Case Study No. 7

Good practice in the preparation of research protocols

It is important that research protocols contain sufficient information that the structure of the activity is clear and that they can be used as reference documents by the research team. We describe three protocols here that also pay particular attention to statistical issues. We are grateful to the project leaders who have given us permission to include these protocols as examples of good statistical practice.

Protocol 1 is for a drought screening trial within a project funded by the Plant Sciences Programme and led by Adam Price from the University of Aberdeen. It is an initial draft as passed to team members and to a statistician for their comments. We would have some comments about the proposed trial. The good practice that we wish to encourage is that the information provided is ideal for the intended purpose, namely, to encourage informed discussion.

In the protocol we note the following points in particular:

- There are diagrams as an appendix to the protocol that show the intended plot layout. This, in conjunction with the information (Section B) shows the care that has been taken in the site selection.

- Section C of the protocol specifies the experimental design at each site.

- Section C, under the subtitle *Monitoring* specifies the proposed measurements to be taken and the recording times.

- Section E specifies a strategy if the proposed workload cannot be fulfilled, due to time or resource constraints.

Presenting the intended plot layout on a map showing the soil penetration resistance helps determine the suitability of the proposed location for each of the plots at each site. This information, together with knowledge of the variation due to prevailing winds, has been used to determine the most appropriate set of homogeneous areas to be used as "blocks" in the design.

Unlike the other protocols described here, this draft protocol does not include sections on the justification for the study, etc. This would normally be provided, but is not necessary here, given the objectives of this draft.

Protocol 2 is a completed protocol for a set of researcher-managed trials on soil and water management in Nepal. It concerns a Natural Resources Systems Programme (NRSP) project led by Morag McDonald of the School of Agricultural and Forest Sciences at the University of Wales in Bangor. This is a good example of a complete specification.

- The first three sections give the Purpose, Output and the Activities. Separate protocols were used to deal with each of the activities. We have included here the protocol, detailed in Section 4, which deals with the design and analysis for one of the activities.

- The plot layout is given very clearly in an Appendix.

- We note in particular the details that are supplied on the measurements to be taken and methods of data collection.

- Setting up the structure of the analysis shows an awareness of the need to think about the way in which the data will be analysed to answer research questions.

Protocol 3 is also based on an NRSP Project, led by Julian Barr at the Centre for Land Use and Water Resources Research, University of Newcastle. The protocol is for a survey concerned with the management of common property resources. This protocol was very clearly written. We note in particular:

- The inclusion of a description of the survey design that shows how ideas normally used in experimental designs can be used in the design of a survey. This survey essentially has two stratification factors, i.e. four stakeholder groups and whether participants within each stakeholder group participated or not in a consensus building workshop. These two factors correspond to two "blocking" factors in experimental design. The "treatment" of interest was the *before* to *after* change.

- The clear specification of sample sizes involved.

- The inclusion of a draft of the questionnaire to be used.

- Field testing of the questionnaire.

Acknowledgements:

We are very grateful to the authors of the three protocols included within this case study, i.e. the project leaders, for their permission to use this material and for providing comments on an initial draft of this case study.

PROTOCOL 1

Initial draft protocol for the Plant Sciences Project R7435 titled "Analysis of environmental effects on expression of root penetration QTLs in upland rice and development of PCR markers for QTL selection in drought resistance breeding"

DROUGHT SCREEN WARDA 1999

Proposed protocol following preliminary fieldwork at WARDA and discussions between the team leader and research team members.

A) WARDA SITE SURVEY

Approximately 10 sites in the WARDA M'be site will be briefly characterised for suitability for further study. All sites must be within reach of sprinkler irrigation. Soil penetration profiles will be produced and the soil profile will be described. The sites will hopefully include an upland site on the Plateau, both in the deep soil profile zone (>120cm) with a fairly high penetration resistance (25-45 cm) ca. 2-3 MPa and with a lower penetration resistance in this depth range, one in the shallow soil profile zone (40 cm), and soils in the hydromorphic and continuum areas.

B) DETAIL SURVEY OF 3 SITES

Three sites will be chosen based on their contrasting soil physical properties. These will hopefully include one deep plateau soil site with the least impedance of such soils when wet (probably the top of the Plateau on field P6H2C), a sandy/loamy hydromorphic soil with an acceptable penetration resistance (< 3 MPa, hopefully < 2 MPa) to depth (> 60 cm) which we expect to respond differently to soil drying, and a further soil, either plateau or hydromorphic, with a greater penetration resistance than its counterpart. If necessary, subsoiling (0-40 cm) will be used to remove a compaction/cultivation pan on one of the sites. These sites will probably be the area that have previously been used for QTL screening (P5H2C) and one of two hydromophic zones.

Hydromorphic zone 1 (B1S5P) is described on the soils map as Fi2: footslopes with imperfectly drained, deep clayey soils (1-2% slope). Hydromorphic zone (B3S3P and B3S8P) is described on the soils map as Umdo2: middle upland slopes with well drained moderately deep to deep, non-gravely, loamy soils (slopes 2-4%). These sites will be screened for spatial uniformity of penetration resistance by measuring (using the penetrometer) a 5m square grid. The soil profile will be examined and soil samples analysed for chemical properties (pH, exchangeable Ca^{2+}). Foliar application to correct for Zn deficiency will be considered on these soils. Also note that rice stripe necrosis virus is found on the Upland Plateaux site, especially in P5H2C, and in the hydromorphic zone 1 (B1S5P). This may cause trouble.

C) ROOT GROWTH UNDER IRRIGATION AND DROUGHT

On each of the three sites, providing they prove suitable, two types of plot replicated three times will be laid out. Plot designs will either be split-plot designs with 3 replicates and with +and – drought as the main treatment. One plot design will be divided into 3 sub-plots containing only varieties Azucena, Bala and CG14. The other plot design will contain 6 varieties (Azucena, Moroberekan, Bouake 189, WAB56-104, CG14 and V4) as subplots.

The soil will be prepared using a minimum of trafficking and when trafficking does occur, the wheel track positions will be controlled to leave a clearly marked set of untrafficked beds (i.e. between the tractor wheels). Any repeat passes of traffic must use the same tramlines (i.e. wheel tracks). Any turning of vehicles must take place outside the plot areas. Nutrients will be supplied at a minimal level to prevent deficiency symptoms (low input). Herbicides will be applied as pre-emergence herbicide (medium input) and hand weeding will be used thereafter (very important that this is only done when the soil is <u>not</u> too wet). Plants will be monitored for symptoms of deficiency and this will be corrected by spraying. Plants will be sowed in hills 25 cm apart in rows 25 cm apart. Each hill will be sown with 4 seeds, which will be thinned to 2.

Three variety plots
For the split-plot design, these will be laid out in 4 m x 24 m areas. Sub-plots of Azucena, Bala and CG14 (seed germination to be assessed prior to sowing), 2 m wide (by 4 m long) will be sown side by side. There will then be a barrier plot 12 m wide followed be another sub-plot of both Azucena, Bala and CG14. One side will be irrigated, the other will be the drought treatment.

The 3 sites will be sown at 1 week intervals. This means that site 2 will be sown 1 week after site 1 and site 3 will be sown a week after this. This means that when site 1 reaches week 4, this whole site must be analysed, which is 12 profile faces a week. The following week, site 2 will be analysed and so on.

Six variety screen
For the split plot design, the layout will be similar but the sub-plot length will be only 2 m and the plot width will be only 1 m. Therefore the whole plot will occupy 2 x 24 m. These will be irrigated in the same manner as the three-variety drought screen. All of these plots will be sown 1 week after the 3-variety screen on site 3 has been sown.

Water regime
These plots will be irrigated with approximately 30mm of rain by sprinkler irrigation at a rate of approximately 15 mm hr^{-1} twice weekly (60mm per week total) applied in the early evening. Irrigation will therefore take place on the Saturday, 2 days before sowing (on a Monday), and 2 days after sowing (Wednesday) (das), on day 5, 9, 12, 16, 19, 23, 26, 30, 33, 37, 40, 44, 47, 51, 54, 58, 61, 65, 68, 72, 75, 79, 82, 86, 89, 93, 96, 100, 103, 107, 110, 114, 117, 121, 124, 128, 131. If capping of the soil surface is observed, it will be tilled by hand to break up the capping.

Irrigation will stop on the drought plot after the 4^{th} week irrigation (after the irrigation applied on day 26). It will recommence on the 8^{th} week (day 58) giving a 4 week drought. Therefore the irrigations on days 30, 33, 37, 40, 44, 47, 51 and 54 will be omitted. The precise duration to be chosen for drought will depend to some extent on the progress of symptoms of drought stress. *It is intended to give a moderate drought stress and not to kill. Therefore, if it is observed that symptoms develop very rapidly (visible drought before 14-16 days drought), then the period of drought must be reduced.*

Monitoring

Irrigation
Rain gauges to be distributed on each site in order to verify target irrigation.

Tillering
At 10 days and subsequently every 2 days subplots will be monitored for tillering in order to identify the time of 50% tillering. After 60 days, subplots will be monitored weekly for tillering (on 5 marked representative plants) in order to identify when tillering stops.

Soil moisture
At present there are only 6 TDR probes. It seems likely that these will be added to, so that 36 probes will be available. If so, TDRs will be placed at 2 depths (20 cm and 40 cm) in every CG14, Azucena and Bala droughted (3 variety) sub-plot of just two sites.

Soil Penetration
Penetration profile measurements will be made on a weekly basis on each droughted subplot during drought. For the 3-variety screen, the area around the central 1 m of the subplot will be sampled 10 times. For the 6-variety screen, penetration will be measured on 5 occasions avoiding the centre of each subplot.

