of expertise in biometrics.

- There is an important need to sensitise research managers, policy makers and donors on the need for strengthening the role of biometrics in NARO.

- There is a need to strengthen human and physical resources by establishing a biometrics unit(s) with adequate numbers of biometricians and technical support staff, and providing scientists with sufficient numbers of computers installed with appropriate statistical software.
- Appropriate courses are needed to train both biometricians and scientists in the use of statistical software and application of relevant statistical methods. The following areas need special attention within such a training programme: data management, design and analysis of on-farm trials, survey methodology, use of generalised linear models and application of spatial and temporal analysis.

Through such training activities there may be opportunities to promote and strengthen collaboration among biometricians both within and outside the East and southern Africa region. This should be a major consideration by participants at this workshop.

Biometrics at the Kenya Agricultural Research Institute

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Introduction

The Kenya Agricultural Research Institute (KARI) comprises 25 research centres and about 15 subcentres across the country. There are 464 research scientists within KARI who require biometric support from 12 biometricians. Thus, the scientist/biometrician ratio is approximately 39:1. Whilst this ratio is better than in other countries in the region represented at this workshop (see, for example, papers by Chirembo; Das; Nabasirye) biometricians are still hardpressed to meet the needs of scientists.

In order to give efficient service to the institute, the research centres are grouped into five regions: Eastern, Coast, Western, Rift Valley and Nairobi. Each region is headed by a team leader who is responsible for all the biometric requirements in the region. This arrangement has helped scientists to appreciate better the importance of biometric input in their research activities and the biometricians are beginning to become more involved at different stages of research. Most research is either on farm, on station or in the form of surveys. Nine of the biometricians have MSc and three BSc degrees.

Biometrics software and training

Most research centres have computers which contain current, licensed versions of SAS, Genstat and SPSS. These were acquired by KARI through funding from the Department for International Development (DFID), UK from 1996 to 1999. Mstat also exists but its use is limited and not encouraged. Through the support of DFID all biometricians have their own computer or at least have access to a computer in their research centre.

Some short in-house courses in biometrics have been run by KARI biometricians at most of the research centres over the past two years. These have covered such topics as experimental design, data analysis for on-farm research, computer operation, use of statistical packages, e.g. SAS, Genstat and SPSS, data collection methods, record keeping and data management. This has been particularly useful to research scientists without a resident biometrician who are now able to manage their work a little better.

Requirements

- Despite the efforts that have been made over the past two years, professional development courses are still needed to help the biometricians provide more effective support to their clients. These could include short management courses, short technical courses and research attachment fellowships.
- It is also necessary to train the three BSc qualified biometricians to MSc level, not only because such training will improve their capabilities as consultant biometricians but also because it will give them more standing with their clients. Staff with only a BSc qualification are assumed by scientists to be capable only of performing routine data analysis.
- Whilst all biometricians have benefited from the recent support given to them by the University of Reading during the DFID-funded programme, they still need more experience and guidance in data management and in biometric techniques appropriate to on-farm research. This training in the statistical methodology required for adaptive, on-farm research is also needed by scientists. This is an area in which many scientists are seeking advice.
- Finally, training in the disciplines in which the biometricians mainly operate, e.g. animal, crop and natural resources research, could improve the contributions that biometricians can make, particularly if some were able to specialise in given fields.

The current position of biometric support for agricultural and natural resources research in Malawi

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Introduction

Agricultural and natural resources research in Malawi has two biometric support units, one belonging to the Department of Agricultural Research and Technical Services (DARTS) in the Ministry of Agriculture (one biometrician) and the other to Bunda College of Agriculture, University of Malawi (two biometricians). The latter is primarily engaged in teaching with few consultancy activities (see Jonazi, this proceedings). The number of research scientists currently working in the agricultural and natural resources research in the country is summarised in Table 1. With only three biometricians, and two of these heavily involved in teaching, there is consequently poor interaction between biometricians and scientists. The biometrician to scientist ratio at DARTS is 1:80.

Table 1. Number of scientists involved in agricultural and natural resources research and teaching in Malawi.

Institutions	Numbers of scientists and their academic qualifications			
	PhD	MSc	BSc	Total
Colleges	40	37	4	81
DARTS	23	44	13	80
Other government research institutions	7	48	37	92
Private research institutions	9	10	3	22
Total	79	139	57	275

History of biometric support

The role of the DARTS biometrics unit is to advise research workers on the design of experiments and the interpretation of results and to organise computer and other services for the analysis of data. The unit was established in 1969 under the United Kingdom's Agricultural Research Council (ARC). It quickly gained confidence among research workers who frequently sought guidance in experimental techniques. By 1974 the unit had

three biometrician, two of whom were local staff who had been trained at the University of Cambridge, England. The ending of the ARC support in April 1975 terminated the contract of the expatriate biometrician. From September 1996 to the present a lone biometrician has served the unit. The unit was provided with a good collection of books and journals when it was supported by the ARC 25 years ago but nothing has been added since.

Training of scientists in biometry

Most scientists are initially recruited as BSc graduates from the University of Malawi and sent abroad for advanced training. Some, however, now stay in Malawi for MSc training at the University of Malawi through donor-supported programmes such as The Rockefeller Foundation and Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ). The four-year BSc programme at the university has some statistics courses with experimental design taught in the final year.

Thereafter, further training in the application of biometry is mainly through consultations with the biometricians, often only when a scientist is faced with a problem of data analysis. Short courses are rare due to lack of funds and non-recognition of their importance by management. Field plot layout and sampling procedures are areas of particular concern especially as many scientists leave these tasks to research assistants who are often untrained in this area. Consequently, orientation of plots and blocking procedures are not being followed (Mtukuso and Chiremba 1999). There is also a lack of rigorous attention to data recording. Data such as 0.5, 1.14, 1 recorded for the same variable are commonly seen in field data books.

Other research institutions are encouraged to use the Bunda College and DARTS biometrics units. However, apart from one of the two private research institutes shown in Table 1 none have done so.

Lack of statistical software support

Government research funding as a proportion of agricultural GDP, often used as a measure of support to agricultural research, is well below the expected international level of 2% and declining. Research funding relies on donor-funded development budgets. Such funding does not usually take into account biometric support nor provide for general in-country training in biometrics to keep pace with modern biometrics and computing developments. Statistical software is thus limited and much is used unofficially. Some software has been procured by scientists at the end of their graduate studies and some provided some time ago by donors. There are few manuals and scientists lack training. The most frequently used software for statistical analysis includes SAS, Genstat and Mstat.

Requirements

The lack of professional biometric input to agricultural research projects has strong implications for the quality of project results. A number of activities need to be initiated in Malawi with regard to the development of biometric skills. Among such activities are the following:

- strengthen the number of biometricians in DARTS and other government research institutions
- enhance the recognition by heads of research institutions of the key role of biometrics in agricultural research, the importance of short-term biometric courses for scientists and the need for increased contacts between Malawi's isolated biometricians and other biometricians in the region
- establish a local group in Malawi of the Sub-Saharan African Network (SUSAN) of the International Biometrics Society (see Odulaja, this proceedings)
- incorporate biometric needs in funding proposals in order to enhance the purchase of journals, books and statistical computer software.

Reference

Mtukuso A.P. and Chiremba A.M. 1999. Report of the monitoring of DARTS research experiments, 1998/99 season.

Capacity of livestock research scientists in applied biometry in Tanzania

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Introduction

The Livestock Production Research Institute (LPRI) at Mpwapwa in Central Zone of Tanzania is involved mainly in livestock research on dairy and beef cattle, small ruminants (meat and milk), pastures and forages and in socio-economic studies. These programmes are integrated within disciplines such as animal breeding and genetics, animal nutrition, animal health and husbandry, range ecology and management and animal reproduction. Currently, the institute has also embarked on biodiversity and conservation projects of livestock germplasm. The institute collaborates with the livestock research departments and centres in the six other zonal centres in Tanzania and also with the Animal Science and Production Department at Sekoine University of Agriculture at Morogoro. Some of the multidisciplinary research projects conducted on farms are also associated with crop research scientists and socio-economists.

The paper is a result of discussions with some livestock research scientists at LPRI and other centres in Tanzania. A full detailed survey of biometric needs was not done.

Biometry capacity among scientists

Most scientists are involved in both on-station and on-farm research. Insufficient knowledge of biometrics has usually been the main setback during research project design, data analysis and interpretation of results. Most research scientists have limited knowledge of basic statistics. This has led to various projects being either abandoned halfway due to bad experimental design or not being analysed correctly. Whereas a research scientist has been trained in basic statistics, and some have been introduced to statistics for on-farm research, the general capacity in the application of biometrics from design to presentation of results is poor. Furthermore, livestock researchers have not been able to avail themselves of new database management and statistical software due to lack of training. Assistance in increasing the capacity in applied biometry at the institute and livestock research centres is important, especially for researchers working on long-term research projects conducted both on station and on farm.

Access to biometry expertise

Expertise in biometrics is limited due to the small number of scientists with an advanced knowledge of biometrics. Table 1 summarises the level of biometric knowledge among the livestock scientists. Thus, data analysis of small trials has often relied on simple statistical techniques. Sometimes, scientists have depended on the Statistics Unit within the Rural Economics Department, Sekoine University of Agriculture for data involving both on-station and on-farm research. The assistance of the International Livestock Research Institute (ILRI) has occasionally been sought for the analysis of large data sets covering many years of data collection. Staff from universities abroad such as the University of Reading and the University of Agriculture, Norway have also sometimes assisted in data analysis and interpretation of results.

Table 1. *Level of biometric knowledge among 41 livestock research scientists (11 with PhD, 26 with MSc and 4 with BSc qualifications).*

Knowledge of biometrics and software	Scientists (%)
Use of computer for data management and analysis	<40
Basic statistics (mean, SD, SE)	>60
Experimental design	<20
One or two-way analysis of variance	<40
Regression analysis, correlation	<40
Covariance analysis	<10
Categorical data analysis	<5
Animal breeding and genetic data analysis	<5
Designing and coding of survey questionnaires	<5
Survey and on-farm data analysis	<5
Principal component analysis	0
Interpretation of analysed data	<10
Use of Minitab, Systat statistical software	<20
Use of SAS or other advanced statistical software	<5

Data management and statistical software resources

Computer hardware has previously been provided through a project funded by the World Bank. However, the number of computers available in working condition to research scientists is low (i.e. 1 computer for 10 scientists). The software available consists mainly of word-processing (Word or Word Perfect). Excel, Lotus or Dbase are occasionally available.

The use of computers for data management is patchy. Some data from small trials are entered in(to) Minitab or Excel. Scientists and technicians have also entered some animal breeding and survey data in Dbase. The institute has only two computers running on Windows 95. These are used for administration, accounting and sometimes research data management. The institute does not have a licensed statistical package and scientists rely on

unsupported versions of Minitab and Systat. Several animal breeding and husbandry projects have not been analysed due to lack of professional biometric support and lack of appropriate statistical software.

Training in biometrics

There have been only two basic courses in biometrics for scientists and technicians during the past ten years. These were conducted at the Sekoine University and two scientist from LPRI attended. Two scientists also attended a course organised by ILRI on an introduction to Dbase and SAS. Thus, most scientists have not had any formal training in data management or use of statistical software.

The main areas of biometric assistance required by livestock scientists both at LPRI and elsewhere in Tanzania are as follows:

- data management for long-term and short-term projects
- experimental design
- data analysis and interpretation of the results both for continuous and categorical data
- questionnaire design, data management and analysis of on-farm and survey data
- multivariate methods
- use of statistical software and interpretation of results, e.g. SAS, SPSS
- genetic analysis of animal breeding data to derive selection criteria for future breeding programmes
- use of results for future planning and policy formulation.

Requirements

The present efforts to enhance the biometric capacity of scientists is timely due to an increased thrust in livestock research in Tanzania during the past five years.

- This enhancement in biometric capacity needs to be accompanied with the acquisition of up-to-date data management and statistical software.
- Software for use in livestock research institutes should be standardised both for data management and analysis.
- To achieve this a network of research workers primarily involved in data management and analysis in the East and southern Africa region should be established to assist other research workers.

Biometrics services and capacity at the Kenya Forestry Research Institute

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Introduction

The Kenya Forestry Research Institute (KEFRI) was established in 1986. Previously it existed as a Forest Research Conservancy within the Forest Department. Following recent rationalisation of government ministries the institute was moved from the Ministry of Research and Technical Training to the Ministry of Environment and Natural Resources.

An internal review of the institute was undertaken in 1995. This was followed by an external research programme and management review in late 1996 and early 1997 and, as a result, the research programmes were consolidated into four core research programmes, namely Farm Forestry, Natural Forests, Forest Plantations and Dryland Forestry. Furthermore, a research matrix project management approach across programmes was adopted to encourage problem-oriented and multidisciplinary research. Research findings with scope for extensive application by a spectrum of end users are now considered to be essential. A Service Programme whose main functions are the documentation and dissemination of research findings supports the four core research programmes (KEFRI 1999). This new structure of KEFRI became operational in September 1998. KEFRI currently employs 95 research scientists, (PhD, 11; MSc, 51 and BSc, 33). Twenty-four of these scientists are training for higher degrees (PhD, 13 and MSc, 11).

This paper describes the biometric situation in KEFRI and ways to improve it based on results of an informal mail survey done in November 1999 by the Service Programme. A quick appraisal was done to generate information on availability of or access to biometric expertise within and outside the institute, types of statistical and data management software used, availability of computers and the numbers of scientists that need training in biometrics. A one-page questionnaire was sent to 70 scientists. Fifteen completed the questionnaire.

Biometrics services

In 1988 KEFRI employed a postgraduate mathematician to provide a service in biometrics. A biometrics and data processing unit was created comprising the designated biometrician and a technician. Nine years later, in 1997, the biometrician proceeded for PhD training abroad. It is presumed that after training the officer will resume work at KEFRI.