Drought symptoms
Starting one week after drought begins, the severity of drought stress for each subplot will be monitored 3 times a week. Visual scores of leaf rolling and leaf drying (1-5) will be assessed. Leaf area index will be measured. In addition, plant height will be measured on 5 representative, marked plants, in both drought and controls (controls must be monitored since the cold night temperatures may cause reduced growth). These measurements should enable the determination of when drought symptoms first appear for each sub-plot.

Root profile analysis of three-variety plots
After 4 weeks (around day 28) and then every subsequent 3 weeks (days 49, 70 and 91), root profile counting will be conducted on the three variety plots only [Note that it would be unwise to conduct this analysis the day after irrigation]. This will involve digging a trench of 6 m length, by 1 m wide by 1 m deep across the face of the Azucena, Bala and CG14 sub-plots for both the control and drought plots. This trench will extend 0.5 m into the plot. Every subsequent profile measurement will be conducted a further 0.5 m into the plot. On each occasion, the central 1 m width of each sub-plot will be inspected for data collection. If trafficking was used, the plot will have been planted so that this central 1m lies between the tractor tracks (and therefore has suffered no compaction). The depth of the deepest root will be measured.

The density of roots at specific depths will be determined as follows. At a distance of 3 cm in front of a row of plants, a clean profile face will be exposed. One team will analyse this face using the grid system they have developed. Subsequently, the shoots of 5 plants in the row above the face will be cut off and bagged prior to drying for biomass assessment. Then, on only the Azucena and Bala subplots, at a depth of 10 cm, a horizontal plane of 12 cm depth (i.e. 12 cm into the profile) will be exposed by removing the soil above it. Using a 5 cm grid of 50 x 10 cm the number of thick (nodal, >0.5mm thickness) roots on the plane of 100 cm x 10 cm (i.e. the grid will be laid down twice, side by side, along the width of the profile) will be counted in each grid square. Subsequently, a plane 10 cm lower (at 20 cm soil depth) will be exposed and the count repeated. This will be repeated at 30 cm depth and so on. This will continue until a rooting density that is significantly less than 0.04 roots/cm^2 is observed (40 roots). The aim is to be able to estimate the depth at which this rooting density occurs. This requires only 3 measurements, one in which rooting density is approximately 0.04 root/cm^2 and one reading immediately (10 cm) above and below this. Therefore, with experience it should be possible to eliminate the measurements in the top part of the soil as the plants age, and conduct only 3 or 4 measurements.

Once these measurements have been conducted, a vertical face will again be cut, 9 cm behind the removed plants (i.e. at 12 cm from the first vertical face), and the team will count roots again. Soil samples will be taken from the freshly exposed face, just outside the area to be used by the team for root examination, at three depths in order to measure soil matric potential. These depths will be 15-20 cm, 24-28 cm, and approximately where the rooting front has reach the 0.04 roots/cm^2 density (this depth will be recorded). Penetrometer readings will be taken from the plot surface in the area 0.5 m immediately behind the profile face (10 readings/variety subplot). After analysis, the profile face will be covered by expanded polystyrene (to prevent thermal gradients) backed by corrugated iron (for rigidity) which will be held firmly against the profile by wooden stakes to prevent soil movement.

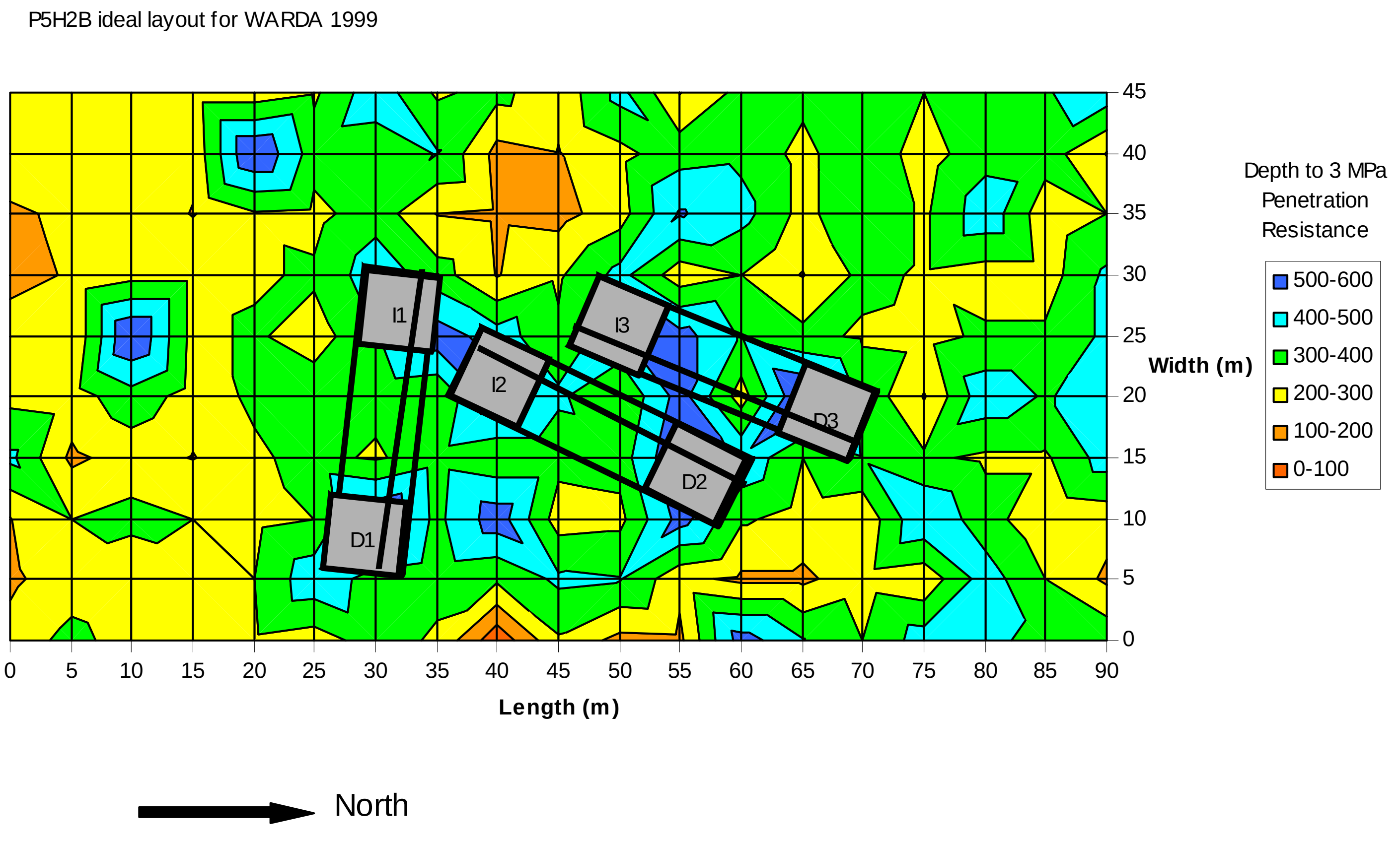
Root profile analysis on the 6-variety plots
These will be analysed for rooting profile and soil matric potential only at 12 weeks, using the methods described above.

D) YEAR 2 EXPERIMENTS
On two sites, 4 replicate plots of a population of 110 RILs and 5 of each parent will be sown. Layout will consist of subplots of 2 x 1 m, 30 of each in 4 rows back to back (ie a total area of 8 x 30 m). Two replicates will be droughted. At a time indicated by year 1 results, root profiling will be conducted by digging two 30 m long trenches in the plot, which will expose all sub-plots at once. Probably only one or two droughted replicates on only one site can be root-monitored. Availability of these sites and germination rates of these seeds should be investigated in advance.