Since 1997 KEFRI has had no internal biometric support and most KEFRI scientists currently do not consult a biometrician when designing their experiments. Only 5 of the 15 respondents reported that they consult a biometrician and, of these, two have access to a biometrics service outside KEFRI. This individualistic approach to research by KEFRI scientists has encouraged them to utilise their own research experience in the design and analysis of their experiments according to their respective fields of specialisation. The research areas for which scientists nevertheless believe that biometrics services are needed are, in descending order: on-farm trials, on-station experiments and laboratory experiments.

Statistical and data management software

Scientists use different types of software for data management and processing (Table 1). Most scientists have access to shared computers, running on Windows 95. One or two projects have computers running on Windows 98.

Table 1. Different computer software used by 15 of 70 KEFRI scientists responding to a quick appraisal survey of biometrics needs.

Type of software	Number of users
Data management	
Quatro Pro	1
Excel	7
Lotus	5
Statistics	
Genstat	2
Minitab	2
SAS	1
SPSS	2

Training needs in biometrics

Seven of the 15 respondents have received some training in biometrics during the past five to 10 years. Three reported that the courses were relevant to them, three not. The remedial short-term training courses that the 15 respondents considered important are listed in Table 2. The perceived training needs are primarily in the use of statistical packages, in experimental design and in data management.

Improvement of biometrics services in KEFRI

The questionnaire included a question on respondent's opinion on how the biometrics services in KEFRI can be improved.

- A number indicated that certain scientists with a background in forestry/agriculture be trained to take a lead role in providing biometrics services to their programmes.
- A second scenario was that the central biometric facility with qualified staff be re-established.
- Some respondents suggested that there was a need for all scientists in KEFRI to be trained in biometric-related subjects.

Table 2. *Training needs in biometrics and related subjects considered most important by 15 of 70 scientists responding to the questionnaire.*

Type of course	Number of respondents
Relevant statistics software	9
Data management	4
Experimental design	4
Data interpretation	1
Sample survey	1
Collection, management and processing of sociological data	1
Non-parametric statistics	1

Finally, it could be argued that, although the survey was undertaken as a quick appraisal of biometric needs and there was no follow-up of non-responders, the poor response (15/70) may indicate a general lack of appreciation among a number of KEFRI scientists of the importance of good quality biometric support.

Reference

KEFRI. 1999. *Strategic plan 1999–2004*. KEFRI (Kenya Forestry Research Institute), Muguga, Kenya.

Rapid assessment of biostatistic and computer application capacity of the research scientists in the Kenya Medical Research Institute, Kenya

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Introduction

The Kenya Medical Research Institute (KEMRI) was established in 1979 under the Science and Technology (Amendment) Act of the same year to represent the national body responsible for carrying out research in the field of biomedical sciences in Kenya. The institute is also mandated to co-operate with other organisations, research bodies and institutions of higher learning within and outside Kenya in training programmes and on matters of relevant research. Currently, there are 10 research centres in the institute which were created to focus their research activities on certain specific areas of national and/or strategic importance. The institute has a workforce of approximately 1500 of which 500 are the research personnel, many of whom (about 50%) have postgraduate qualifications at the masters, doctoral and post doctoral levels. A recent survey conducted among the scientists in KEMRI revealed that most of the on-going biomedical research work is community based (60%). Of the remaining research activities these are either carried out in health facilities (30%) or at the central laboratories (30%) or both.

Biostatistic and computer application capacity among scientists

The institute had in its planning stages put up a structure for the development of a unit for providing specialised services in epidemiology, biostatistics and information technology. This was clearly specified in the initial mandates of the then Medical Research Centre (now known as Centre for Public Health Research (CPHR)). A few activities have been implemented since 1983. Notable among them are epidemiology and biostatistic support to major projects in KEMRI, development of the KEMRI Biostatistics and Management Information Systems Group, training in research proposal development and training in computer applications, data management and analysis. The unit put in place mechanisms for improved accessibility to computers—from one computer in 1983 to over 100 computers

of 486 and above processors today. There are currently four biometricians (one with a PhD and three with an MSc degree) and two trainees. However, the current CPHR research mandate does not clearly spell out the structure and role of the unit, and there is no clear structure linking the unit to research activities in KEMRI. This is coupled with inadequate budgetary provision for the support of established services. Although most of the computer hardware and software packages have been acquired through a project funded by the Carnegie Corporation, the number of computers available to research scientists is still inadequate. Expertise in biostatistics and computer applications among the scientists is limited. There have been only two basic courses in biostatistics and computer applications organised for newly employed scientists in the institute during the past eight years.

A recent rapid survey of biostatistic and computer application capacity among approximately 50 scientists shows that only 10% of the scientists can competently carry out data entry, management and analysis, while most of them (90%) seek the expertise of a biostatistician. Nevertheless, the majority of scientists are using spreadsheet software such as Excel and the database systems Access or Dbase for data entry and management prior to statistical analysis (Table 1). SPSS is widely used (70%) by scientists for data analysis due to ease of access to a user manual (90%) supplied through the Carnegie funded project. SAS and Epi-Info are also used to a lesser extent for data analysis by some of the scientists.

Table 1. Percentages of scientists in KEMRI trained in the use of software packages for data entry, management and analysis, percentages of scientists currently using the package and, of these, percentages with access to a user manual.

Software package	Scientists trained in KEMRI (%)	Scientists currently using package in KEMRI (%)	Current users with access to manual (%)
Dbase	20	20	20
Access	10	20	20
Excel	40	30	20
Epi-Info	10	20	30
SPSS	30	70	90
SAS	10	20	50

Prioritised needs

Varying levels of statistical expertise amongst scientists have been observed. About 30% have expressed the need to undergo a basic training course in biostatistics and a further 30% at an advanced level. The majority of the scientists (90%) have expressed the need to undergo a refresher course in data management and analysis while some 40% feel that they need a permanent help desk established in the institute. Acquisition of more computers and software was mentioned by 30% of scientists.

- It is clear from the above that there is an urgent need for establishing mechanisms for addressing the above issues by setting up an operational unit for biostatistics and information management systems.

- It is also necessary that the unit be provided with an operational structure that facilitates provision for support of specialised services to the institute in order to improve the quality of scientific output in both developed research proposals and published research papers.
- Opportunities should also be explored to promote closer collaboration among biostatisticians working in the area of biomedical sciences within and outside the region.

Applied biometry in the research programmes at the National Animal Husbandry Research Centre, Kenya

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Introduction

The Animal Husbandry Research Centre (founded in 1903) is situated in Naivasha approximately 100 km west of Nairobi and covers 4000 hectares. It is one of centres of the Kenya Agricultural Research Institute (KARI) (Wamae, this proceedings). Its mandate is to conduct breeding and nutrition research in Friesian and Sahiwal cattle, small ruminants, poultry and pigs. The centre has 16 research scientists and 7 technical officers and, for research purposes, possesses 1500 Sahiwal cattle, 240 Friesian cattle, 920 goats, 150 pigs and 1000 chickens.

The research scientists fulfil the following disciplines: genetics and breeding (2), reproductive physiology (1), ruminant nutrition (7), poultry nutrition (2), animal health (1), agricultural economics (2) and biometrics (1). Research is conducted both on centre and on farm.

There is now a major emphasis on fitness traits in livestock (survival, disease incidence and reproductive rates) to complement growth and lactation traits. These are recorded in experiments both on centre and on farm, though, on farm, there is also the requirement to collect socio-economic, environmental and management data. Biometric input is thus important in the design of these studies and the analysis of these complex data sets.

Biometrics support

The centre has its own biometrician and some senior research scientists are also able to assist young members of staff. Consultation with a biometrician at KARI headquarters is also possible and contact is maintained with biometricians at the University of Nairobi and Egerton University. For more advanced genetic analysis ILRI has been extending a helping hand.

Biometrics courses financed by the Department for International Development (DFID), UK have been run over the past two years (see Wamae, this proceedings). Unfortunately, only research scientists working on DFID-funded projects benefited from these courses.

Requirements

- Despite the biometrics training that has been given, research scientists still need training in the use of the statistical packages, such as SAS and Genstat.
- Additional training is also needed in the application of applied biometrics in general, especially for young scientists that have recently joined KARI or have just completed higher degree programmes.
- Farm survey design and data analysis is an area of high priority. Scientists need to be able to identify the appropriate study design and be able to properly collect, compile and analyse the data and report the experimental results.

Assessment of the current status in the design and analysis of experiments at Matopos Research Station, Zimbabwe

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Introduction

Matopos Research Station is one of the four livestock research stations of the Department of Research and Specialist Services (DRSS) in the Ministry of Lands and Agriculture. The work of the station is primarily concerned with extensive and semi-extensive land use in an environment where rainfall is low to medium and highly variable.

Research is targeted towards developing technologies for sustainable livestock production within a semi-arid environment and using rangeland and other feedstuffs to do so. The management of rangeland, nutrition and the role of indigenous breeds of domesticated ruminants feature prominently. The research focuses on the three species of cattle, sheep and goats, on the use of donkeys and cattle for draft power, on forage production and on smallholder dairy production.

The scientific research team

The research team is composed of nine scientists from different agricultural disciplines. The scientists plan, design and execute experiments undertaken both on station and on farm. The individual scientists do analysis of experimental results although they often consult among themselves on the best statistical procedures to use. The station has recently embarked on on-farm research activities for which knowledge of the design of on-farm experiments is limited. Training in biometrics for on-farm research is, thus, needed. Scientists have been trained in biometric methods pertaining only to fairly standard on-station experiments.

This situation calls for the appointment of a biometrician on site. Access to biometric expertise is limited. The two biometricians in DRSS belong to the Biometrics Unit at headquarters in Harare about 400 km away. They provide services to all research units in DRSS, i.e. Livestock and Pastures Division, Agronomy Institute, Crop Breeding Institute, Plant Protection Unit, Dairy Services and so on. They are readily available for consultation to units based in Harare, but access to them from Matopos Research Station is difficult because of lack of resources for travel etc.

Computer software

Most computer hardware has been purchased through donor-funded projects. The current situation is very favourable with at least one computer per scientist. Available data entry software includes Excel, Lotus and Dbase. Most popular are Excel and Dbase. Statistical packages include Genstat and Harvey's General Least Squares Program. SAS has long expired and there are no funds to renew the license.

Requirements

- Research scientists and their research technicians need training to update themselves with the latest statistical packages.
- Training in the design and analysis of on-farm experiments (especially for livestock research) is needed.

Biometrics at the Kutsaga Research Company, Zimbabwe

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Introduction

Kutsaga Research Company is an agricultural research organisation with 25 research officers specialising in tobacco research. The research officers conduct a diversity of experiments in agronomy, plant physiology, plant breeding, plant pathology, entomology and nematology. The company conducts approximately 125 experiments annually, most of which are on station but with quite a few on farm.

Biometrics support

Kutsaga has a Biometrics Department with three biometricians, so all the research officers have access to biometrics help. In fact, all the experiments must pass through this department at all the critical stages such as experimental design, data analysis and report writing. All the biometricians are active members of the International Biometric Society (Group Zimbabwe) and therefore are in frequent interaction with other biometricians from other organisations both nationally and internationally. Training for scientists in biometrics is done almost entirely in house with occasional courses and on-the-job training. The biometricians, however, are relatively inexperienced and so the training is inadequate to fulfil all the needs. In the past some biometricians have been sent abroad for further training but this has become very expensive and unsustainable.

Data management

Data management is the responsibility of the Biometrics Department. Kutsaga has a computer network of 75 computers (workstations) with hard disks varying from 1 to 8 gigabytes in size. All research project outlines, raw data and results are stored on the network server with each research officer having read-only access. The main statistical software used by the Biometrics Department is the Windows 6 version of SAS. Some research officers, however, have other packages such as Minitab and Statistix, which they use mainly for data exploration.

Future needs

- Both biometricians and scientists need training in analysis of categorical data, spatial statistics, generalised linear models and handling of data with overdispersion.
- Such training could be conducted in the form of short courses locally or regionally, or by sending a biometrician on a short attachment at a well-established biometrics unit to get hands-on experience from experienced biometricians.

University training in biometrics/ biostatistics in Zimbabwe: the current situation

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Introduction

The University of Zimbabwe has five faculties for which there are requirements for biometrics/biostatistics training, namely the faculties of Agriculture, Medicine, Veterinary Science, Science and Engineering. All departments within the former three faculties have a requirement for biometrics teaching. The relevant groups within the latter two faculties are a) the departments of Statistics, Biology and Geology and the institutes of Environmental Studies and Food, Nutrition and Family Sciences in the Science Faculty and b) the Water Quality and the Geographical Information System (GIS) units in the Engineering Faculty.

Over the years there has been a gradual reduction in the numbers of biometricians in the university. The situation today is shown in Table 1.

Table 1. Academic statisticians and biometricians in the University of Zimbabwe.

Faculty	Department	Academic	
		statisticians	Biometricians
Agriculture	Crop Science	-	1
	Animal Science	-	0
	Other departments	-	0
Medicine	Community Medicine	-	2
	Other departments	-	0
Veterinary Science	All departments	-	0
Science	Statistics	7	1
	Other relevant departments	-	0
Engineering	Relevant departments	-	1

The table demonstrates that trained biometricians are in short supply and, consequently, unable to provide the needs for biometric support. The Department of Animal Science, for instance, has a vacancy for a biometrician that it has been unable to fill.

University of Zimbabwe Statistics Department

The Statistics Department produces roughly 60 graduates with a BSc general degree and 15 with a BSc honours degree each year. In addition, about 15 students receive a Diploma in Statistics and three or so an MSc degree.

The Statistics Department currently has a strong theoretical bias, particularly at the MSc level. Few staff are engaged in active research and very few attend conferences, travel out of the country for meetings or belong to international associations. The staff are young, mostly former MSc students, and there are no staff at a senior level.

The Diploma in Statistics was introduced in 1994 in the hope that it would attract students with a first degree in an applicable area such as agriculture, geography, geology, demography etc. and provide them with sufficient statistical knowledge to make them competent statisticians in their particular area of expertise. In addition, the programme was introduced to enable government employees to upgrade themselves locally, thus saving the costs of travelling to Dar es Salaam, Tanzania for the East Africa Statistics Training Centre programme. Unfortunately, the diploma course has now become almost totally the domain of school teachers who are eagerly searching for routes to leave the teaching profession. The bottom line is that the Statistics Department is not currently in a position to properly train biometricians in Zimbabwe.