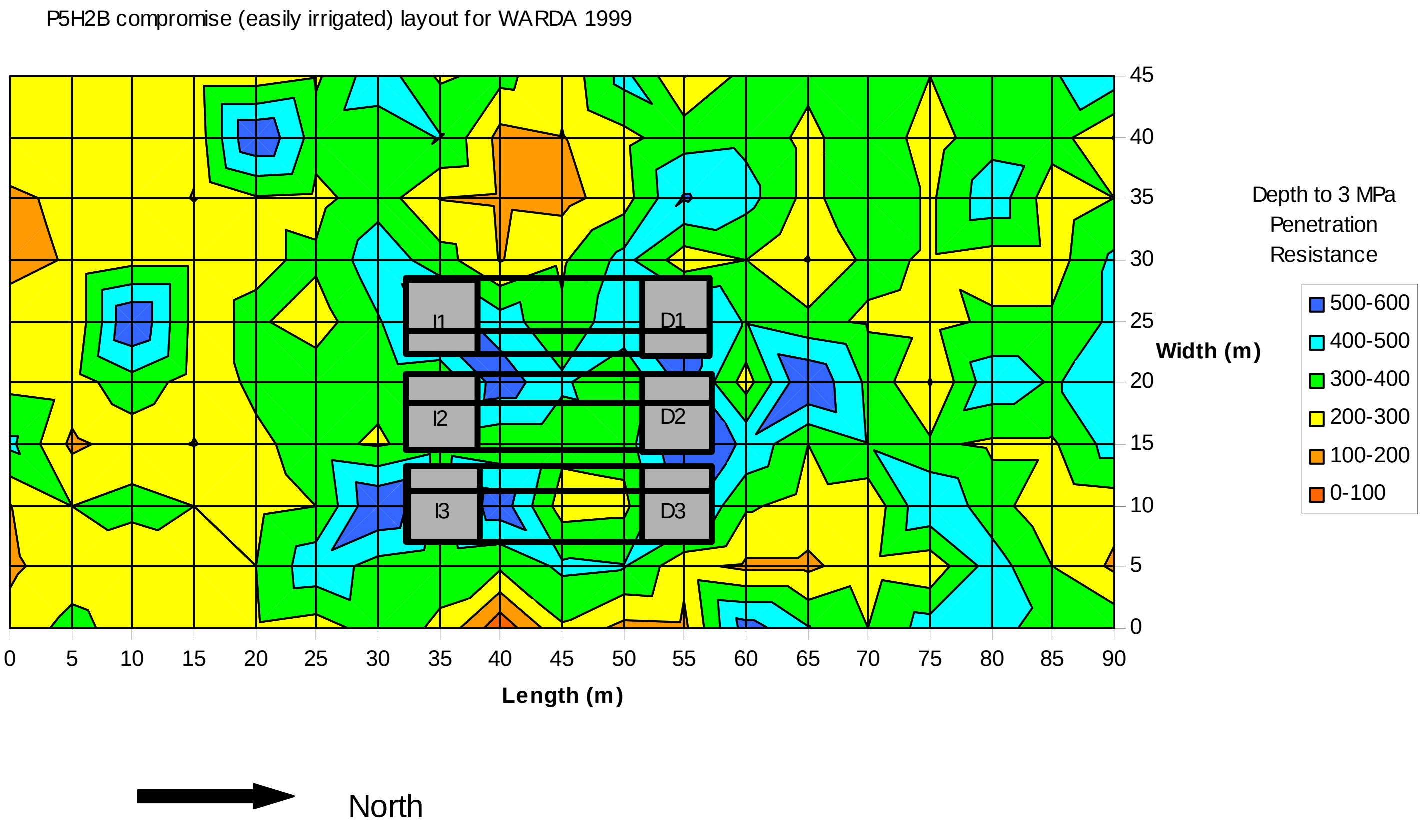
E) FLEXIBILITY FOR YEAR 1 PROJECT ACTIVITIES
In the event that the workload of the project cannot be fully fulfilled, some activities can be sacrificed. These are (in order of most dispensable);
1. Plant height measurements on controls conducted only once a week.
2. Drought symptoms measured only 2 x per week
3. Weekly penetration measurements on 6-variety plots conducted every 2 weeks
4. One whole replicate (to be decided jointly)

In the event that the workload can be increased, soil matric potential can be measured on CG14 and horizontal root profiling of CG14 can be conducted.

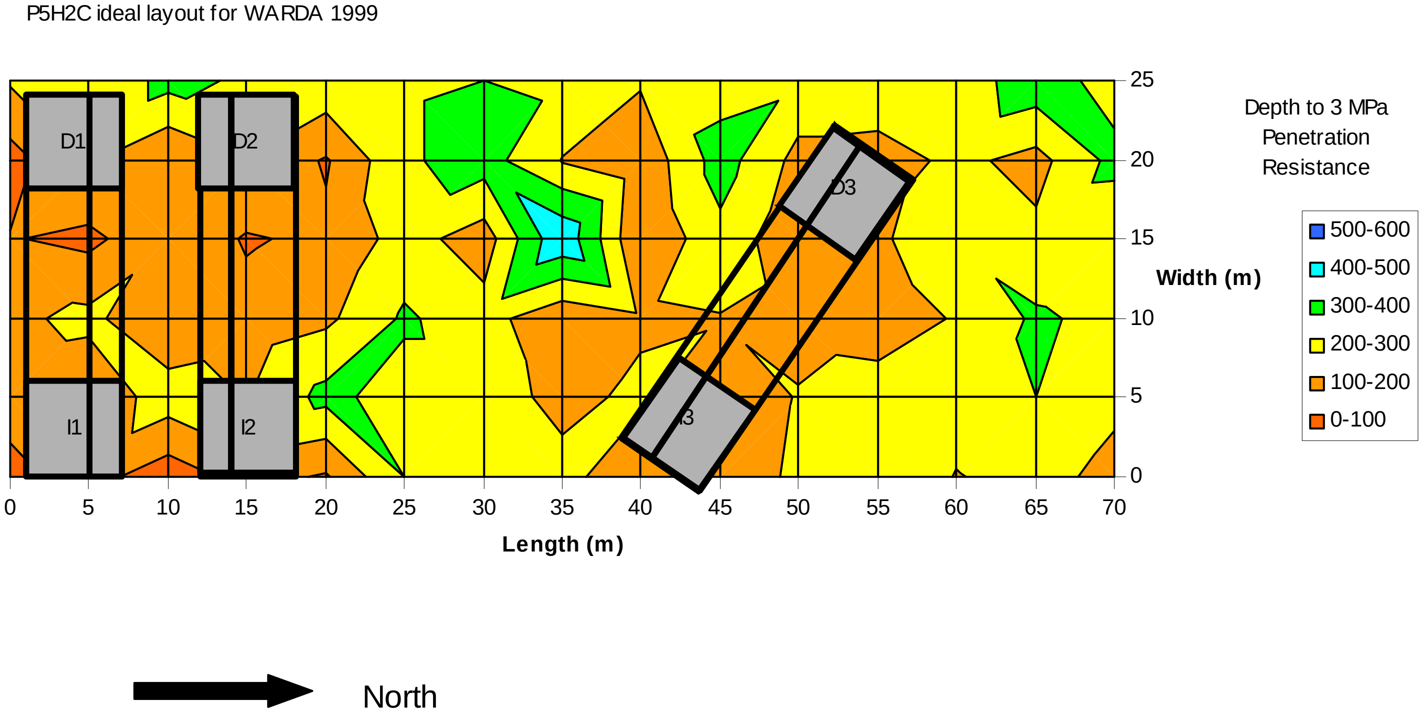
Appendix 1 (Page 1 of 2)



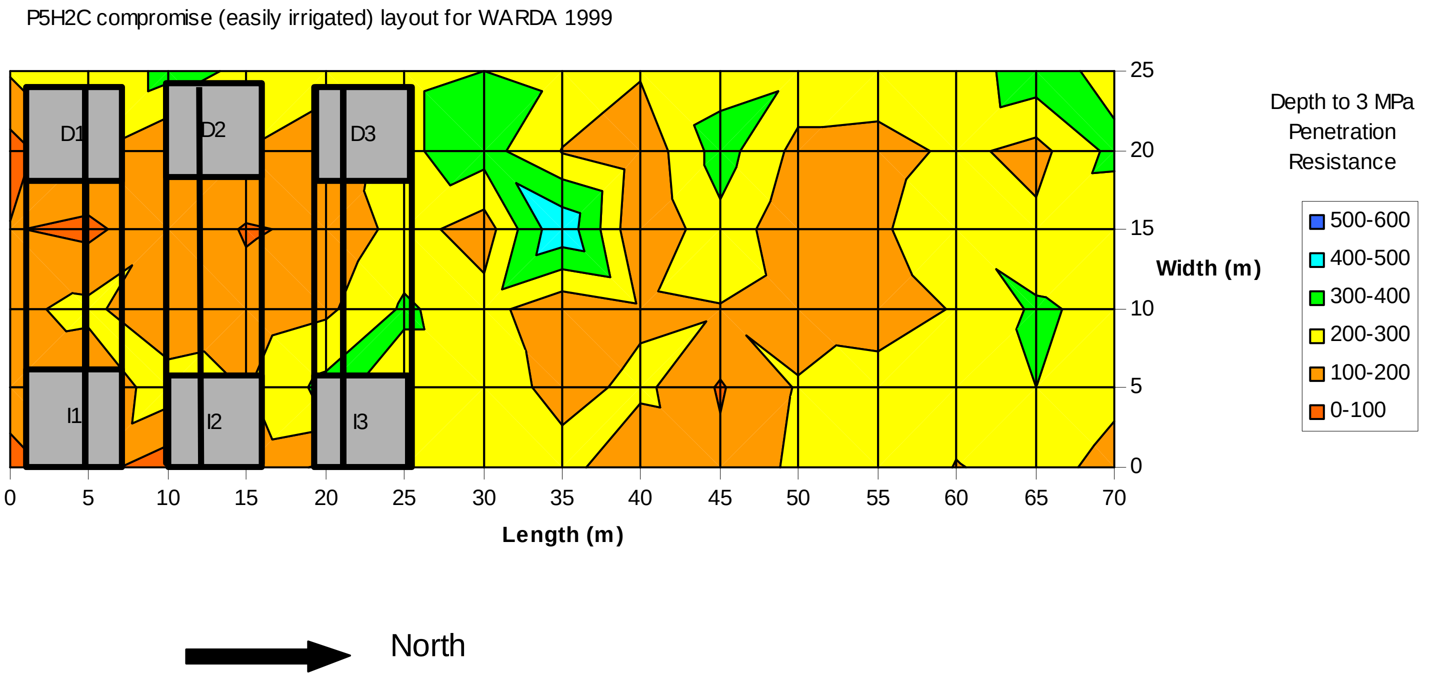
Appendix 1 (Page 2 of 2)



Appendix 2 (Page 1 of 2)

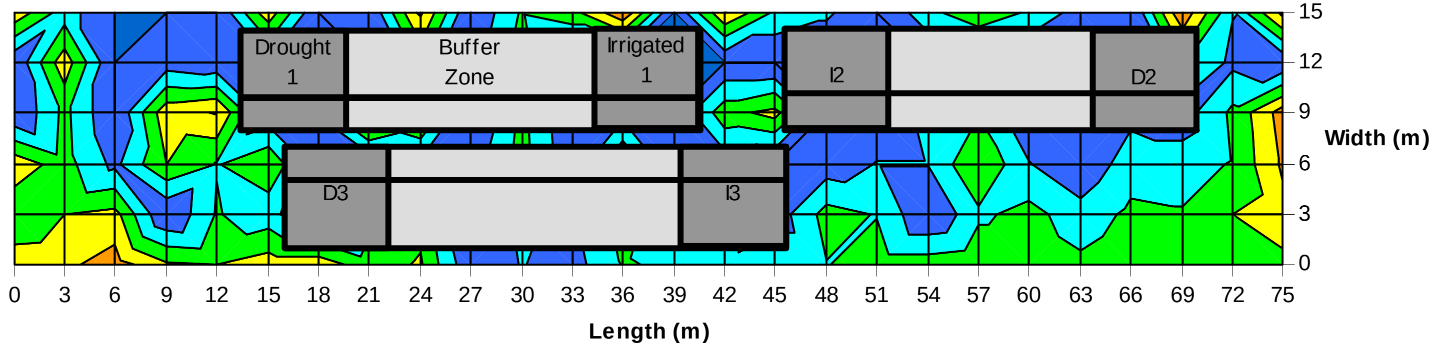


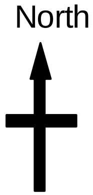
Appendix 2 (Page 2 of 2)



Appendix 3 (Page 1 of 1)

B3S3P proposed layout for WARDA 99





Note, replicate 1 has a 15m buffer zone and replicate 3 has a 17 m buffer zone while for replicate 2 it is the normal 12 m

PROTOCOL 2

A complete version of a protocol for one activity of the Natural Resources Systems Programme (NRSP) Project R7412 titled "Incorporation of local knowledge into soil and water management interventions which minimise nutrient losses in the Middle Hills of Nepal", led by Morag McDonald, School of Agricultural and Forest Sciences, University of Wales in Bangor.

1. Purpose

To ensure that nutrient losses due to leaching and erosion are minimised by devising economically and culturally viable land, soil and water management techniques. The protocol builds upon the sophisticated local knowledge of the movement of water across soil, as well as existing scientific data and will be incorporated into participatory technology development.

2. Outputs

2.1 Local knowledge and perceptions of soil and water conservation methods acquired and distribution with respect to spatial and cultural variation mapped

2.2. Interventions which minimise nutrient losses designed by combining local knowledge and scientific knowledge, building on the existing erosion studies

2.3. Adoption and adaptation of interventions by farmers evaluated

2.4. Suite of regional recommendations for system compatible interventions developed and promoted

3. Activities

3.1 INITIAL PARTICIPATORY APPRAISAL AND KNOWLEDGE ACQUISITION

3.1.1 Participatory rural appraisal.
This will include problem prioritisation, and causal factors; identification of potential solutions and reactions to possible interventions; the identification of farming groups willing to participate in the strategic trials; and their evaluation criteria

3.1.2 The distribution of knowledge will be mapped by using the initial knowledge base to create a non-leading questionnaire which will be administered to a large, stratified, random sample of people across the western mid-hills

3.2. PARTICIPATORY TECHNOLOGY DEVELOPMENT

3.2.1 Strategic trials (researcher-managed) will be established building on the existing plots of Gardner *et al*. in the Lumle command area. The existing plots will function as controls for comparison with adjacent plots incorporating interventions

3.2.1.1 Leachate and runoff will be analysed for total nitrate, ammonium, phosphorus, cations, dissolved organic carbon and pH

3.2.1.2 Bioassays of productivity will be conducted by monitoring sub-plots of crop production within plots under the different interventions

3.2.2 Farmers, NGO's and scientists will be brought together in a series of small rural fora to create opportunities to discuss new ideas, and farmers can then plan their own trials (farmer-managed) building on new information

3.3. EVALUATION OF ADOPTION AND DISSEMINATION

3.3.1 The rate of adoption by farmers will be assessed from field observations.

3.3.2 The evaluation criteria of farmers who adopt the interventions will be evaluated, and any subsequent adaptations documented.

3.3.3 Farmers' innovations in their trials will be evaluated. Their assessment of the efficacy of the interventions, and any constraints to their adoption will be evaluated.

3.4. PROMOTION

An extension manual of techniques for the improved interventions to facilitate soil and water management will be produced. The manual will be guided by ICIMOD and will contain regional recommendations. Dissemination will be in cooperation with NGO's, government agencies, farmer groups and bilateral programmes.

4. Sampling and analysis protocols relating to activity 3.2.1

4.1 Site selection

Previous work by the Royal Geographical Society (with the Institute of British Geographers), Queen Mary and Westfield College and Agricultural Research Station Lumle sought to understand the reasons for variability in soil and nutrient loss on rainfed agricultural terraces on *bari* land in different farming systems and agro-ecological zones in Nepal. The variables measured include surface runoff, erosion, volumes and chemistry of leachate in 25 plots at three contrasting locations; Naya Tola (20-25^o slopes, annual rainfall 1000-1500mm); Landruk (terraces 0 - 5^o slope, 3000-3500mm annual rainfall); Bandipur (terraces 0-5^o slope, 1100-1500mm annual rainfall). The results show that erosion is important during heavy rainfall events pre-monsoon in April/May on steep cultivated slopes and even on low slopes because of high surface runoff and, later in the season, nutrient losses through leaching on moderate and lower slopes or where runoff is controlled are significant as infiltration throughout the monsoon is increased and high nutrient losses occur. The key researchable constraint is to develop soil and water management interventions that control erosion without resulting in high leaching and so are effective in minimising total nutrient losses. The target group of farmers are smallholders cultivating rainfed *bari* lands in the middle hills of Nepal.

4.1.1 Landruk

4.1.1.1 Experimental design:

Participating farmers in this phase of the trials were pre-selected as those who had been participating in the previous trials. To provide data continuity, it was not possible to move the existing plots. The interventions (treatments) were chosen by PRA and local knowledge acquisition as activities in 3.1. The interventions are designed to test basic principles of the relative influence of run-off and run-on in causing nutrient loss and the relative merits of barrier and cover effects in the prevention of such losses in particular environments. A limited range of farmers is involved in the testing of interventions in this phase because of the necessary costs and rigour of experimentation. However, a broader spectrum of interventions and farmers will be involved in less rigorous farmer-managed trials from February 2001 (Activity 3.2.2). A randomised block design was used regarding farmers as blocks. The plots were randomised as much as possible, but in some blocks it was necessary to have the closed plots as the outer plot to avoid run-on being channeled into the adjacent plot.

Farm	Number of plots	Cropping Pattern
1	3 (1 old + 2 new)	Wheat-short duration maize
2	3 (1 old + 2 new)	Long duration maize-barley
3	3 (1 old plot extended)	Wheat-short duration maize
4	3 (2 old + 1 new)	Long duration maize-barley
5	3 (2 old + 1 new)	Wheat-short duration maize

The interventions were chosen to be independent of the cropping pattern. They are;

a) Control (open)
b) Run-on controlled (closed)
c) Barrier on risers: a hedgerow of *Flemingia macrophylla* above the riser, and slips of *Setaria* inserted into the riser (between the stones or into the riser as necessary).

The difference in cropping pattern is recognised (Appendix I), but this variability is part of the farm (block) variability and the farmers usually alternate the cropping patterns between seasons. However, there is a need to check if there is a treatment x cropping pattern interaction because if there is, then reporting of results needs to be done for each cropping pattern separately, rather than averaged over cropping patterns. This applies only to the first season (after the 2000-cropping season, all the plots will be converted to the same cropping pattern).

Example of ANOVA:

	DF	
Cropping pattern	1	Overall farm to
Block	3	farm variability
Treatment	2	
Cropping pattern x treatment	2	
RESIDUAL	6	
TOTAL	14	

The low degree of freedom for the residual component means that the residual variation is not well estimated. This is not too serious if the treatment differences are very clear, or if the residual mean square is quite small relative to the treatment mean square. If this is not the case, conclusions from the ANOVA must be interpreted with some caution.

The difference in cropping pattern also leads to the possibility of a treatment x block interaction. This is part of the residual and therefore cannot be investigated in this experiment. The previous data indicates that the control plots (open) can deviate quite widely from the closed plot (Figure 1), thus indicating the presence of an interaction.

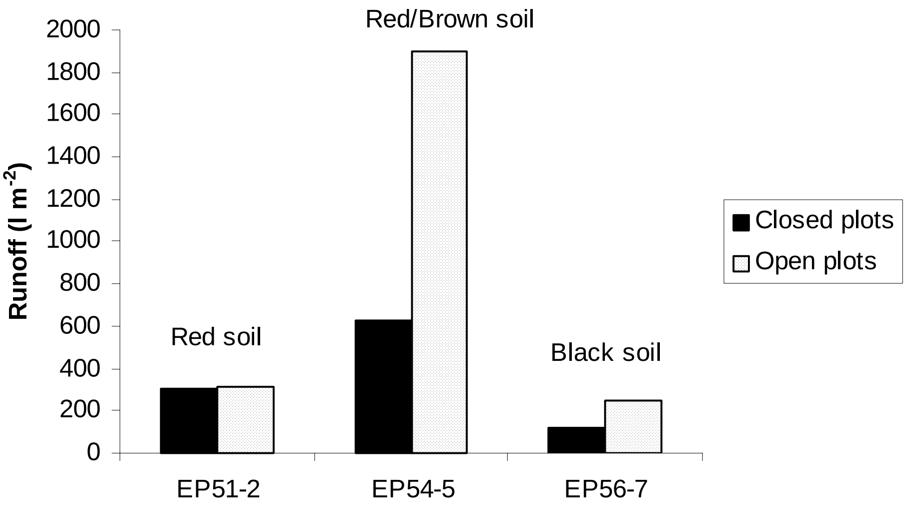


Figure 1. Comparison of runoff from closed and open plots – Landruk 1998 (from draft final report, QMWC, 2000).