Other universities in Zimbabwe

Prospects may be better at two other national universities. The Applied Mathematics Department of the National University of Science and Technology currently offers a broad based degree in applied mathematics. Students can specialise in statistics. Current interest is focused on industry and students go on attachments during the course of their studies. There appears to be considerable enthusiasm in the department and more active research. The department would probably welcome an invitation to expand their syllabus to include biometry.

The Agriculture Faculty in The Africa University has a part time lecturer (I believe) who offers appropriate statistics courses to students.

The way forward

- There is an urgent need for faculty staff to be educated in the benefits of correct biometric procedures in their research and in the dangers of amateur dabbling.
- At the same time there needs to be a revision of the statistical curricula in all relevant university departments.
- A research network among biometricians, both practising biometricians in research and lecturers teaching applied biometrics in universities in the region covered by this workshop, would be beneficial. Many biometricians work in isolation and regular

communication would help to bolster their confidence in the work they do and enable them to exchange experiences and ideas with others in the application of biometric methods. Organisational models that may be adopted for this purpose are, for example, the International Clinical Epidemiology Network (INCLIN) that holds regular research workshops and the Royal Statistical Society in the UK.

Teaching of biometrics in the Faculty of Agriculture, University of Nairobi

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Introduction

The Faculty of Agriculture at the University of Nairobi offers a variety of courses in agricultural research and study. Research scientists in all disciplines require biometric input in their work. The main types of research for which this is required are on-station and on-farm studies and field and laboratory experiments. There are four biometricians employed on the staff of the Department of Crop Science which provides support to research scientists across all departments within the faculty. However, the biometric support provided is insufficient for a number of reasons. On the one hand, scientists, though aware of the availability of the biometricians, do not always appreciate their input as a vital aspect of research. Instead, they see biometrics as a service discipline for help in the final phases of data analysis and reporting. On the other hand, this leads to a lack of exposure to current biometric practices and related problems. In this situation the thrust remains on the classroom curriculum which is based on standard biometric techniques. Attachments to research institutes on a part-time basis is being used as one approach to enhance the quality of support that can be provided by the biometricians.

Computer hardware and software

The data management and statistical software available are Lotus, Dbase, Mstat, SPSS and Genstat. Several computers are distributed throughout the various departments. In particular, the Department of Crop Science houses nine computers donated a year ago by The Rockefeller Foundation. Access to these computers is limited to postgraduate students and staff. Computer access is still extremely limited for the large numbers of undergraduate statistics students.

Undergraduate teaching

Mathematics and statistics, whether abstract or practical, require ample time for practice. However, this has not been possible due to limited time for tutorials and shortage of teaching assistants for the large number of students.

It is also difficult for students to achieve their full potential in the understanding and following of the biometrics courses owing to a lack of teaching materials. There is also a need to focus the statistical courses more on application of biometrics without at the same time losing sight of the fundamental concepts.

Postgraduate teaching

In contrast to the teaching of courses to undergraduates the syllabus for biometry in MSc courses has been restructured. It now has a strong element of practical biometrics and computer training. In addition to the 80-hour biometry course in year 1 (which includes 30 hours of computing) it is planned that 40 more hours will be allocated for computer sessions in year 2 during the students' projects to cater for training that may not have been covered in year 1.

Opportunities for improvement

- Biometrics staff would benefit from opportunities for further training both to PhD level, so that they can have equal standing with many of their clients, and through short courses offered locally or abroad. Given a stronger emphasis biometric input in research would enhance multidisciplinary studies.
- Periodic workshops on new approaches to practical biometrics and statistical software are needed to ensure that curricula are kept up to date.
- A greater willingness to share resources within the university would be of mutual benefit. Donor-funded, project-oriented research often works against this with computers, for example, being restricted to those projects for which they were purchased.
- There is finally the need to update biometrics books and journals within university libraries and provide better access to Internet services to enhance research quality.

Biometric support in the faculties of Agriculture and Forestry and Nature Conservation, Makerere University, Uganda

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Introduction

The Faculty of Agriculture has seven departments, namely, Agricultural Economics, Agricultural Engineering, Crop Science, Soil Science, Food Science and Technology and Agricultural Extension and Education. The Faculty of Forestry and Nature Conservation comprises of four departments, namely, Community Forestry and Extension, Forestry Biology and Ecosystem Management, Forest Management and Forest Products Engineering.

The following undergraduate degree programmes lasting four years are offered in the Faculty of Agriculture: BSc degrees in Agriculture, Food Science and Technology, Agricultural Engineering. Each department also offers specialised MSc and PhD programmes. The current number of undergraduate students is: BSc Agriculture 405, BSc Food Science and Technology 150 and BSc Agricultural Engineering 98. Postgraduate students number around 70. Two undergraduate degrees are offered in the Faculty of Forestry and Nature Conservation: BSc in Forestry and Community Forestry and Extension. There are 160 undergraduate and 10 postgraduate students studying in the faculty.

Biometric support

The total number of academic staff is 105 with 85 in the Faculty of Agriculture and 20 in the Faculty of Forestry and Nature Conservation. They all require biometric assistance for on-station research, on-farm experiments, field surveys and social and environmental studies. Within the faculties there are two biometricians, one with a PhD and one an MSc degree. A third biometrician is away on extended study leave. Assistance has also been sought from time to time from the International Livestock Research Institute (ILRI) for

genetic data analysis, from the International Centre for Research on Agroforestry (ICRAF) for agro-forestry data analysis and also from the University of Reading.

Computer and software resources

Data management is done by two computer technicians using spreadsheet software, namely, Excel, Lotus and Quatro Pro. Available statistical software are SPSS, SAS and Mstat. Minitab has also recently been installed on one computer. There are a total of 25 computers in the two central pools (one for each faculty) used mainly by students. Although limited in number, these computers are up to date. Much of the software, however, is currently unlicensed. In addition each department has several computers which are used by staff and postgraduate students.

Training in biometrics

Courses currently offered in biometrics are: 'introductory statistics' for first year students, 'biometrics' for second year students and 'applied statistics and biometrics' for postgraduate students. The courses are fairly elementary and cover various basic statistical methods appropriate to agricultural experimentation. However, they fall short of all the needs of the two faculties.

Requirements

The main areas where biometrics help is required are

- short courses in data management, design of research studies, analysis of data and interpretation of results
- provision of up-to-date licensed statistical software, e.g. SAS, Genstat, Minitab and Epi-Info.

There may be opportunities for the two biometricians on staff to work with other biometricians in the region to develop these extra courses. Hopefully this workshop may go some way to achieving this.

Biometrics training in the Faculty of Forestry and Nature Conservation, Sokoine University of Agriculture, Tanzania

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Introduction

The Faculty of Forestry and Nature Conservation at Sokoine University specialises in forestry and wildlife disciplines (Forest Biology, Forest Economics, Forest Engineering, Wood Utilisation, Forest Mensuration and Management and Wildlife Management). The teaching of biometry is both at undergraduate (BSc) and postgraduate (MSc and PhD) levels. There are on average 30 forestry and 45 wildlife undergraduate course students who receive statistical training during their first year and about 30 in total at MSc level. Biometry applications also occur in research, consultancy and extension.

Biometrics teaching and assistance

There are 28 lecturing/research staff (24 PhD and 4 MSc) and 10 research technicians in the faculty. Unlike the situation at Makerere University in Uganda (Bareeba and Balaba Tumwebaze, this proceedings), there are no biometricians on staff and so most lecturers supervise student projects requiring statistical input. At least two of the forestry lecturers conduct the undergraduate and postgraduate classes in biometrics each year, and at least 10 carry out research and consultancy projects requiring biometric input. Thus, they rely on their knowledge of biometry gained during their postgraduate studies. Lecturers in the Department of Forestry are able to share the required courses in biometrics but lecturers in the Department of Wildlife are required to call in help from the Faculty of Science. Apart from the undergraduate and postgraduate courses given by staff no other special biometrics training courses are available for staff or students.

Computer and software resources

Undergraduate students have access to a campus-wide computer laboratory (approximately one computer per 50 students). Postgraduate students have access to the Faculty Computer Unit with about 16 computers, mostly up to date and running on Windows 95 and 98 and

up to 200 MHZ speed. Most staff have access to other specific donor-funded project computers. Available statistical software are Statgraphics, SAS, Minitab, SPSS, but old, unlicensed versions are being used. Data management is done using Excel. Access and Dbase are available but hardly used.

Requirements

- Refresher and upgrading courses are particularly needed for professional training and the introduction of new methods in applied biometrics.
- Up-to-date statistical software are needed.
- An important facility would be the development of a help desk which could be located in the university or elsewhere and accessed by e-mail for necessary professional biometric advice.
- There are requirements to improve both BSc and MSc biometry curricula to meet current developments in research methods and also to allow better use and interpretation of statistical software.

Biometrics training at Bunda College of Agriculture, University of Malawi

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Bunda College of Agriculture is a constituent college of the University of Malawi. It has about 70 lecturers and over five hundred students at undergraduate and graduate level in one of seven departments ranging from crop science to animal science to agricultural engineering. The college has two MSc qualified biometrics lecturers who are available for consultancy to all lecturers and students.

Statistical courses given to students include a) introduction to statistics, b) design and analysis of experiments and c) biometry and computing.

Computer and software resources

Computing facilities are extremely weak with only a few lecturers having a computer in their office. The general computer pool available to students comprises a total of 15 286 computers only. One or two departments have small computer rooms for exclusive use, but the Department of Crop Science, that houses the two biometricians, has none. Mstat is the only statistical package available to undergraduate students. Some lecturers and their graduate students have access to unlicensed copies of Genstat, SAS or SPSS.

Requirements

With these extremely limited computing facilities it is impossible to give practical demonstrations of data collection in the field, nor their analysis and interpretation. Thus, statistical courses are predominately theoretical.

- The main priority is to upgrade the college's computing facilities to allow modern Windows versions of statistical software packages to be run.
- Once this is achieved it will be possible for the biometricians to conduct regular short courses for scientists and their technicians to update them on practical aspects of biometrics.
- At the same time there will be a need to purchase statistical books and journals for the college library.

Strengthening biometry and statistics in agricultural research: Review of the CTA study

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Introduction

Between 1995 and 1998 the Technical Centre for Agricultural and Rural Cooperation (CTA) commissioned a study by Rothamsted Experimental Station to examine the reasons underpinning the problems encountered by scientists in African, the Caribbean and Pacific countries (ACP) in incorporating good biometric quality in their research work (Riley 1998).

The study comprised three phases.

Phase 1: Questionnaire survey

Over 500 scientists in ACP countries were sent a questionnaire to find out their level of biometrics training, their understanding of design and analysis methods, the availability of facilities and their use of software for data handling and analysis. This phase culminated in a workshop at the University of Hohenheim, Germany where representatives of both biometricians and scientists met to discuss the outputs of the first phase and to make recommendations for the next steps.

Phase 2: Desk studies

Four desk studies were conducted:

- **Book study:** This study surveyed a wide range of statistical textbooks in English and French and their suitability for use in developing countries. They were reviewed and listed with categorisations ranging from 'easy to understand, suitable for non-statisticians learning basic statistics' to 'advanced methodologies, suitable for research statisticians.'
- **Survey of international agricultural research centre (IARC) biometricians:** This study surveyed biometricians within the Consultative Group on International Agricultural

Research (CGIAR) centres and queried the extent of their interactions with national agricultural research institutes (NARIs).

- Survey of NARI professional biometricians: This survey queried the training levels of these biometricians, their available equipment and software.
- Survey of Pacific Researchers: This desk study examined more thoroughly a range of scientists in the Pacific region to substantiate the questionnaire survey in phase 1.

Phase 3: Diagnostic case study of a NARS in an African country

In order to explore more deeply the reasons why scientists may not have good biometric skills or support, a case study was made of a national agricultural research service in an African country. This three-week study involved an assessment of the position in the organisation of the biometrics personnel, a study of the efficiency of the services provided by them to the scientists and recommendations for future developments of the group.

Main findings of phases 1 and 2

These two phases demonstrated the current status of biometrics in the ACP countries, the poor and declining availability of professional biometricians, the outdated ability of available biometricians and of scientific researchers, the inappropriate levels of statistical computing, Internet facilities and books in biometrics. The lack of relevance of many national and international biometrics training courses was shown and their relationship with the paucity of ACP scientific research publications. The location of biometric departments and lack of responsibility of biometricians within institutional structure and management programmes may be one reason for decline in biometrics, compounded by decreases in donor funding for biometric support and research. Excellent attempts by international institutes and professional societies to promote the biometrics discipline were noted and are applauded although such initiatives cannot be broadly effective if made in isolation.

Recommendations based on these findings build upon the necessity for a focused, concerted effort by many involved players to reverse this perceived decline. Governments and national institutions are urged to appreciate that long-term policies incorporating research quality, underpinned by professional biometric input, are essential for precise recommendations for sustainable multidisciplinary agricultural development. Donors (funding agents, international and regional institutes, professional societies and training institutions globally) are encouraged to modify their activities to incorporate a professional, modern, computer-based biometric input in all their projects and training activities. Biometricians are encouraged to address practical agricultural problems and to interact with scientists using fewer technical terms to promote biometric understanding. ACP biometricians are encouraged to seek new and sustainable directions for limited aid funds.

Finally, the necessity is stressed for multilateral actions: only in combination can the recommendations proposed above have any appreciable impact.

Main findings of Phase 3

The study of the African NARI showed a number of key issues which were hampering the efficient provision of professional biometric skill to the researchers.

Institutional management

The NARI had already been subject to a major restructuring programme to modernise its approaches in relation to globalisation and market reform. The biometrics personnel—comprising a single person—had been given the added responsibility for organising the documentation and publications section of the organisation and had been provided with extra staff to handle this. However, he had no extra staff to provide biometric support while he organised the documentation staff! The biometrician clearly had a good relationship with the Director General of the NARI, who had requested this review and who suggested that a project be designed to assist the biometrician's professional development.