However, this reflects the usual farmer situation, so there is some justification to keeping this variation in the statistical testing process. This should be kept in mind at the time of analysis to see how far the interaction appears to exist (by looking at plot means). There may also be a requirement to log transform the data if the homogeneity assumption of ANOVA is violated.

4.1.1.2 Monitoring

4.1.1.2.1 Soil samples

The annual composite soil sample will be taken on a stratified basis from the upper, mid and lower plot (Figure 2).

This gives the opportunity to analyse within-plot variability, and more importantly, the interactions between treatments, cropping pattern and terraced position:

	DF
Cropping pattern	1
Farm	3
Treatment	2
Cropping pattern x treatment	2
Main plot residual	6
MAIN PLOT TOTAL	14
Terrace position	2
Position x treatment	4
Position x cropping pattern	2
Position x cropping pattern x treatment	4
Sub-plot residual	18
SUB-PLOT TOTAL	44

The samples will be analysed for: total and available nitrogen and phosphorus, exchangeable cations, pH, particle size analysis and bulk density.

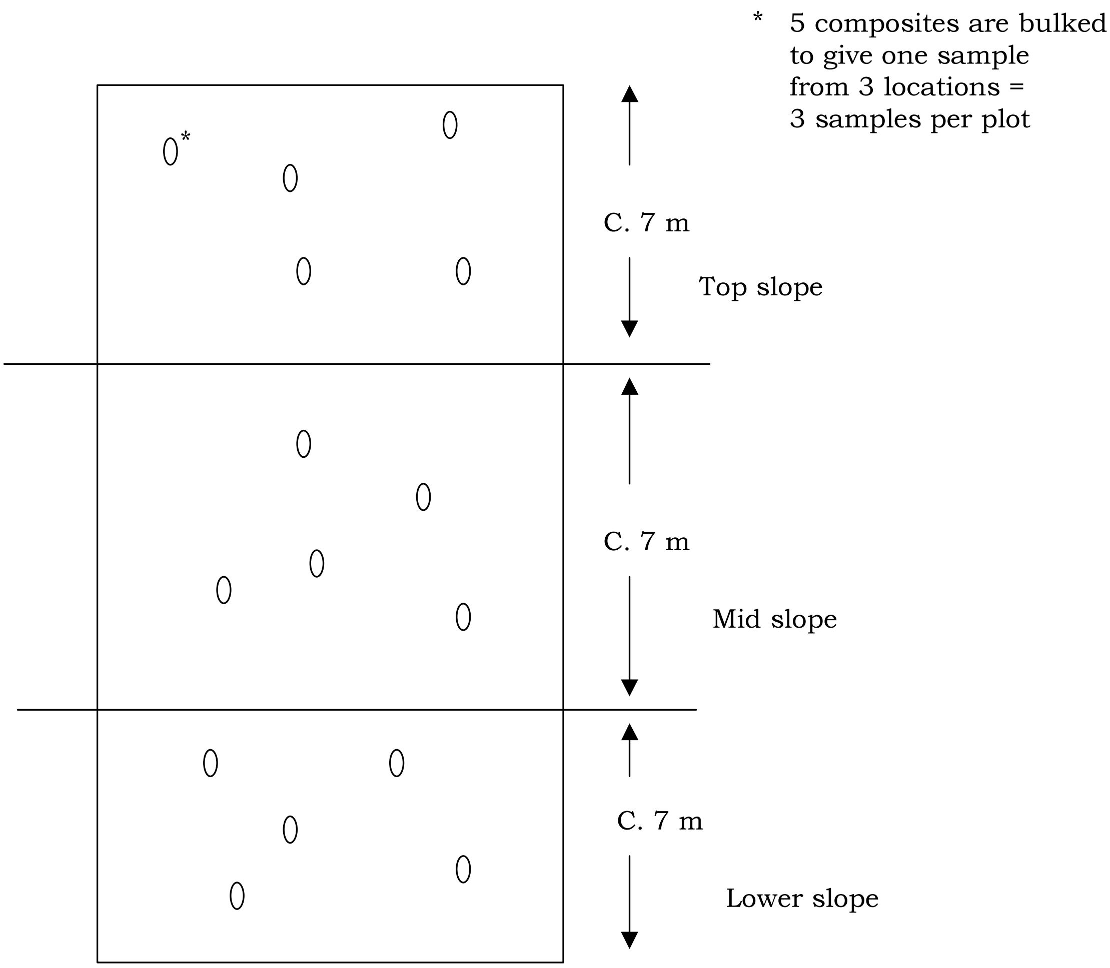


Figure 2. Annual plot soil sampling at Landruk

4.1.1.2.2 Infiltration

In each plot there are 3 lysimeters. A sample will be collected weekly from each lysimeter, and the 3 samples bulked each week. The composite sample will be filtered in the lab. If rainfall exceeds 85mm in any one week there is a risk the lysimeters will overflow. So, if >85mm of rain is measured in the rain gauge, the lysimeters will be emptied. All water collected from the lysimeters in any one week will be bulked to provide a composite sample for the week. In the wet season it will be necessary to have a bottle for storage of the accumulating sample which must be kept as cool as possible – in shade under the house etc. (definitely out of direct sunlight). This will be sub-sampled (100 ml bottles) for return to the lab. The samples will be analysed for total nitrate, ammonium, phosphorus, cations, dissolved organic carbon and pH.

Statistical analyses will account for within-plot variability (section 4.1.1.2.1). Even though nutrient concentrations will be determined on a bulked sample, the separate measurements recorded of leachate volumes will permit separate observations of nutrient amounts.

Soil moisture will be determined at the same time as the lysimeters are emptied using the Theta probes. A qualitative description of soil moisture over time is expected to provide useful insights on the development of soil saturation.

4.1.1.2.3 Runoff water

The drums will be checked on a daily basis and samples will be collected weekly, unless all drums are full, in which case samples taken as frequently as is required and bulked up all over the week. The sample will be taken from the first drum if second and third are empty. The sample will be taken from drum 2 if only drum 3 is empty. The sample will be taken from drum 3 if all 3 drums have water in. The samples will be analysed for total nitrate, ammonium, phosphorus, cations, dissolved organic carbon and pH.

4.1.1.2.4 Runoff sediments

The drum to be sampled will be vigorously stirred and a 1 litre sample taken from it. The sample will be filtered and the filter paper retained for drying and weighing. The soils from the filter paper will be retained over the whole season and bulked together for analysis. The samples will be analysed for total nitrogen and phosphorus, exchangeable cations, pH and particle size analysis.

4.1.1.2.5 Rain

Samples will be collected once a week at the same time as lysimeter/runoff samples, and the total volume recorded for the week. In the wet season, samples will need to be totaled over the week if more frequent measurements are required. The samples will be analysed for total nitrate, ammonium, phosphorus, cations, dissolved organic carbon and pH. Although there will only be one recording per week from the site, these data will be used to calculate a plot level value for run-off and infiltration as a percentage of the amount of rain.

4.1.1.2.6 Crop productivity

Measurements of productivity are actually not fundamental to the testing of the hypothesis. An economic measure for each plot may be appropriate (including the labour implications for each type of intervention). However, given their ease of measurement, and the desirability of describing the productivity of each plot, sub-plots of production will be recorded over the project period. The methodology for this will vary according to the farming system.

4.1.2 Nayatola

4.1.2.1 Experimental design

All plots are under maize-wheat. The interventions are;

a) Control (closed)
b) Strip crops of maize with mulched ginger
c) Strip crops of maize with a legume

Example of ANOVA:

	DF
Block	4
Treatment	2
RESIDUAL	8
TOTAL	14

4.1.2.2. Monitoring

4.1.2.2.1 Soil samples

The annual composite soil sample will be taken on a stratified basis from the upper, mid and lower plot within each type of strip crop (Figure 3).

This gives the opportunity to analyse within-plot variability, restricting to values taken from the maize strips only from the intervention plots:

	DF
Block	4
Treatment	2
Main Plot RESIDUAL	8
Main plot TOTAL	14
Position	2
Position x treatment	4
Sub-plot residual	24
SUB-PLOT TOTAL	44

The samples will be analysed for: total and available nitrogen and phosphorus, exchangeable cations, pH, particle size analysis and bulk density.

A further analysis can examine the differences between the ginger/legume and the maize (ignoring the control plots):

Block (and plots within blocks)	9
Treatment (ginger, legume, maize)	2
Residual	8
Total	19

This design is unbalanced, and the results will be reported as adjusted means, not raw means.

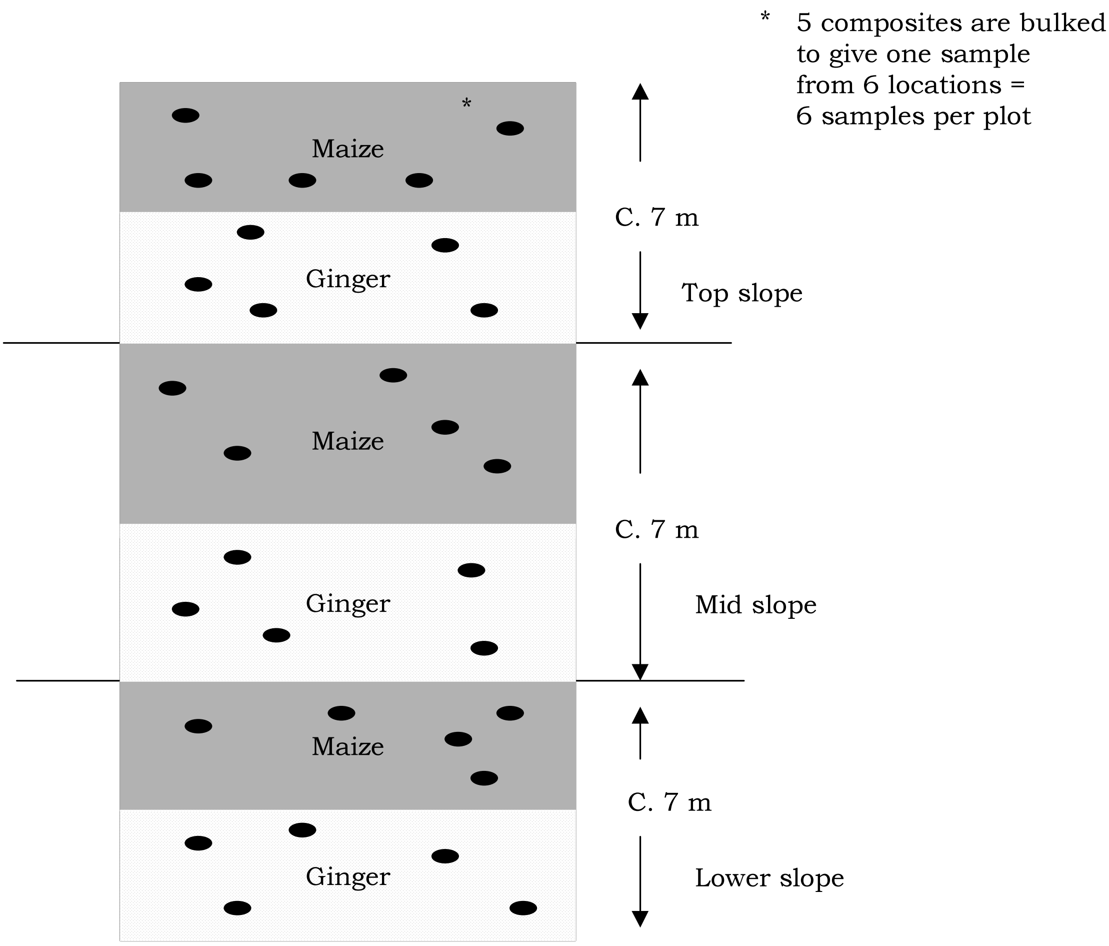


Figure 3. Annual plot soil sampling at Nayatola (Intervention (b) used for illustration)

4.1.2.2.2 Infiltration

In each plot there are 6 lysimeters. A sample will be collected weekly from each lysimeter, and the 3 samples bulked each week from under either the maize or the experimental strip crop. The composite samples will be filtered in the lab. If rainfall exceeds 85mm in any one week there is a risk the lysimeters will overflow. So, if >85mm of rain is measured in the rain gauge, the lysimeters will be emptied. All water collected from the lysimeters in any one week will be bulked to provide a composite sample for the week for each strip type. In the wet season it will be necessary to have a bottle for storage of the accumulating sample which must be kept as cool as possible – in shade under the house etc. (definitely out of direct sunlight). This will be sub-sampled (100 ml bottles) for return to the lab. The samples will be analysed for total nitrate, ammonium, phosphorus, cations, dissolved organic carbon and pH.

Statistical analyses will account for within-plot variability (section 4.1.1.2.1) Even though nutrient concentrations will be determined on a bulked sample, the separate measurements recorded of leachate volumes will permit separate observations of nutrient amounts.

Soil moisture will be determined at the same time as the lysimeters are emptied using the Theta probes.

4.1.2.2.3 Runoff water

As 4.1.1.2.3

4.1.2.2.4 Runoff sediments

As 4.1.1.2.4.

4.1.2.2.5 Rain

As 4.1.1.2.5

4.1.3 Bandipur

4.1.3.1 Experimental design

Farm	Number of plots	Crop
1	1	Maize-millet/upland rice
2	1	Citrus (10 years) intercropped with maize
3	3 (1 plot is 5mx5m)	Maize-millet/upland rice
4	1	Citrus (>20 years)

No interventions are anticipated at this site because of the high degree of variability on cropping patterns, which precludes an experimental approach being taken without the addition of 3 new blocks of plots.

4.1.3.2 Monitoring

4.1.3.2.1 Soil samples

The annual composite soil sample will be taken on a stratified basis from the upper, mid and lower plot (as in Figure 2).

The samples will be analysed for; total and available nitrogen and phosphorus, exchangeable cations, pH, particle size analysis and bulk density.

4.1.3.2.2 Infiltration

In each plot there are 6 lysimeters (3 old design and 3 new design). A sample will be collected weekly from each lysimeter, and the 3 samples bulked each week for each design. The composite samples will be filtered in the lab. If rainfall exceeds 85mm in any one week there is a risk the lysimeters will overflow. So, if >85mm of rain is measured in the rain gauge, the lysimeters will be emptied. All water collected from the lysimeters in any one week will be bulked for each plot to provide a composite sample for the week. In the wet season it will be necessary to have a bottle for storage of the accumulating sample which must be kept as cool as possible – in shade under the house etc. (definitely out of direct sunlight). This will be sub-sampled (100 ml bottles) for return to the lab. The samples will be analysed for total nitrate, ammonium, phosphorus, cations, dissolved organic carbon and pH.

4.1.3.2.3 Runoff water

As 4.1.1.2.3

4.1.3.2.4 Runoff sediments

As 4.1.1.2.4.

4.1.3.2.5 Rain

As 4.1.1.2.5

4.2 Statistical analyses over time

This is only applicable to Landruk and Nayatola. Data from Bandipur will be examined on a descriptive basis only.

4.2.1 ANOVA

An ANOVA a year for each of three seasonal divisions, for each response (mean values, volume weighted means, percentages of rainfall etc.) based on a sensible summary (Figure 4) of the response in the time period. ANOVA's of the slope within each seasonal division, or the time to maximum may be important. However, this will be decided after exploratory data analysis.

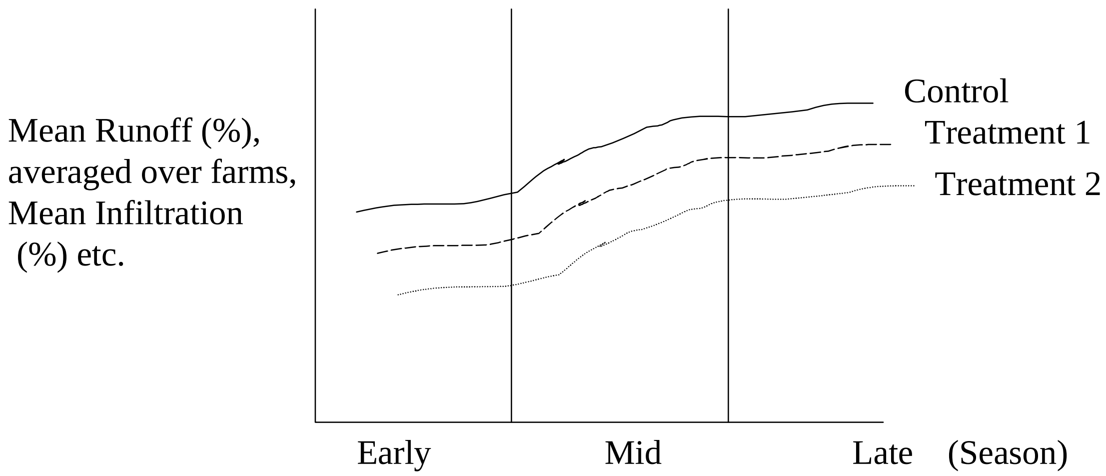


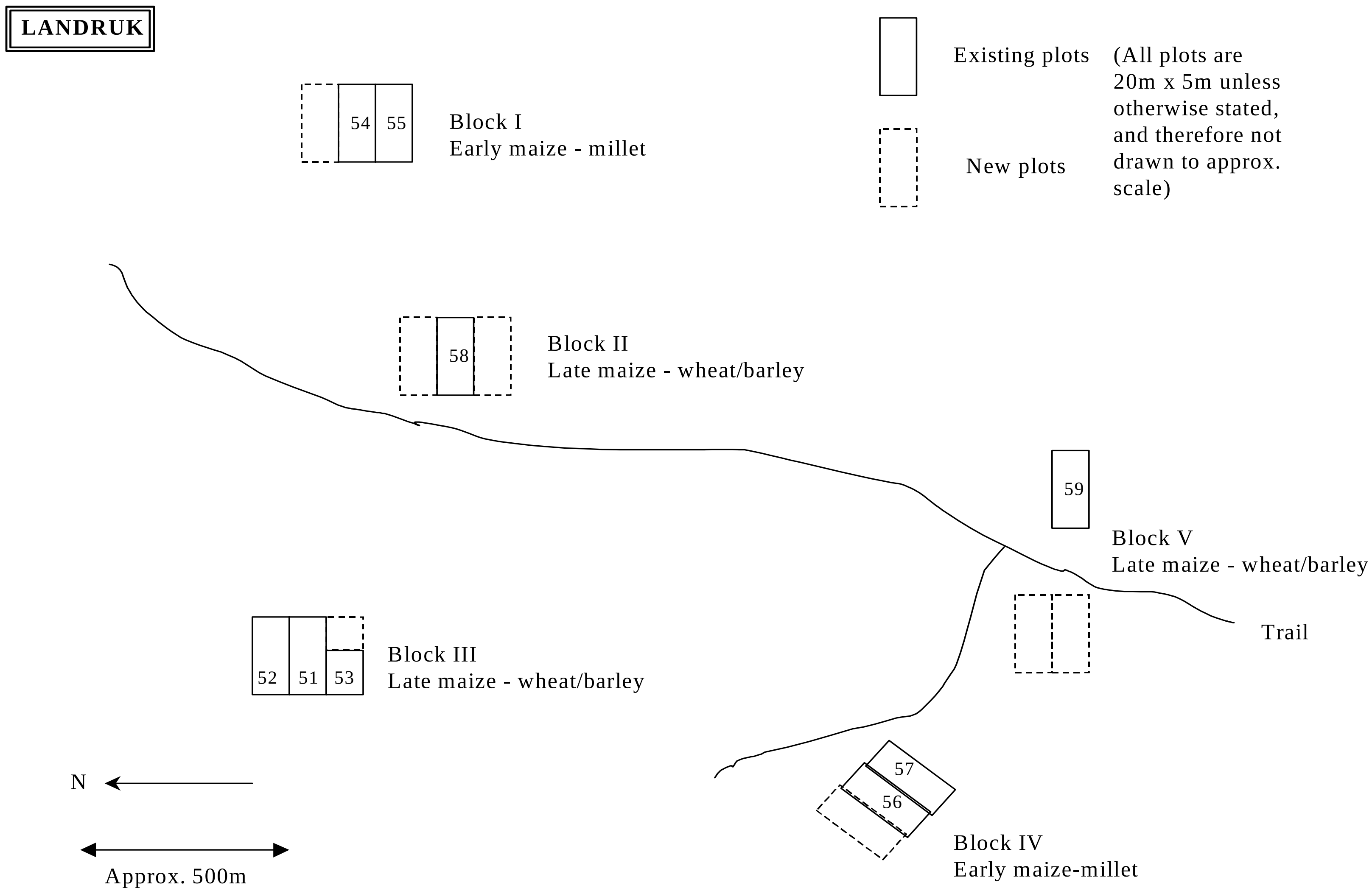
Figure 4. Exploratory data analysis of all weekly measurements to determine a sensible seasonal summary.