Biometrician management skills

The research activities of the NARI encompass a wide range of disciplines—socio-economic, animal, perennial crop and annual crop studies. However, the multidisciplinary interactions are not strong and the biometrician is responding very much to specific disciplinary requests and is not able to develop his own perspectives in multidisciplinary studies. As scientists become more adept at routine statistical analysis using commercial software, the skills of professional biometricians may become sidelined. The need for the biometrician to develop skills in multidisciplinary areas is essential, both to be equipped to respond to the changing needs proposed by the NARI restructuring programme and to ensure continued job prospects. Time must be made available by the biometrician to talk to scientists and to plan collaborative work programmes.

Biometrician technical skills

The biometrician had received no formal university training since 1983, although he had attended a number of short courses given at IARCs. His access to the Internet and software are excellent, so computing facilities are not problematic. He is very much aware of the need for more up-to-date skills and proposed topics to upgrade his knowledge.

Together with the biometrician we proposed a strategy to provide: a) improvements in the skills of the biometrician, involving short attachments to biometricians in European universities, b) training courses provided by IARC biometricians (from which the NARI

biometrician would gain knowledge) and c) the identification of key scientific personnel to go to an IARC for training in specific biometric topics. In this way, skilled biometric resource persons would be available in the scientific departments, alleviating the pressure on the NARI biometrician who could in turn concentrate on the provision of more advanced biometric advice.

Conclusions

The case study in Phase 3 represents a unique situation. However, whilst all institutes are different, there are common factors underlying the lack of progress in improving biometric skills.

- The first of these is the need to upgrade regularly with new techniques. Whilst training attachments are fruitful, they are expensive though it is becoming more cost effective with increased access to the Internet and material on these techniques at a range of websites.
- The second factor is to be aware of the changes in research directions as globalisation and environmental concerns become more important, and to have the skills to manage these changes by updating one's biometric knowledge with the most appropriate skills to support the new directions.
- The desire to learn every new technique should not be encouraged, but to develop expertise in key methods appropriate for the clients' priority research will develop the biometrician's own confidence and encourage others' confidence in the biometrician.
- It is better to manage well a little knowledge than to mismanage a lot of knowledge.

Reference

Riley J. 1998. *Strengthening biometry and statistics in agricultural research*. Study Report. CTA (Technical Centre for Agricultural and Rural Co-operation), Wageningen, The Netherlands. 27 pp.

Opportunities for advanced training

Opportunities in biometry—The South African perspective

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Introduction

Biometry was first introduced at the University of Natal, Pietermaritzburg (UNP) in 1949. Later it was incorporated as part of the curriculum for students in agriculture, in particular, at universities of Stellenbosch, Pretoria, Potchefstroom for Christian Higher Education and Orange Free State. The University of Natal, however, is the only institution in South Africa, and indeed sub-Saharan Africa (SSA), that currently provides an undergraduate degree in biometry. Biostatistics is part of the curriculum of universities of Cape Town, the Witwatersrand and Orange Free State in association with faculties of Medicine, Public Health and Pharmacology.

Biometry at the University of Natal

The Department of Biometry, established 50 years ago under the auspices of the Faculty of Agriculture and the Ministry of Agriculture, recognised the importance of biometry in the development of sound and effective agricultural research practice.

To meet the demands of an expanding university, biometry merged with statistics (previously taught in the Department of Mathematics and Applied Mathematics) to form the Department of Statistics and Biometry in 1974. As of January 1999 the UNP abolished its department structures, opting instead for schools. To this end the former departments of Mathematics and Applied Mathematics, Statistics and Biometry and Computer Science merged to form the School of Mathematics, Statistics and Information Technology. At the same time the faculties of Science and Agriculture also merged to become the School of Science and Agriculture. The University of Natal has committed itself to a programme whereby all students in science and agriculture, in particular, will be able to demonstrate certain basic competencies. Students are expected to acquire research skills, critical analytical and problem-solving skills and skills in report writing and presentation. They are also expected to demonstrate basic numerical ability and familiarity with information technology.

In its approach to addressing research-oriented problems, biometry has been integrated into the undergraduate curricula of the majority of agricultural disciplines. These include,

for example, agronomy, crop and soil science, genetics and plant breeding, animal and poultry science, agricultural economics, plant pathology and microbiology. Postgraduate students in agriculture, for instance, are required to have (or obtain) credit for at least two courses in biometry.

Biometry teaching

Biometry teaching at Pietermaritzburg is directed at: (a) students intending to major in biometry, a four-year BSc (honours) degree, (b) students entering the Masters and PhD programmes and (c) service courses for students in the various agricultural and life science disciplines. Courses are modular and vary from two to four lectures per week with three-hour weekly tutorials. All tutorials are computer-based with students being introduced to the use of statistical software such as Minitab (first year courses in statistics) and Genstat (all biometry courses). Software such as Geo-EAS and PC-CARP, respectively, are used in addition to Genstat for specialised courses such as spatial statistics and sample survey methods.

BSc (Honours) in Biometry

The basic BSc Statistics course, which leads to the BSc (Honours) in Biometry, has the following structure. Core courses in mathematics cover algebra and number theory, calculus and advanced calculus, applied linear algebra, discrete mathematics and numerical equation solving. Statistics courses include probability theory, statistical inference, stochastic processes, statistical modelling for finance, multiple linear regression, logistic regression and multivariate analysis.

The BSc (Honours) in Biometry may be taken as a one-year (full time) or two-year (part-time) course following a primary undergraduate degree in statistics. Students are required to select five modules from an offering of eight topics which include sampling, experimental design, time series and forecasting, mixed models and spatial statistics, advanced experimental design, generalised linear models, financial statistics and medical statistics, together with a mini-dissertation.

MSc (Biometry)

The MSc is a two-year programme with two options:

- dissertation only with two formally presented seminars on related work
- a one-year course comprising selected modules from the honours' programme, followed by a dissertation in year two.

The latter option has been specifically designed to accommodate students from other universities to enable them to upgrade their earlier qualifications in order to meet the requirements for an MSc (Biometry) degree.

PhD (Biometry)

This degree is awarded on the basis of a dissertation.

Biometry service courses

Biometry, since its inception in 1949, has formed an integral part of the curriculum of students in agriculture at UNP. From a single course, 'Introduction to biometry for agriculture students' (later to become the title of a well-known biometry textbook by A.A. Rayner) additional courses in biometry have been added to satisfy the demands of various curricula of the different agricultural disciplines. Some of the courses in biometry presently available to students in agriculture and life sciences are listed below together with an indication of the disciplines that have contributed to the development of such courses over the years.

- **Biometry 210 (Introduction to statistical methods):** This is a compulsory course for all students in agriculture and life sciences and is generally taken in the second or later year of study. Intending postgraduate students from other universities are required to do this course unless their skills otherwise demonstrated. Enrolment has averaged about 110 students per annum over the past five years.
- **Biometry 222 (Introduction to experimental design and multiple regression):** This is a compulsory course for all students registered for research-oriented degree options, such as students studying for crop and soil science, plant breeding/genetics, animal and poultry science, horticultural science and plant pathology. A major feature of this course is that students are required to submit two assignments for evaluation: a) research data analysis and reporting and b) planning a research project. This includes the formulation (aim, objectives, etc.) of a research proposal for a suggested experiment using any one of a selection of experimental designs covered by the curriculum. The proposal is required to be discipline specific, e.g. crop science, animal science etc.
- **Biometry 314 (Multiple regression and logistic regression):** An introductory course in modelling given to undergraduate students studying agricultural economics and plant breeding/genetics and postgraduate students in hydrology and agricultural engineering. It is a compulsory course for postgraduates in animal nutrition modelling.
- **Biometry 316 (Introduction to multivariate analysis):** A prescribed course for undergraduate students in agricultural economics and range and forage management. It is an elective for student in wildlife management. This course is often taken in conjunction with Biometry 314.
- **Statistics 213 (Sample survey methods):** This was originally developed for undergraduate students in agricultural economics, but demands from disciplines such as dietetics, community resource management, sociology and psychology have necessitated major revision to the syllabus to accommodate these diverse demands.
- **Biometry 701 (Practical advanced experimental design):** A practically oriented course for final year undergraduate and postgraduate students in crop and soil science and

plant breeding. In recent years it has also become popular as a non-degree course for plant breeders from various commercial seed companies as described below.

Special courses

The Division of Statistics and Biometry is called upon from time to time to present courses ranging from one day to two weeks on special topics for special interest groups from both within and outside the university environment. It is estimated that the cost of training in South Africa is about half that for similar courses in Europe and the USA. Such courses have been given, for example, to practising biometricians, statisticians (needing a conversion course), researchers in agriculture, ecology, wildlife management, marine biology and related disciplines, plant/tree breeders, animal and poultry nutritionists and agricultural extension personnel.

The following is a list of topics presented over the past five years:

- mixed models (REML) and spatial analysis (for tree/plant breeders)
- distance sampling (for wildlife management/ecologists)
- experimental design and analysis (for research personnel in Lesotho Ministry of Agriculture, Swaziland sugar companies and South African timber companies)
- changeover designs (for research/extension personnel from various feed companies)
- multivariate linear regression (for research personnel from the Ministry of Forestry).

All courses given in-house are computer-based with each participant having access to his/her own computer; it is envisaged that such courses could be transported to other regions in East and southern Africa covered by this workshop. Indeed, the Division of Statistics and Biometry at the University of Natal, Pietermaritzburg would like to be part of any initiatives to strengthen biometry in East and southern Africa.

Teaching of biometrics at MSc level: Approaches adopted at Limburgs Universitair Centrum, Belgium

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Biometrics is an exciting scientific field in which statistical practice and methodology go hand-in-hand with research in agriculture, biology, medicine etc. Indeed, the rapid growth of biological and medical research promises that, on a worldwide scale, the need and the role of biometricians/biostatisticians will continue to grow.

The MSc in Biostatistics at the Center for Statistics of the Limburgs Universitair Centrum (LUC) welcomes people with a university degree who seek to specialise in biostatistics. Students mainly come from mathematically oriented fields. Graduates from other scientific fields can also apply provided they can prove excellent mathematical skills.

The Center for Statistics offers a well-balanced, fine-tuned programme with lecture courses, homework assignments, hands-on experience and papers all focused on the same subject: biostatistics. The teaching staff consists of seven professors and five staff members from the Center for Statistics and seven professors from different universities in Belgium, each a specialist in his/her field. Renowned visiting professors from abroad also regularly teach in the programme. A practical training in industry or in a scientific institute is a compulsory part of the programme; it is much appreciated by the students.

International training programmes

The MSc in Biostatistics, offered by LUC, is one of the international courses supported by the Flemish inter-university Council (Flanders is one of the three regions in the Kingdom of Belgium). For many years Flemish universities have been involved in co-operation with a selected group of universities in developing countries and the support of academic institutions overseas in programmes that contribute to the availability and quality of education and research in the southern part of the world (South Actions Programme). Flemish universities are also keen to share specialised development-related knowledge and experience with foreign students through international training programmes and international courses organised in Flanders (North Actions Programme). The MSc in Biostatistics is one of these international courses. To facilitate access to these programmes for students from developing countries, the Flemish inter-university Council provides, for each of the programmes, a limited number of scholarships. For the MSc in Biostatistics the number of grants per year has ranged from seven to ten over the past five years. Since 1991

the following numbers of students from the East and southern Africa region covered by this workshop have enrolled: Kenya (7), Malawi (3), Tanzania (1), Uganda (3) and Zimbabwe (3).

Objectives of the MSc programme

These can be described in three ways.

Objective 1

Data collection is a typical aspect of modern research. Appropriate ways to present data (graphically), to handle data (summary statistics) and, especially, to interpret data require a profound statistical knowledge. It is at this level that the biometrician will bring in his/her expertise. The domains of application include experimental studies in agriculture and biology (e.g., crop and livestock research), studies in ecology (pollution problems), public health research (epidemiology) and medical research (clinical studies). In collaboration with researchers the biometrician translates the relevant scientific questions into appropriate statistical models. The statistical inference for these models, based on well-collected and clean data, provides the backbone of good scientific conclusions. Therefore, a well-trained biometrician should be able to:

- provide statistical expertise so that the experiment is correctly designed
- advise project teams on the statistical elements of the experiment/study (selection of relevant biological/medical parameters)
- produce summary statistics, analyses and reports and
- give a professional interpretation of the results of the statistical analyses.

Practical realisation: We believe that these objectives are essentially reached by the programme that we have developed. An overview of the courses is given in Table 1.

Objective 2

The biometrician will be able to provide the appropriate statistical inference (output) for the scientific questions under consideration when he/she has good expertise in the use of statistical software.

Practical realisation: All students in the programme have free access to the 'statlab' (statistical laboratory). The computers and statistical software are for the exclusive use of the biostatistics students. Students rely heavily on the available statistical software for most of the homework assignments and for all the project work. Available software include SAS 6.12 and S-Plus 2000 amongst other more specialised packages.

Objective 3

The biometrician is a member of a multidisciplinary team. He/she therefore should have good communication skills. Moreover he/she should be able to deliver clear scientific reports.

Table 1. International course programme: MSc in Biostatistics at Limburgs Universitair Centrum.

Description	Hours (T+P) ^a	Credits
First year		
First quarter (October–December)		
A1 Exploring data	15+15	3
A2 Statistical computing packages	15+15	3
A3 Regression	15+15	3
A4 Analysis of count data I	15+15	3
A5 Mathematical tools for statistics	35+35	7
Second quarter (January–March)		
A6 ANOVA	15+15	3
A7 Analysis of count data II	15+15	3
A8 Multivariate techniques	15+15	3
A9 Survey methodology	20+20	4
A10 Time series	15+15	3
Third quarter (April–June)		
A11 Data management	15+15	3
A12 Statistical reading	15+15	3
A13 Computer intensive methods in statistics	20+20	4
A14 Practical training and project		15
Second year		
First quarter (October–December)		
B1 Topics in statistical inference	20+30	4
B2 Nonparametrics	15+15	3
B3 Advanced linear modelling	20+30	4
B4 Categorical data analysis	20+30	4
B5 Medical biology	15+15	3
Second quarter (January–March)		
B6 Nonlinear statistical models	15+15	3
B7 Longitudinal data analysis	30+25	5
B8 Dependent and incomplete data structures	30+25	5
B9 Epidemiology	15+15	3
Third quarter (April–June)		
B10 Survival analysis	30+25	5
B11 Genetic statistics	15+15	3
B12 Clinical trials I	15+15	3
B13 Clinical trials II	15+15	3
B14 Topics in clinical trials ^b	15+15	3
B15 Bayesian data analysis ^b	15+15	3
B16 Scientific reporting	15+15	3
B17 Practical training and reporting	100	6

a. T = theory (lectures, discussions...); P = practice (tutorials, laboratories...).

b. One course chosen.