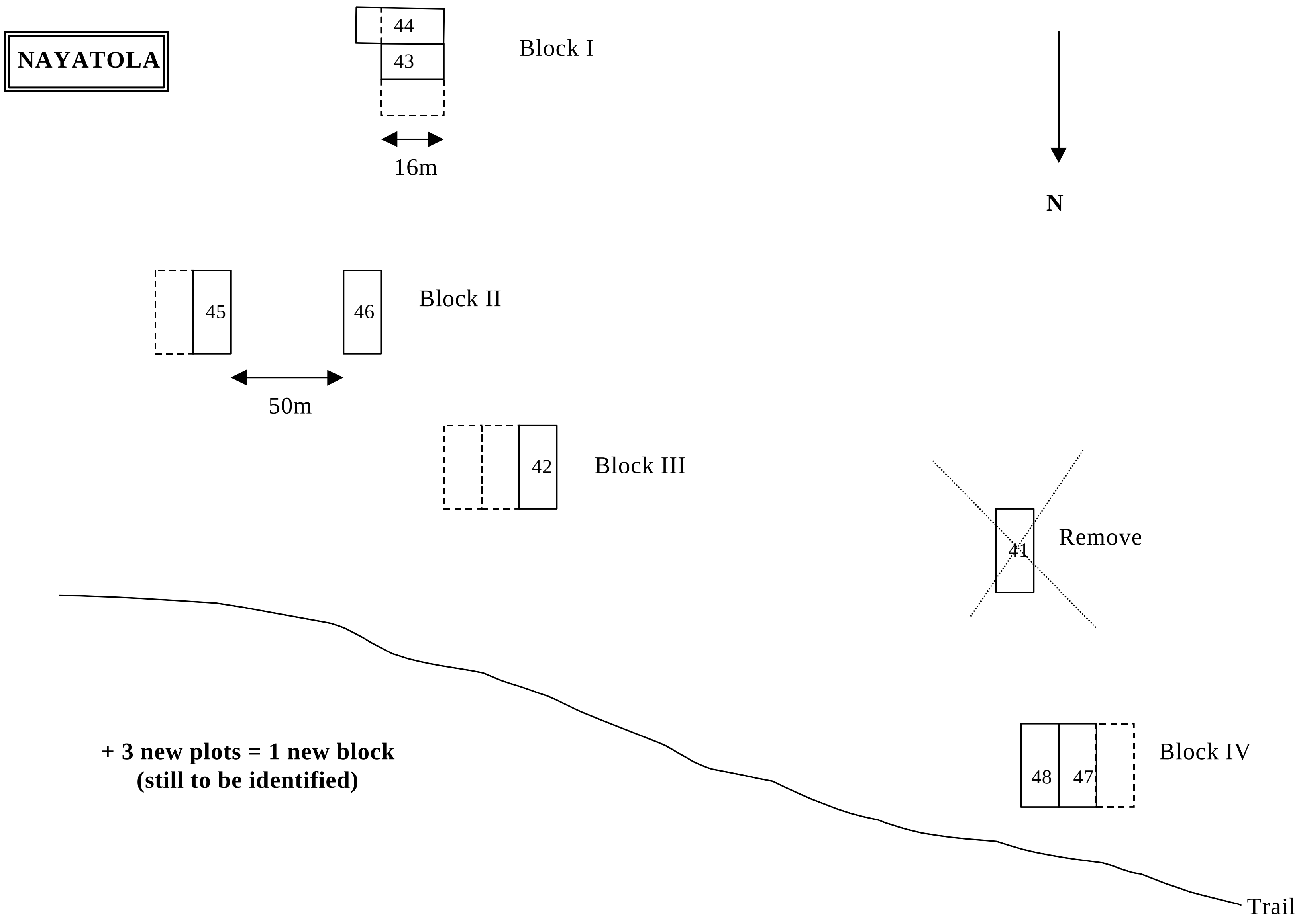
4.2.2 Contrast analysis

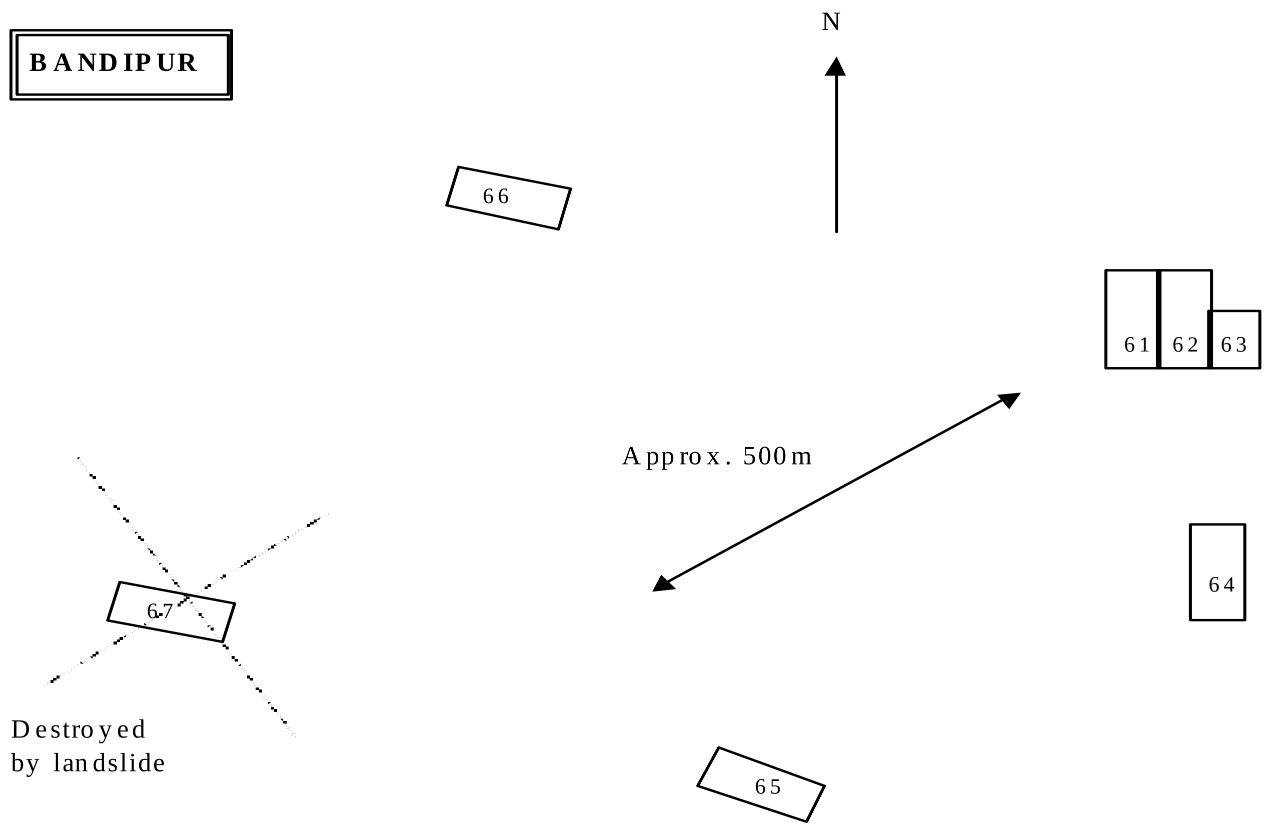
Differences between individual treatment means will be tested by contrasting:

a) Intervention 2 v. Intervention 1.
b) Control v. an average over intervention treatment

Appendix I: Plot layouts




NAYATOLA
44
43
Block I
16m
N
45
46
Block II
50m
42
Block III
41
Remove
+ 3 new plots = 1 new block
(still to be identified)
48
47
Block IV
Trail


BANDIPUR
N
66
61
62
63
Approx. 500m
64
67
Destroyed
by landslide
65

PROTOCOL 3

Initial draft protocol for the Natural Resources Systems Programme (NRSP) Project R7562 title "Methods for consensus building for management of common property resources", led by Julian Barr at the Centre for Land Use and Water Resources Research, University of Newcastle.