Practical realisation: Students are given (weekly) homework for all courses. Students hand in written solutions by the next course lecture and receive feedback from the lecturer one week later. Homeworks are sometimes replaced by project work. Students hand in

written reports on their findings. Oral examinations are part of the verbal training of our students. More formal ways to develop the communication skills of our students are through a number of courses, e.g. statistical reading, scientific reporting and practical training.

Project thesis

For their practical training students take part in ongoing studies in pharmaceutical companies, medical research institutes, institutes for public health etc. The idea is that, in collaboration with the researchers responsible for the study, the students formulate relevant statistical questions for the study under consideration and perform the corresponding statistical analysis based on statistical models whose validity they are required to demonstrate. They write a final report on their project work. Each student gives an oral presentation of his/her project, followed by a defence of the work and answering questions from a committee of staff teaching in the programme.

Finally, students are welcomed from developing countries and, as described above, many have successfully applied for scholarships and enrolled in the programme. We believe that the programme is well structured and provides the necessary training for prospective applied biometricians in the developing world. This will be further strengthened with increased links with universities in East and southern Africa and a regional grouping of biometricians that can maintain links with the students once they have returned to the region on completion of their studies. In future, the region might also help LUC select candidates for the MSc programme so as to increase the impact of the course in the countries concerned.

New initiatives

New initiatives at the University of Nairobi following a biometrics conference in Mombasa, 1997

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Introduction

In September 1997 the East, Central and Southern African Network (now Sub-Saharan African Network—SUSAN) of the International Biometric Society (IBS) held its fifth scientific meeting in Mombasa, Kenya. The theme of the conference was 'Enhancing African Capacity in Biometry.' The main issues discussed during the conference included the strengths, weaknesses, opportunities and threats of biometry in Africa, the effective use of statistics in society, the role of biometricians as professional trainers and the role of biometricians in research institutions.

Observations

It was clear from the discussions that the use of mathematics and/or statistics is prevalent in a large number of agricultural, medical and environmental departments in many universities and polytechnics in sub-Saharan Africa (SSA). There are also a considerable number of students graduating in statistics and mathematics. However, statistical courses tend to be theoretical and do not give suitable practical training in biometry. There are thus insufficient numbers of qualified students equipped for the various spheres in which there are potential job opportunities, e.g. in medicine, pharmacy, environment, agriculture etc. On the other hand, the few biometricians that exist, many of whom have been trained abroad, appear to have been unable to interact effectively among themselves and with other colleagues. They also have limited access to current literature and are unable to keep up to date with modern statistical methods. It was concluded that the major threat to the development of biometrics as a highly recognised profession is, firstly, the apparent stagnation brought about by the misleading concept of the biometrician as a data technician, not as a scientist in a multidisciplinary team, and, secondly, the apparent lack of appreciation of the importance of the role of biometricians by policy makers.

Resolutions

A number of resolutions were made which can be summarised as follows:

- There is a need to popularise biometry and statistics at all levels of education and the community at large.
- The contents of courses targeted at the training of biometricians/statisticians should be updated regularly; in particular, postgraduate programmes in biometry in universities should be given high priority. Within such courses the research projects (for students and trainers) should be practical.
- Biometricians should actively participate in the research planning process, interact actively with colleagues in other institutions and organise regular courses, both to update the statistical knowledge of scientists and to help ensure the statistical quality and acceptability of scientific manuscripts emanating from their institutions.
- Biometricians in research, business and academic establishments need to participate in regular seminars and short courses, undertake joint research projects and provide joint supervision of the university students partaking in these projects.

Development of linkages

Within Kenya itself there were strong recommendations to encourage university departments of statistics to develop stronger links with research institutions and to devise new courses in applied biometry. As a result, linkages were established between the Department of Mathematics of the University of Nairobi (UoN) and International Livestock Research Institute (ILRI) to enable lecturers teaching courses in statistics at the university to acquire and develop skills in applied biometrics. These linkages were also to provide opportunities for joint training programmes at MSc and PhD levels in applied biometry.

The approaches that have been adopted are:

- the attachment, part-time, of UoN staff to ILRI whilst continuing their teaching assignments at the university
- periodic attachments of university staff for short periods to overseas institutions in Europe to enhance research and teaching and practical skills in modern biometric methods applicable to research problems appropriate to the developing world
- improved teaching through revised curricula development and training materials.

Achievements so far

- Two lecturers (Dr Henry Mwambi, Mrs Rosemary Wangeci) of the Department of Mathematics, UoN, have been financed to spend two days a week at ILRI since May 1998.

- Funding obtained from Limburgs Universitair Centrum (LUC), Belgium to enable Rosemary Wangeci to spend two months in Belgium, prior to the commencement of a joint PhD programme between LUC, UoN and ILRI, which has now been funded by the Belgium Technical Cooperation.
- The Department of Mathematics, UoN has, with effect from October 1999, launched a BSc degree in Statistics which allows specialisation in applied biometry. It has also developed an MSc degree programme in Applied Statistics/Biometrics. Inputs from the University of Reading were used in planning this programme, which is expected to commence in October 2000.
- Two students are currently studying for an MSc in Applied Biometrics at LUC, Belgium.

Acknowledgements

It was partly through these initiatives and through its own appreciation of the shortcomings in training in applied biometry in East and southern Africa, that The Rockefeller Foundation was stimulated into financing the present workshop. We are most grateful to The Rockefeller Foundation and particularly to Dr John Lynam, for its positive support.

Biometrics training for MSc students in agriculture: Approaches being undertaken in the Faculty of Agriculture, University of Nairobi

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Introduction

This presentation uses a Rockefeller Foundation supported project in the Faculty of Agriculture at the University of Nairobi (UoN) to show how it is possible to leverage outside support to strengthen areas of weakness and build partnerships that can enhance biometrics training in universities.

Existing applied biometrics in MSc training

MSc courses are available within the Faculty of Agriculture, UoN for a number of disciplines, e.g. crop science, soil science, animal production, crop protection, agricultural economics, range management, applied nutrition and food science and technology. A lecturer in biometrics in the Department of Crop Science teaches biometrics to all the students together, except for those in agricultural economics. The needs of the students in agricultural economics are not catered for in this curriculum. In addition, owing to poor previous training in statistics, students in applied nutrition have currently been separated to follow a less rigorous course. The MSc training is for two years. The first year is entirely course work when most of the biometrics teaching is given; students carry out their research projects in their second year. Funding was provided in 1998 by The Rockefeller Foundation to strengthen the biometric input into MSc student training. The funding was primarily used to set up a modest computer laboratory in the Department of Crop Science. Funding was insufficient to hire a computer manager. Instead we hired an assistant with some computing knowledge to help with hardware and software maintenance, and organised a crash course for other staff in order to develop a general level of basic computing competence among those involved in teaching in the laboratory. This worked reasonably well and we were able to put in place adequate practical computing and statistical skills to support the research phase in year two of the MSc course (Figure 1). So we thought!

Preparatory phase (end of year one) for field research and thesis completion

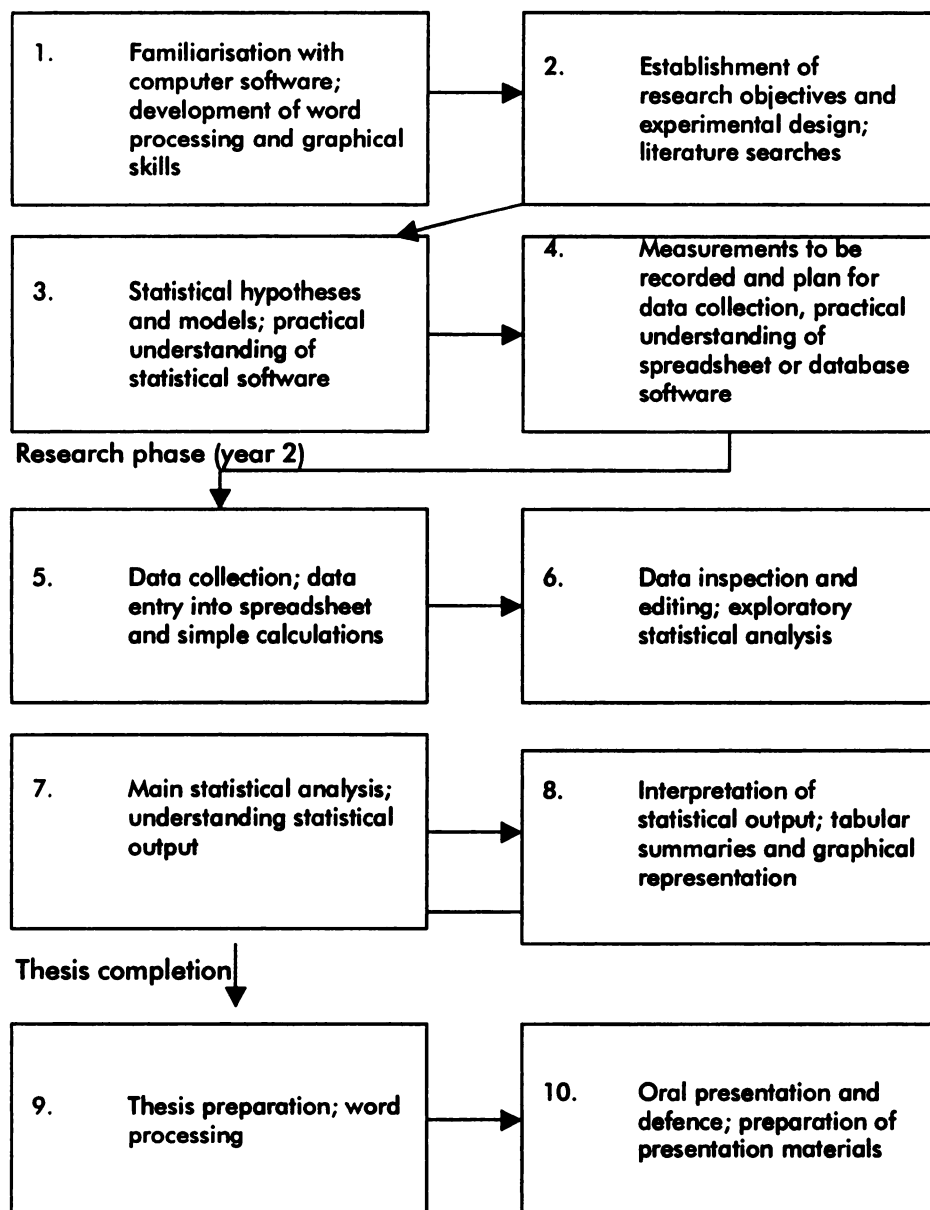


Figure 1. The progression in biometric and computing skill training needed for successful completion of the research project in year two of an MSc in Agriculture.

Improvements required

Figure 1 demonstrates the progression that students are expected to follow during the execution of their research projects. During the preparatory phase at the end of the first year students are expected to have defined research objectives, have undertaken bibliographic searches, defined null hypotheses, planned the design of their experiments, the measurements to be recorded and the methods of data collection. They are also expected to have acquired sufficient skills in spreadsheet and statistical software to plan the statistical models they will fit to their data. However, students received a major shock at the end of year one when suddenly they found themselves thrust into the situation of applying what they had learnt for real. Indeed, a questionnaire to students at this time demonstrated the need for extra training prior to the writing of research proposals. At this stage the assistance of the International Livestock Research Institute (ILRI), where one of the junior biometricians on the staff of the Department of Crop Science was currently on attachment, and also the Department of Mathematics at the UoN, was sought. A week-long workshop was organised in which the students participated in sessions on development of research objectives and hypotheses, data handling and management, statistical analysis by Genstat and interpretation of results.

Achievements of workshop

The week-long course resulted in some major achievements.

- Fuzzy experimental objectives were clarified and the hypotheses to be tested better understood.
- Experimental designs were in many cases revised and often simplified, e.g. a split-split-split-plot reduced to a split-split plot. There appeared to be the mistaken idea in many students' minds that the more complicated the experimental design the more impressive would be the thesis.
- All four members of staff teaching biometrics in the department attended and interacted with the students. Hopefully this will have increased the likelihood of increased consultations during the research and analysis phase. Previously students had worked entirely under the direction of the supervisors with little interaction with the biometrics members of staff.
- An improved understanding was achieved for the measurements that were necessary to collect during the students' experiments and those that were not. The importance of writing down statistical models and doing dummy statistical analysis runs prior to starting their project was better appreciated.
- The possibility of a stronger link between biometricians in the Faculty of Agriculture and those in the Department of Mathematics, UoN and ILRI was initiated.
- So successful did this approach appear to be that it was felt that a similar course for supervisors might be equally beneficial.

Future

A questionnaire completed by students at the end of the workshop highlighted the areas in which they felt they were strong and those in which they were weak. The weak areas will be considered for emphasis during the normal classwork sessions.

A major lesson that we have learnt over the past year is that, given the will, great things can be achieved from a small beginning, and, by working together, a little funding can go a long way to ensuring the relevance and usefulness of the existing postgraduate syllabus to the quality of future agricultural research in the region.

We should now be able to build on what we have achieved so far by adopting our research methods to meet the needs of the changing scene in agricultural research. Through the linkages being established with other biometricians in Nairobi there should be improved opportunities to work together on the tools required to support the new areas of on-farm agricultural research being developed. Not only will this require close working relationship between biometricians themselves but also between biometricians and scientists, both within and outside the faculty.

Strategies for improving biometric support and training: A case study of an integrated biometrics development strategy in Guinea

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Introduction

Since the early 1990s the World Bank has financed a project to enhance the research capacity in the Institute de Reserche d'Agricole de la Guinea (IRAG) in francophone West Africa. The institute has approximately 100 scientists in six stations and these are mainly crop researchers. Early attempts at biometrics training in 1992 as part of this project were found to be too theoretical. A review was therefore done in 1997 by the biometrician from West African Rice Development Association (WARDA, Côte d'Ivoire) to determine the real needs for biometrics training. The recommendations from this review were that the scientists should be trained in the design of experiments and in the analysis of research data if they were to obtain a more practical appreciation of biometrics. Genstat was proposed as the most appropriate software for analysis.

The training which resulted from this review was conducted mainly by biometricians—from Niger, Bénin and Guinea who are employed in national and international institutes—within the region. External support was provided from three international research institutes: International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), International Centre for Research in Agroforestry (ICRAF) and WARDA that work within the region. The University of Reading was involved only when sufficient resources were not available locally. This paper describes the training.

Timetable of events

A two-week course in design of experiments was given in May 1997, just before the planting season. This used training materials originally developed by ICRAF for agroforestry researchers, and which had been broadened and translated into French by ICRISAT and used several times already in West Africa. Twenty scientists attended this course given by a team of three biometricians from Institut national de recherche agricole du Bénin (INRAB), WARDA and IRAG. The course was then repeated at four of the stations.

In October 1998 these courses were followed by an initial course on methods of statistical analysis. Since no one from within the region had sufficient experience in Genstat, a biometrician from the University of Reading was involved in running a course. It became clear during the course that the scientists needed training in data entry and management before they could deal easily with data analysis.

A two-week course was therefore given in July 1999 on data entry using Excel and on simple data analysis. The Excel materials were prepared by staff from the University of Reading using data from Guinea and translated into French in Bénin. Again twenty scientists attended the course. Immediately after the course one of the presenters gave further one-week courses on data entry at five other stations.

Finally, the full analysis methods course was given in November and December 1999. This used training materials prepared by staff from ICRAF and the University of Reading in June 1999 and translated into French by the Bénin biometrician. This two-week course was run by a team of four biometricians—one from the University of Reading and the rest from within the region—and was largely a revision of the earlier course covering simple and more complex methods of analysis. This was followed straight away by repeat courses at three stations but at a slower pace and covering only simple methods. Scientists used their own data for the practical work.

Level of success

In analysing the achievements to date of this training programme it is important to emphasise that the World Bank was looking for a solution from within the region to the biometric needs in Guinea. Staff involved in the training were, with one exception, all from francophone West Africa and they were all highly motivated towards making the training successful. Furthermore, the Director of Research at IRAG is a biometrician and thus gave key support to the training. (This has its drawback, because as Director of Research he has limited time to devote to biometric support in the midst of his other duties.) Other important positive aspects of the training were (a) it was given in French, the language of the region, (b) it was participative and (c) it evolved to meet the needs of the participants.

In retrospect, the process took too long. The twenty scientists participating in courses kept changing because of different commitments at the time; it would have been better had the training been completed within one year. Also, because of the way the training evolved, the analysis methods course was repeated three times (though not always to the same twenty scientists). The courses were aimed at biological scientists. Socio-economists were not included and separate training was arranged for them. One can argue for a more integrated approach in the future to the training of all staff at an institute, especially with the evolving multidisciplinary nature of on-farm agricultural research.

Further concluding remarks

In conclusion, it is important to emphasise that the players in this biometrics training programme were from both national and international institutions. The participation of ICRAF, ICRISAT and the University of Reading has been important to develop the course material and approach. However, it has been essential to involve regional biometricians from Cote d'Ivoire, Bénin and Niger as these provide the basis of a team of local biometricians able to sustain biometrics training in the region in the future. Although all scientists at IRAG will soon have been trained in biometrics and data management to a certain level, this is just the first step. Further training will be needed. Some of the scientists have been identified as resource persons who will be able to help in this regard. The interaction with international institutes and overseas institutions will need to be sustained so that the trainers can be kept abreast with up to date biometric methods appropriate to research conducted in West Africa.

Acknowledgements

The following are the biometricians who, in addition to Roger Stern, participated in the training programme: Abdoulaye Adam (WARDA), Gaston Kokode (INRAB), Zobinou Mawusi (formerly ICRISAT), Sekou Beavogui (IRAG). Their major contributions are acknowledged.

Biometrics training for agricultural students: Approaches adopted at the University of Reading

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Introduction

Agriculture students at the University of Reading take courses in biometry. There are separate courses for undergraduate and postgraduate students, and they consist of two hours of lectures and two hours of practical work per week during two 10-week terms. This year, for the first time, the postgraduate course has been taught mainly by staff in the Statistical Services Centre (SSC), who all regularly provide consultancy support to their clients during the course of their work. The course was attended by approximately 70 students following programmes in agriculture, horticulture, wildlife management and vegetation surveys.

Previously the course took a fairly traditional approach to statistics. We did not believe that it equipped the postgraduate students adequately with the biometric skills necessary for research work in a life sciences environment. Consequently, we changed the content radically. This paper summarises the changes we have proposed and our initial experiences of teaching 'relevant biometric skills' to research students.

New philosophy—A 'research methods' course

Until recently the material on our university course for postgraduate agriculture students could be described as conventional. Descriptive statistics, the Normal distribution and the use of t, Chi-square and F-tests have all been taught in a fairly standard way. Further topics included the analysis of simple designed experiments such as randomised blocks, factorial experiments and split-plot designs and how to do regression analysis. Practical classes either involved tutorial sessions with hand calculators or hands-on computer work

We felt that this format was of limited use to students, as they were not being exposed to the types of situations to which they would find themselves later. Even within their MSc or PhD courses it did not prepare them sufficiently for their subsequent research projects. Too much time was spent on the mechanical application of statistical methods so that students were not:

- a. being given sufficient tuition on how to plan and manage their own research investigation
- b. being exposed to datasets that were of sufficient size and complexity to relate to the data that might be collected in a research project
- c. being introduced to the methods needed for dealing with complex data structures.

These views parallel those described by Stern and Allan (this proceedings) in relation to the training strategy for scientists in Guinea. (Similar experiences have been described by Akundabweni (this proceedings) in the teaching of biometrics to MSc students in Nairobi.) In the courses at the University of Reading we have been trying to make the same type of change for university students who are just starting their research career. Our new approach is built around the general objective of introducing the students to the topics needed for research methods. Where appropriate we have included in our teaching materials adaptations of course notes designed by the International Centre for Research in Agroforestry (ICRAF) (see Stern and Allan).

One major change to the course content is to put greater emphasis on the planning of research investigations. With the current trends in agricultural research we believe that students need to know not just the principles of experimental design, namely blocking, replication and randomisation, but also the ideas and concepts of surveys and other field studies, the steps in identifying research objectives and selecting the type of study that best meets these objectives and the decision on which treatments to apply and measurements to make.

We are trying to link together different components of the course. For example, the description of the different types of measurements that can be collected links to the need for more advanced tools to be able to analyse a wide variety of types of data, not merely data from a normal distribution. Another new component is to give prominence to the importance of a good data entry and management strategy. We have found that a researcher's lack of knowledge of how to manage his/her data has contributed to his/her inability to conduct a full and satisfactory analysis.

Topics covered previously remain useful. But the further techniques required in research investigations are also being introduced. A key topic is the collection of data at multiple levels (households within villages, plants within plots, quadrats within sampled areas etc.). In such situations the course addresses the concepts and approaches to data analysis and interpretations of results, rather than the theory. The methods are illustrated using appropriate statistical software.

Course content

During the first term (the term just ended) we cover:

- a. planning ideas
- b. data management, statistical software for analysis
- c. review of inference ideas and simple statistical methods.

During the first half of next term, the agriculture students will follow a different programme from those specialising in wildlife management and vegetation survey. For example, the agriculture students will have sessions on:

- a. analysis of experimental data for a range of common designs
- b. methods of dealing with common complications
- c. dealing with multiple levels in experimental data (e.g. split-plot).

These sessions cover topics such as how to lay out an experiment for increased precision, and how to deal with complexities such as repeated measurement data or data collected over multiple levels. The objective is to raise student awareness of the important issues in these different topics and to provide guidance on some simple but sensible approaches to the analysis.

The two groups of students are brought together again for the last quarter of the course. Then, within the framework of modern modelling, students are introduced to the general linear model and shown how these modelling principles can be extended to the analysis of non-normal data.

The practical sessions on the course are varied. Some use statistical games, such as (a) The Rice survey and the Tomato experiment, where the objectives are to encourage sensible strategies for designing studies, and (b) To the Woods and Mice which respectively illustrate the benefits of stratification and blocking. Students also review published papers for the clarity and appropriateness of the statistical content and carry out practical work using Excel, Minitab and Genstat.

On the computing side we make the assumption that students are computer literate, and in particular that they have met Excel before. Most of our agriculture students are from abroad and, where this is not the case, they attend extra sessions in computer literacy organised within the university.

Course materials

The Statistical Services Centre has recently produced a number of Good Practice Booklets for the Department for International Development (DFID), UK to provide guidance to their researchers in the field. These have been written to describe concepts, approaches and methods of design and analysis in a non-mathematical way. Some of these booklets have been used within our course materials, in particular:

- a. Data Management Guidelines for Experimental Projects
- b. Disciplined Use of Spreadsheet Packages for Data Entry
- c. Some Basic Ideas of Sampling
- d. The Design of Experiments
- e. Informative Presentation of Tables, Graphics and Statistics.

So far ...

At the half-way point both positive and negative comments have been received. Many staff and students in agriculture have been positively excited by the course, but those in wildlife management and vegetation survey feel that the material is less relevant to them. This may be addressed in term two, which provides more specialisation for the different groups. Also, despite removing much of the theoretical aspects of analysis from the course, students still find statistical analysis difficult to understand. We need to consider how to overcome these problems in future years.

Computers are still not sufficiently integrated into the course structure. We would like to have practical sessions which incorporate any mix of instruction, study design, data collection and analysis and with computers available to assist when required. For this we need lecture/practical rooms with both computers and space for other activities. Currently this is not the case, but we are hopeful that it will change shortly.

In conclusion

After only one term we believe, for the reasons given above and from the reactions we have received, that our new approach to the course is appropriate. It aims to meet the changing approaches to agricultural research as described by Lynam (this proceedings) and achieve the realisation that 'Biometrics is an exciting scientific field in which statistical practice and methodology go hand in hand with research in agriculture, biology, medicine etc.' (Janssen, this proceedings).

The role of international agricultural research centres in research support

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Introduction

Much of the function of a research institute can be considered to that of supporting research. However, here I use the phrase 'research support' to refer to technical input to research activities with the aim of increasing their effectiveness, efficiency and overall quality. Biometricians have provided much of this support, traditionally in the areas of design of experiments and surveys and analysis of data. In recent years, however, the type of support demanded has broadened to include design of a wide range of study types, data management and computer modelling, but the same group of professionals is still expected to provide it. They have become 'research methods experts', and it is this role which is discussed here.

Research support for the region

There are now around 10 CGIAR-affiliated (Consultative Group on International Agricultural Research) international agricultural research centres (IARCs) with research activities in the region covered by this workshop. They work in collaboration with a range of partners including national agricultural research institutes (NARIs), universities and regional networks. Research support is provided in a number of ways:

- a. Those centres (International Centre for Research in Agroforestry (ICRAF), International Centre of Insect Physiology and Ecology (ICIPE) and International Livestock Research Institute (ILRI)) with headquarters in the region have small but experienced biometrics groups.
- b. Of the remaining centres some get limited support from their own headquarters, others do without.
- c. NARS have varying levels of biometrics skills, from none to those with reasonable numbers of support staff but of limited experience.

IARC biometricians work actively with national agricultural research systems (NARS) staff to increase their capacity and effectiveness. However, the limited mandate and

biometric resources of each centre make it difficult for them to work with NARS in a strategic and comprehensive way on development of skills in research methods.

The demand for research method skills in the region is enormous. Young scientists joining research teams today are no more adept at using traditional methods than those who joined 10 or 20 years ago. Yet, in addition to learning these traditional methods, changes in the nature of much of the research require skills in new areas. Some of the changes include:

- increased emphasis on natural resource management, with the need to work at multiple scales and to analyse tradeoff
- increased emphasis on output of options and decision support, rather than recommendations and technical packages and
- increased responsiveness to stakeholder needs.

Each of these changes involves new methods that are not within the standard toolbox of most scientists in the region and may not even be documented well.

This large demand is not currently being satisfied. It is unrealistic to expect a large increase in resources to meet it. Instead we have to find ways of using existing resources more effectively.

A possible development

A regional research support group (RRSG) could be established with the overall aim of increasing the effectiveness of agricultural and natural resources research in the region. This could be achieved by pooling the resources of the international centres to create a single unit.

The RRSG would be managed as a single unit, but it would be geographically dispersed. Biometric support functions are provided most effectively when biometricians are in close contact with the scientists with whom they work. The staff will therefore be placed in locations with a high concentration of scientists and any increase in research support staff numbers would increase the number of locations with staff, rather than increase the number of staff at any one location.

The RRSG would therefore pool resources currently committed to research support, increasing the efficiency and effectiveness of their use. The effect would be to:

- increase the range of biometric and other research support skills available to research teams
- provide local and accessible support, allowing support staff to be active research team members
- increase the speed and effectiveness with which new methods and approaches are disseminated to all researchers in the region
- provide a base from which researchers in all projects in the region (whether at headquarters or not) can get support
- provide a body with the mandate, skills and resources to undertake effective and structured capacity building with NARS

- provide a body of sufficient weight that can attract funding and 'buy in' from other organisations and
- encourage interactions among biometricians and hence increase their capacity to undertake research on the development of new methods.

Getting started

Before such a group can be started reactions are needed from the various stakeholders, including those represented in this workshop. The next step will be the completion of a concept note for discussion with NARIs, IARCs and other research organisations in the region. Based on these reactions the preparation of a proposal to potential investors, both research centres and donors, will commence.