1. Project summary [from RD1]

The Purpose is development of methods for community participation in integrated sustainable management of floodplain natural resources. The Output is development of consensus building methods for improved management of common property resources. Fisheries in inland waterbodies is the focus, but a range of stakeholders, not only fishers, will be included. The project links to the Community-Based Fisheries Management-2 (CBFM-2) bilateral project. CBFM-2 NGOs will test a consensus building methodology. This process will be evaluated and used to improve the methodology. Lessons learned in Bangladesh and elsewhere will be reviewed and synthesised as a decision support tool and best practice guide.

2. Problem statement

We will be undertaking a series of structured stakeholder workshops at three locations to discuss options for community-based natural resources management. The aim is to engender mutual learning between (sometimes conflicting) stakeholder groups, to promote collective and empathetic action over resource management. We need to try to assess the level of 'consensus' in the communities before and after the workshops. If there is an increase in consensus compared to a control group, we can attribute it to our workshop process.

Two approaches exist to measuring consensus:

- Measurement of consensus building outcomes:
  e.g. increase in number of agreements reached over management of NRs, establishment of local CB-NRM organisations, increased membership of CB-NRM organisations, and eventually measurable improvements have their been in biodiversity, and production from the common property resources (CPRs).

- Measurement of consensus building process:
  e.g. how much participants in the CB process have learnt about each other's livelihoods, and about each other's use of aquatic NRs, how much has their awareness of the issues in management of aquatic CPRs been raised, and are they more likely to co-operate over CPR management?

Measurement of outcomes is more straightforward, but clearly requires a sufficient period after consensus building activity for action to be taken that can be monitored. This project does not have the time-scale to do this.

Therefore the task is to assess the process of consensus building; essentially to measure whether the workshops have stimulated an attitudinal change in participants that means they are more likely to collectively agreed on CPR management decisions. Community agreement and attitudes that predispose people to co-operate are facets of social cohesiveness. This in turn is a definition of social capital. Thus, a consensus assessment survey (CAS) activity is envisaged which entails the measurement of social capital. The World Bank and DANIDA have recently funded the Social Capital Initiative (SCI) that aims to address just this problem. The project is thus utilising SCI concepts and tools (Krishna & Shrader, 1999; Krishna & Uphoff, 1999) to design a targeted survey that will assess social capital amongst the CPR stakeholders at two points in time.

3. Survey design

Sample size: 120 households (HH)

Two treatments: HH part of consensus building (CB) process
HH not part of CB process [control group]

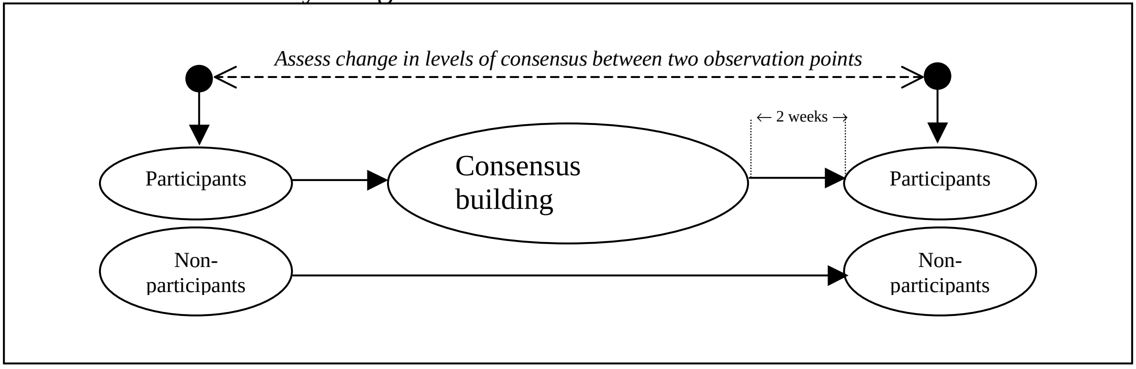
4 sub-treatments: 4 stakeholder groups:

- male heads of households from medium/large agricultural HH (m-Farm)
- male heads of households from landless HH (m-LL)
- female heads of households from landless HH (f-LL)
- male heads of households from fishing HH (m-Fish)

Two periods: A before/after study

- Level of consensus assessed before CB process for participants and non-participants of the CB workshop.
- Level of consensus assessed 2 weeks after the end of workshop for participants and non-participants of the CB workshop.

Schematic of the study design



CAS design and number of HH surveyed.

	Survey point	
Stakeholder group	**Before workshop**	**After workshop**
Stakeholders involved in consensus building workshop		
m-Farm	15	the same 15
m-LL	15	the same 15
f-LL	15	the same 15
m-Fish	15	the same 15
Stakeholders **not** involved in consensus building workshop (*Control group*)		
m-Farm	15	the same 15
m-LL	15	the same 15
f-LL	15	the same 15
m-Fish	15	the same 15

4. The Consensus Assessment Survey (CAS)

Introduction & Background (*to be completed*)
What the research is about…   We are interested in……
The questions are hypothetical, but you should answer as if it was a real situation.
*Need instructions to enumerators.   *Need Bengali version

Key terms: consensus, unity, solidarity, reciprocity, exchange, co-operation, assistance, trust, empathy, willingness to participate, collective action, empowerment, philanthropy

Collective action

1. Overall, what proportion of people in this village participate in community activities?

[ ] 16 Anas: Everybody (1)
[ ] 14 Anas (2)
[ ] 12 Anas (3)
[ ] 10 Anas (4)
[ ] 8 Anas (5)
[ ] 6 Anas (6)
[ ] 4 Anas (7)
[ ] 0 Anas: Nobody (8)
[ ] Don't know (0)
[ ] No answer (9)

Reciprocity & co-operation

2. If it was agreed that an area of the *beel* should be set aside as a fish refuge, and fishing was banned inside that area, what proportion of people would observe this ban?

[ ] 16 Anas: Everybody (1)
[ ] 14 Anas (2)
[ ] 12 Anas (3)
[ ] 10 Anas (4)
[ ] 8 Anas (5)
[ ] 6 Anas (6)
[ ] 4 Anas (7)
[ ] 0 Anas: Nobody (8)
[ ] Don't know (0)
[ ] No answer (9)

3. If a community project does not directly benefit everybody in the village, but benefits poorer people in the community, how many people would contribute time or money to the project?

[ ] 16 Anas: Everybody (1)
[ ] 14 Anas (2)
[ ] 12 Anas (3)
[ ] 10 Anas (4)
[ ] 8 Anas (5)
[ ] 6 Anas (6)
[ ] 4 Anas (7)
[ ] 0 Anas: Nobody (8)
[ ] Don't know (0)
[ ] No answer (9)

Unity

4. To what extent are people in communities around this *beel* in harmony with other users?
Reply on 10 point scale:
1 = as much harmony as I can imagine
10 = I cannot imagine a less harmonious situation

Empowerment

2. How much influence do you think that people like yourself can have in solving disputes over land and water?
Reply on 10 point scale:
1 = what people like me say has no influence in solving these disputes
10 = I cannot imagine people like me having more influence in solving these disputes

Trust

6. Suppose someone in your family faced the following choices, which one would he/she prefer most:

[ ]	Go fishing on their own, getting a catch of 2kg	(1)
[ ]	Go fishing with another person, getting a catch of 5kg	(2)
[ ]	Don't know	(0)
[ ]	No answer	(9)

7. Please tell me *in general* whether you agree or disagree with the following statements:

a. In this village people work together to help each other if they face problems	[1]	[2]	[3]	[4]	[5]	[0]	[9]
b. In this village things happen best when people work together in a group	[1]	[2]	[3]	[4]	[5]	[0]	[9]
c. People in this village are only interested in their own welfare	[1]	[2]	[3]	[4]	[5]	[0]	[9]
d. The way I make a living affects other people in a beneficial or harmful way	[1]	[2]	[3]	[4]	[5]	[0]	[9]
e. Most people in this village do not pay attention to the opinion of others	[1]	[2]	[3]	[4]	[5]	[0]	[9]
f. If there is a problem, there is always someone there to help me	[1]	[2]	[3]	[4]	[5]	[0]	[9]
g. People in this village share a common understanding of the main problems they face	[1]	[2]	[3]	[4]	[5]	[0]	[9]
h. If people here face a problem with a neighbour they would prefer to negotiate with them rather than enter into a conflict with them	[1]	[2]	[3]	[4]	[5]	[0]	[9]
i. People this here around this *beel* look out mainly for their own interests and are not much concerned with the welfare of the area as a whole.	[1]	[2]	[3]	[4]	[5]	[0]	[9]
j. People like me in this village have the same interests as similar people in other villages around this *beel*.	[1]	[2]	[3]	[4]	[5]	[0]	[9]

[1]	Strongly agree;	[2]	Agree;	[3]	Neither agree nor disagree
[4]	Disagree;	[5]	Strongly disagree		
[0]	Don't know;	[9]	No answer		

8. Please tell which of the following local institutions you are a member of:
Beel Management Committee, Mosque Committee, Women's Group, etc….

5. Notes

- We have field-tested the CAS questionnaire in Bangladesh, and the questions seem to work, and respondents understand how the answering systems work
- The questions requiring answers in proportions (e.g. half the village) use '*anas*' as the answer system. This system comes from the local currency; there are 16 *anas* in one *taka*. Rural people are familiar with using this 16-base system for proportions; e.g. 4 *anas* is 25%.

- An anchored 10 point scale system, developed by ICLARM, is used on other questions. The end points of the scale (anchors) are defined by respondents. I think this is OK because we will be measuring change in response over time from exactly the same respondents.
- The survey design and sample size are constrained by the available time and staff resources.

6. References

Deepa Narayan and Lant Pritchett (July, 1997) *Cents and Sociability: Household Income and Social Capital in Rural Tanzania*. World Bank.
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