Training resources in biometrics: A means to sustainable training and education

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Introduction

The purpose of training is capacity building that addresses the knowledge and skill requirements of national agricultural research systems (NARS) scientific and management staff and assists in the development of adequate NARS capacity in agricultural research and analysis. Many of these activities will depend upon partnerships with international agricultural research centres (IARCs), advanced research and teaching institutes and especially with NARS. Whilst the total number of agricultural researchers in Africa has increased significantly, the number for livestock remains a major concern (Wilson et al. 1995) and there are areas, such as biometry, where the need for trained staff is still high.

The International Livestock Research Institute (ILRI) produces training materials to facilitate learning through group or individual training. These materials focus on the areas within ILRI's research mandate. ILRI recently repackaged its training materials for placement on the World Wide Web in its home page. Users can download free of charge the material and use it for learning. This includes text as well as visual material accompanied with audio. Research staff in NARS and university teachers are important audiences for training materials. Teachers need resources that they can use to create locally suitable materials.

This paper describes the concept of training resources and its application in capacity building in biometrics.

Overview of training in biometry

Many institutions conduct training courses and individual training in biometrics in sub-Saharan Africa (SSA). In this paper I provide brief information on biometrics training conducted by IARCs in SSA, in particular ILRI and the International Centre for Research in Agroforestry (ICRAF). IARCs in SSA have offered many biometrics and statistics courses. The following is a sample list extracted from the CGIAR (Consultative Group on International Agricultural Research) Training Database showing the diversity and different titles used between 1990 and 1995:

- a. biometrics and data management in applied research

- b. biostatistics
- c. statistical aspects of laboratory experimentation
- d. statistical data analysis
- e. statistical methods for livestock experimentation
- f. statistics and Mstat
- g. statistics in agricultural experimentation
- h. statistique appliquée à la production animale en Afrique.

Figure 1 shows a declining trend in the number of trainees in biometrics courses offered by the IARCs in SSA. This situation shows that the effort is not parallel to the demand and warrants immediate remedial action.

From its interaction with NARS, ILRI realised that capacity building in biometrics within the NARS is essential. The subjects of experimental design, statistical analysis,

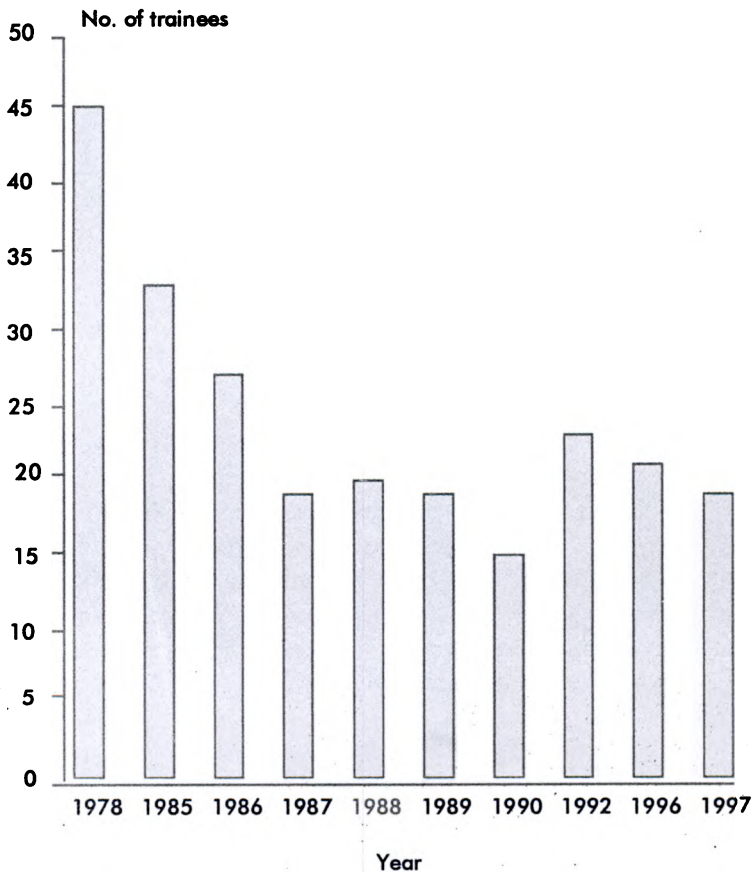


Figure 1. Number of trainees in biometrics courses by international agricultural research centres in sub-Saharan Africa.

interpretation and presentation of results are recognised to be among the top priorities for training by NARS scientists participating in collaborative networks. As an example, ILRI has collaborated in Kenya with University of Nairobi (UoN). As part of this collaboration, two university members of staff from the Department of Mathematics have been attached to ILRI two days a week since May 1998 (see Odhiambo, this proceedings) and one statistical member of staff from the Department of Crop Science has likewise been attached since October 1998 (see Akundabweni, this proceedings). The aim of this collaboration is to develop the skills in applied biometrics for the staff from UoN. The overall objective is that these attached individuals form the nucleus of a future resource group of applied biometricians who are able to offer training to scientists and other statisticians (biometricians) in national universities and national agricultural research institutes (NARIs) in Kenya, much as described by Stern and Allan (this proceedings) in West Africa.

ICRAF has over the years run many training courses in biometrics. These fall under the headings of research design, data management and data analysis. In each category there have been general courses and some more specialised courses aimed at particular clients (e.g. design of participatory experiments and design of agroforestry experiments). ICRAF aims to make all training material freely available to anyone who can use it. Currently this is by down loading from websites. However, ICRAF aims to produce a CD-ROM early in 2000 with a large amount of training material incorporated. This will focus on analysis of experiments, and incorporate, not only material developed and tested on recent courses (see Stern and Allan, this proceedings), but also additional documents from collaborators (particularly University of Reading). It will also include guidelines for trainers, extensive sample data sets etc.

The concept of training resources

ILRI provides animal science training to livestock researchers in NARS at various stages of their career development. One entry point is to facilitate the learning environment at universities while the researcher is training for higher degrees (MSc or PhD). In most cases knowledge and information on animal science available to university teachers that supervise the graduate students are outdated. One of the factors leading to this is the lack of financial resources available to libraries in developing countries. Training resources available commercially are developed to suit developed country situations and it may be misleading to use them to educate students in developing countries. ILRI's approach leads to sustainable learning environments by ensuring that universities periodically receive products with the most up to date knowledge.

The term 'training resources' has different meanings for different users. In general it is used in the Internet to mean lists of courses and/or materials. For example the Teaching Resources Center in Indiana University (<http://www.indiana.edu/~teaching/>) considers its mission is to support teachers by keeping them up to date in the fields of higher learning and good teaching methods. They accomplish their mission by providing lists of web-based training resources. In this paper we adopt a more specific definition of the term training

resources, namely: interactive electronic knowledge and information products that provide, in an integrated manner, resources to teachers and trainers.

Each training resource focuses on a specialised theme and has the following features:

- a. The core resource material contains basic knowledge concepts (mostly as modules).
- b. Other resources complement the core resource material. These training resources are stand alone but can also be linked to the core resource. Examples of resources are modules (concepts), bibliography, problem solving, web linkages, software etc. Resources are designed to be downloaded by teachers. The teachers can use the resources as they are or adapt them for use in their own course work.
- c. The basic knowledge in the core resource is generic and geographically neutral. The other resources are related to specific regions or sites. For example, photographic, video or case study resources provide information applicable to real situations.
- d. All resources comply with pedagogy principles and aim to create learning environments. At the same time resources are flexible enough for the teachers to change to suit their own situations.

Training resources are packaged in electronic format. The advent of multi-media and net-based technologies make it easy to produce and use training resources. Training resources are designed to be highly interactive. This is done in the following ways:

- a. features are included that allow users to select and download resources
- b. download resources can be modified
- c. certain resources are devoted to problem solving
- d. linkage to standard desktop software such as a notepad can be provided to the user so that he/she can write down ideas that occur to him/her while he/she is using the application and then save them to his/her hard disk
- e. multi-media navigation features are used for easy access to the resources
- f. training resources may include search engines for easy access to bibliographies and databases.

ILRI plans in the future to develop and distribute training resources on animal science topics such as crop-livestock system approach, animal genetic resources, small ruminants, livestock nutrition, animal health, biometrics, policy etc. A team of technical experts, namely training materials specialists, graphic specialists, computer programmers and designers, is required to develop a training resource. A resource is developed in CD-ROM format and the Internet will be an additional medium when the bandwidth expands to accommodate the multi-media components of training resources. ILRI and Swedish University of Agricultural Sciences (SLU) started a training resource project in 1999 on animal genetic resources for universities and NARS in East and southern Africa. Staff from NARS, ILRI and SLU will meet in a workshop in January 2000 to finalise the components of the training resource. This product will include resources on core modules, case studies,

bibliographies, photographs, video clips, glossary and statistics. A demonstration CD-ROM is used as a basis for discussion during the present workshop.

Training resources in biometrics

Biometrics is present in the curricula of many universities. Even though the generic concepts in biometrics apply to all areas of research, each area has its peculiar requirements. Thus, experiments in livestock research differ in some respects from those in crop or forestry research. Training resources are a good means to aid teachers to draw on the most up to date biometrics information.

Even though all the features of training resources described above suit biometry, biometrics has unique concepts and activities which require adding special resources. Peculiar features for biometrics teaching can be listed as follows:

Interactive problem solving resource

This resource will provide the teachers with an array of problems that can be used in their courses. These problems are designed to engage. While students are solving a problem, the structure should either provide the student with options for comparing their solutions with those of an expert, return to the core resource to review the steps needed to solve the problem or use a tutorial that explains the solution. Teachers can modify the problems.

Biometrics software resource

This resource will provide public domain software, e.g. Livestock Information Management System (LIMS) for which ILRI has copyright or possibly Instat+ being developed by the University of Reading (Allan and Stern, this proceedings). It may also be possible in future to obtain a licence to incorporate teaching of, say, Genstat.

Linkage resources

This provides e-mail addresses of ILRI biometricians and other biometricians working in livestock research for direct contact. This will promote collaboration.

The future

ILRI proposes a collaborative approach in developing training resources in biometrics on livestock research with universities in East and southern Africa and universities in developed countries as partners. This paper is presented so that the participants in this workshop can discuss this concept of training resources in biometrics and give their feedback on whether it suits their needs.

Reference

Wilson T.R., Ehui S., Mack S. 1995. *Livestock development strategies for low income countries. Proceedings of the joint FAO/ILRI roundtable on livestock development strategies for low income countries held at ILRI Addis Ababa, Ethiopia, 27 February–02 March 1995.* FAO (Food and Agriculture Organization), Rome, Italy/ ILRI (International Livestock Research Institute), Nairobi, Kenya.

Instat+—A computer package to support the teaching of biometrics

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Introduction

Computers are becoming accessible to students, at least at postgraduate level, in universities in Africa and we show how this development can be exploited to support the teaching of statistics.

We do need to consider changing the way we teach statistics. Currently research data are often poorly collected and incompletely analysed. One reason is the lack of understanding of statistical ideas by researchers. This is despite training in statistics. Trainers must therefore accept some responsibility for this lack of understanding. We believe that one way to make the major changes that are required in teaching is through imaginative use of computers within statistics courses.

Once computers are available it is temptingly easy to continue with the same course as before, using computers merely as a teaching aid to help cover the existing materials. This is not sufficient, for reasons we have explained elsewhere (Stern and Allan, Allan and Stern, this proceedings).

At Reading we currently use Excel, Minitab and Genstat on the statistics courses for agriculture students. Instat has also been freely available as a DOS-based package from the Statistical Services Centre since 1994. Recently we have been able to upgrade it, by adding a Windows front end.¹ We are, at the same time, incorporating some of our statistical games and our Good Practice Guides (see Allan and Stern, this proceedings) that are part of our broadened approach to the teaching of statistics at Reading. We anticipate that the first Windows version of Instat will be ready by the end of the first half of 2000.

We believe that Instat+, in its new form, may be useful for trainers of statistics, especially within universities. We envisage that trainers may often want to use more than one software package on a course, and so this package is intended to complement, rather than compete with, other statistical software used in teaching.

1. This work is partly funded by the UK Met Office. They are supporting the update of Instat+'s capabilities for agroclimatic analyses to the Windows environment. The Statistical Services Centre (SSC) is grateful for this support and has used its own funds to implement changes that are needed for training in agriculture.

Our objective here is to test this belief, by demonstrating the new Instat+, and to introduce general ideas on how to incorporate computers effectively into the teaching of statistics.

Basics in Instat+

The core of Instat+ is a simple statistics package that has been tried and tested on PC compatible computers since the 1980s. It is a beginner's package and therefore includes all the statistical features that would support basic training courses in statistics. It has always been easy to use and is now even simpler, being in Windows. We have tried to support good statistical practice within Instat and have maintained this view in the development of Instat+. Hence Instat+ is particularly strong in simple data manipulations (a missing element in many training courses) and in basic statistical methods. These basic methods include descriptive tools, graphics for data exploration, one sample and two sample inference, good analysis of variance and simple and multiple regression.

The new Instat+ imports data from a wide range of other programs including Excel and Mstat. As was the case for Instat, Instat+ can export data to other packages, including Genstat, SAS and SPSS, when analyses are required that exceed Instat's capabilities.

Not-so-basics in Instat+

Students need to understand how analyses can be tailored to the specific objectives of the research. Instat+ caters for this by including such elements as contrasts in the analysis of experimental data.

Students also need to be exposed to a range of advanced statistical methods that correspond to common situations with real data. Thus, Instat+ includes facilities for handling unbalanced experimental designs. It also has a module for fitting log-linear models to count data—a modern method that extends the simple chi-square test to more complex data structures, and shows how advanced methods fit into a general modelling framework.

We have stated that Instat+ complements, rather than competes with, the standard software packages. One role for Instat+ may be to introduce Excel users to the scope of a statistics package for situations when Excel is insufficient.² Courses can then move on to use a more powerful statistics packages if the needs exceed Instat+'s capabilities. For example, Instat+ does not have facilities for multivariate analysis (except multiple regression), nor are its facilities for the analysis of unbalanced and non-normal data as extensive as those in more powerful packages such as Genstat and SAS.

2. The SSC has a booklet on the use and limitations of Excel for statistical analyses. This is available from the SSC website and printed copies can be sent free of charge on request.

Other components

A major component of Instat+ is a facility to analyse climatic data in ways that are of direct relevance to their use in agriculture. These facilities for processing climatic data are of some value to agricultural researchers generally and they provide an application area that is of common interest to many students.

Instat+'s documentation, which is over 1000 pages, is included within the Instat+ HELP system. This system also includes example datasets to illustrate different methods of analysis.

We also plan to include the Good Practice Guides within the Instat+ HELP system.³

In conclusion

The computer is a key tool in making training in statistics more interesting and relevant to students and researchers. Our objective, in demonstrating Instat+ within this workshop, is to provide encouragement to trainers in statistics who wish to broaden the way they currently teach statistics.

Interested trainers of statistics may want to only use selected components of the Instat+ package. For instance, a university department may already be using Minitab successfully for hands-on computer practical work on their statistics courses, but might want to explore the use of our statistical games as a way of demonstrating good experimental design practice. Others may have no access to statistical software because of financial constraints. For them we hope that the fact that Instat+ will be freely downloadable—as well as encouraging good statistical practice—will help them to make their statistics training more relevant.

3. We plan to make versions of the statistical games and these booklets available than those that can be used independently of Instat+. This is to support trainers who wish to incorporate these components while continuing to use their current statistical package.

Research networks

The possible role of the Sub-Saharan African Network (SUSAN) in enhancing capacity in applied biometry in East and southern Africa

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Introduction

The Sub-Saharan African Network (SUSAN) is a network of groups of the International Biometric Society (IBS) in sub-Saharan Africa (SSA). I am the current co-ordinator. Both the network and its parent body are devoted to the advancement of mathematical and statistical aspects of biology.

Concerned by the relatively small number of applied biometricians in developing countries and the lack of critical mass and limited access to the literature IBS initiated a scheme to help to address these problems. The scheme involved regional groups of IBS in developed countries subsidising subscriptions of those in developing countries and sponsoring their attendance to scientific meetings, workshops, symposia, special lectures, etc. As a result, several Africans have obtained training or attachment fellowships in overseas institutions to enhance their biometric skills.

The scheme led to the formation of IBS national groups in Kenya, Zimbabwe, Uganda, South Africa and Botswana. Bye-law 5 of the IBS constitution states that 'a geographically defined area that has 50 or more society members may become a region of the society on approval by Council', and that an 'area with 10 to 50 society members may become a national group on approval by Council'. Furthermore, the bye-law states that 'in areas of the world, with limited group activity, national groups may come together as networks to sponsor conferences.' It was on the basis of this that the groups in East, central and southern Africa came together in 1990 to constitute the East, Central and Southern African Network (ECSAN) of IBS.

Following the formation of Group Nigeria, and its request to join, the network was extended and renamed Sub-Saharan African Network (SUSAN) of IBS in 1997 during the biennial meeting of the network in Mombasa, Kenya. Its bye-laws were approved in August 1999 during the most recent meeting of the network in Ibadan, Nigeria.

Current member groups

In addition to the countries of Kenya (GKe), Uganda (GUg) and Zimbabwe (GZim) in the region represented at this workshop, other existing IBS groups in SSA are Group Botswana (GBot), Group Ethiopia (GEt), Group Nigeria (GNi) and Group South Africa (GSaf). Other countries which are unable to form groups but which nevertheless have IBS member contacts are Malawi, Swaziland, Madagascar, Tanzania, Bénin, Côte d'Ivoire, Democratic Republic of Congo, Cameroon, Senegal, Ghana and Zambia.

Scientific meetings

The network has successfully organised six scientific meetings in the past 10 years. The first scientific meeting (first meeting as ECSAN) was held in Nairobi, Kenya in 1990. The second was held in Harare, Zimbabwe in 1991, the third in Kampala, Uganda in 1993, the fourth in Stellenbosch, South Africa in 1995, and the fifth in Mombasa, Kenya in 1997. The sixth scientific meeting, which was the first as SUSAN, was held in Ibadan, Nigeria in August 1999. The francophone SSA countries were well represented at this last meeting. Efforts are now being underway to initiate IBS groups in some of these countries.

Possible role of SUSAN

There are four major factors that may be considered to determine the effectiveness of a biometrician: the person, the training he/she has received, the environment within which he/she works and the facilities available to develop his/her skills. There are many Africans with the ability and qualifications to be professional biometricians. Most, if not all, have received good training from local and/or foreign institutions. Moreover, the research environments are abundant through the challenges posed by particular biological experimentation problems in SSA. However, many of these people are isolated and lack sufficient facilities in terms of literature, computer hardware/software/Internet connectivity and opportunities to update their knowledge and associate with other biometricians worldwide. By virtue of its composition SUSAN can play a major role in enhancing biometry capacity in sub-Saharan Africa. Some of these roles are already being undertaken in various parts of Africa such as the organising of workshops and seminars, sharing responsibilities for biometrics support, keeping a database of biometricians in the area covered by the network and carrying out surveys of needs. Thus, SUSAN provides the opportunity to increase the respect for biometricians within SSA, encourages them to work together and seeks ways in which they can be provided with better access to literature and hardware and software.

A network within East and southern Africa to enhance capacity in applied biometry?

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Introduction

The ultimate goal of this workshop is to seek ways that African institutions can work together to improve their capacity in applied biometry. By achieving closer collaboration between national agricultural research institutions (NARIs) and universities opportunities for sharing resources, including the licensing of statistical software, can be facilitated. A number of papers in this proceedings (e.g. Agwanda; Das; Keogh; Janssen; Mugasha and Shemwetta; Nabasiye;) alude to the need to establish and maintain better links among biometricians within the region. The existence of SUSAN (Sub-Saharan African Network of the International Biometric Society) is a positive asset, but within the region covered by this workshop there may be a need for a more focused network of committed biometricians who can work together to improve both the quality of biometric input into agricultural and medical research and the image of biometrics too. This paper addresses this possibility.

Linkages between universities and NARIs

Many papers in this proceedings have emphasised the shortage of applied biometricians in NARIs. There is a clear need, therefore, to improve the output of well-trained graduates in applied biometrics from universities. To do this the capacities to teach biometrics in one or two of departments of mathematics/statistics in universities in the region need to be strengthened and regional BSc and MSc courses in applied biometrics initiated. Following the development of course curricula additional assistance can be provided as follows:

- a. assistance in course content and teaching methods and skills by experienced university lecturers from outside the region
- b. assistance in university teaching by applied biometricians working in the fields of agriculture and medicine
- c. short-term attachments of staff to research and educational establishments with experienced applied biometricians and
- d. practical exposure of students to biometric applications in NARIs.

Figure 1 illustrates a possible scenario with two lead universities each with BSc and MSc programmes in applied biometrics. As soon as lecturers gain experience and confidence in teaching the new syllabus, their knowledge can be shared with staff in other universities who wish to introduce applied biometric components into existing mathematics/statistics courses or who wish to improve courses in biometrics to students in life sciences. As linkages

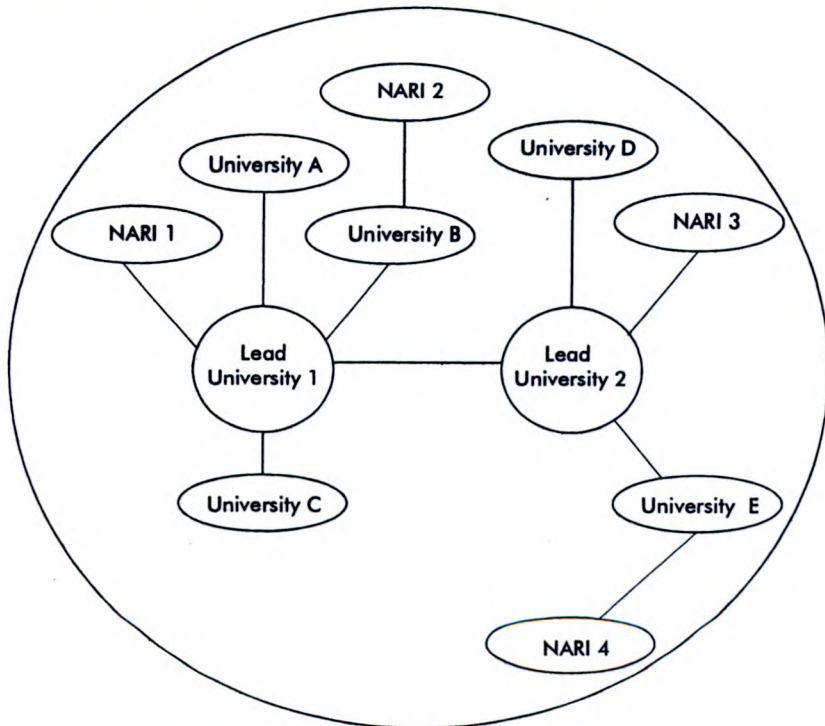


Figure 1. A conceptualised network of universities and national agricultural research institutes for the purposes of strengthening institutional capacities in applied biometrics in East and southern Africa.

between universities develop so also will linkages with NARIs. Figure 1 conceptualises a future network of universities and NARIs in East and southern Africa.

Linkages with other organisations

In order to maximise the benefits gained from linkages between national institutions in the region it will be important to broaden the network to encompass other institutions and networks within and outside the region as illustrated in Figure 2. For instance, existing regional agricultural research networks in East and southern Africa recognise the subjects of experimental design, statistical analysis, interpretation and presentation of results to be among the top priorities for training of scientists. An increased biometric input into the research of these networks would be an important step and raise the profile of biometrics in the region. Coe (this proceedings) describes possibilities for enhancing the contributions

that international agricultural research centres (IARCs) can make in increasing the capacity and effectiveness of biometricians in national agricultural research systems (NARS). Potential benefits achieved from close collaboration with advanced institutions abroad are also emphasised (e.g. Dicks and Njuho; Janssen, this proceedings). Various institutions can be linked to extend the network as conceptualised in Figure 2.

Steering group

It is likely that a steering group will be necessary to allow such a network to function efficiently (Figure 2). Such a group, modelled on other existing research networks, could, for instance, comprise a representative from each of Kenya, Malawi, Tanzania, Uganda and Zimbabwe who would elect a chairman from amongst themselves. Two other members could also join the steering group, namely a representative from the IARCs, to provide, in the initial stages, the secretariat and a representative from other advanced institutions. The terms of reference of the steering group could cover such activities as:

- a. editing of newsletter published periodically to keep members and interested parties abreast of developments

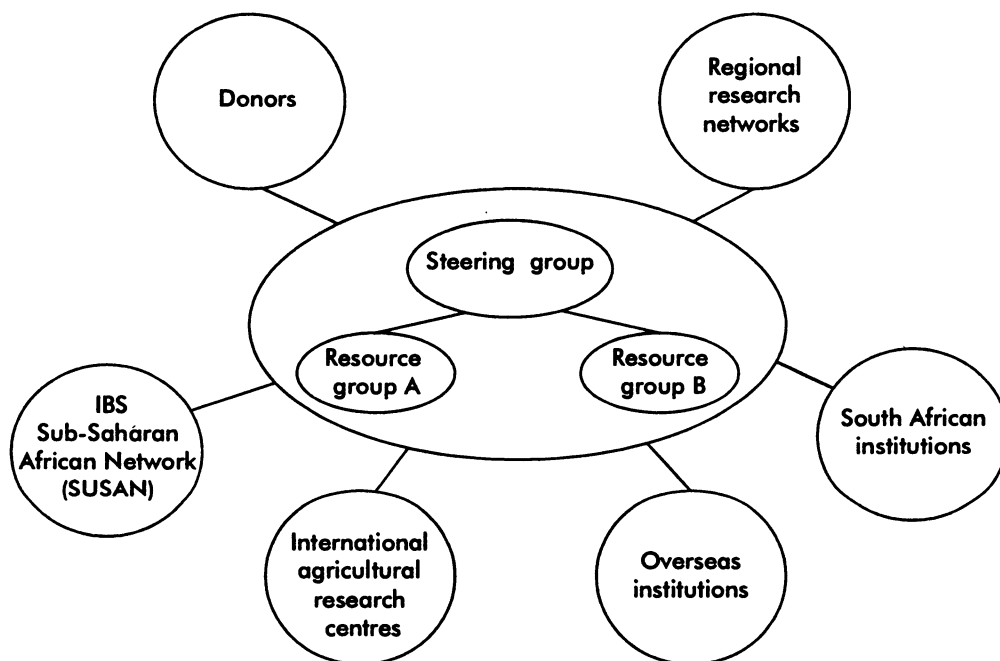


Figure 2. Management of the network conceptualised in Figure 1 through a steering group and resource group of committed biometricians and linkages to outside organisations for which assistance may be needed.

- b. maintaining a database of biometricians and scientists interested in the network and details of attachments of MSc students at advanced institutions abroad
- c. publicising the activities of the network in order to increase awareness of policy makers, donors and stakeholders
- d. provide a focal point through which funding proposals can be channelled for submission to donors
- e. organise, from time to time, workshops or training courses in specialised topics.

Resource groups

Stern and Allan (this proceedings) demonstrate how a team of biometricians from both national and international institutions were put together to conduct a training programme of biological scientists in Guinea in West Africa. Such a model could be readily applied to countries (or institutions within countries) in East and southern Africa. By following a strategy of strengthening the capacity of existing national biometricians through attachments to biometricians in European or South African universities or to biometricians in IARCs (as outlined by Riley in her review of the CTA study) resource groups of trained, national biometricians could be put together to conduct courses for other biometricians and scientists in the region. The inclusion of two resource groups A and B, for illustrative purposes, completes the conceptualisation of Figure 2. An additional function of the steering group would be to ensure that such resource groups are established and sustained.

Getting started

Reactions of participants at this workshop to these suggestions are needed. If there is a general acceptance of these ideas then the next step would be to appoint a steering group. This would be one approach to ensuring that initiatives taken at this workshop have possibilities of reaching fruition.

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ISBN 92-9146-079-6

Printed at ILRI, Addis Ababa, Ethiopia

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