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METHODS FOR PARTICIPATORY INFORMATION GATHERING AND ANALYSIS

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SUMMARY

A methodology for the collection of ranks and scores, and their subsequent statistical analysis was developed during Participatory Rural Appraisals (PRAs) for aquaculture research projects in West Bengal, Eastern India and in Karnataka, Southern India. In order to assess the variation within the community, the criteria for ranking and scoring collected from group discussions with men and women groups, were subsequently ranked and / or scored by the individuals. Three nonparametric statistical tests were compared for the analysis. Friedman two-way analysis of variance, Kendall's coefficient of concordance, and Mood's median test were evaluated in terms of a) the usefulness of analysis output, and b) their ease of use in the field situation. The Friedman test was found to be the most suitable for analysing ranks, as this test has an additional facility enabling pairwise comparisons of groups of ranks, thus establishing the relative order of importance. Because ranks were more easily understood by farmers and thus more reliably collected by extension staff, and the favoured analysis converts scores to ranks, it is recommended that ranks are used in preference to scores, and that midranks are used for tied ranks.

INTRODUCTION

There are two research project associated with this research. The 'Small-scale farmer-managed aquaculture in engineered water systems' aims to investigate the potential for integration of aquaculture into small-scale irrigation systems managed by resource-poor farmers in arid and semi-arid regions of India and Sri Lanka. The 'East India rainfed farming integrated aquaculture' project investigates options for integrated aquaculture in small on-farm water resources in Eastern India. Both projects are funded by the Department for International Development (DFID) and co-ordinated by the Institute of Aquaculture, University of Stirling.

The benefits of encouraging the participation of the local community in agriculture development and research projects are well established (see e.g. Chambers, 1992; Gosling & Edwards, 1995; ODA, 1995). Funding agencies and local governments recognise the need to incorporate local knowledge and priorities into project aims and planning, and therefore encourage 'bottom up' participatory approaches. These aim to empower beneficiaries by involving them as far as possible at all stages of the development process, with the aim of increasing the sustainability of initiatives (Chambers, 1992). Commonly techniques from Rapid Rural Appraisals (RRAs) and

Participatory Rural Appraisals (PRAs) are used for the assembly of information with communities, either in conjunction with more formal survey techniques (such as questionnaires) or as the sole means of data collection. Whereas there is general agreement that the qualitative data collected using RRA and PRA techniques are essential for gaining an understanding of local situations (e.g. Chambers, 1992; Gill, 1993), several authors have expressed a need for more rigorous methodology for the collection and analysis of qualitative data (e.g. Fielding & Fielding, 1986; Martin & Sherington, 1996; Farrington *et al.*, 1997).

Participatory assessments are often carried out with community groups. Whilst interacting with groups enables fast access to a large amount of information, Farrington & Martin (1988) mention the problem of assuming homogeneity within groups. Fielding & Fielding (1986) recommend the use of person-triangulation to assess the level of agreement between individuals, and highlight the need for the development of a method for assessing the variation within communities in relation to e.g. gender or social status.

In a review of 60 papers on participatory farming systems from a range of agricultural journals, Riley & Alexander (1997) found that statistical methodology was often poorly defined and inadequately used. Discussion of collected data was often the only method of data summary, particularly when data were qualitative. Therefore rural appraisal data collected using participatory methods are often perceived to lack scientific rigour, mainly because the data generated are difficult to quantify (Farrington *et al.*, 1997). To date very little material has been published on the statistical analysis of data generated from participatory research. Maxwell & Bart (1995) recommend the use of scores in preference to ranks as these contain more information and are easier to analyse, and suggest that further research be carried out on different techniques of ranking and scoring and their analysis.

As a response to the criticism of participatory methodology, Martin & Sherington (1996) recommend that the relevance of existing statistical techniques be evaluated for different participatory research situations. They suggest that relevant reference material be produced, e.g. by providing a set of case studies of detailed analyses, using a range of statistical ideas and techniques. In particular these authors recommend the development of guidelines on the analysis of ranked observations and hierarchical data / multi-level models. Farrington *et al.* (1997) also highlights the need for more examples on how to carry out statistical analysis of field data.

Considering the field-based nature of most participatory information gathering as well as the need for rapid analysis for swift feedback to the community, it is preferable to keep statistical analysis of data simple and easy to carry out, i.e. to avoid the use of complicated and expensive statistical software.

The aim of the present study was to develop a methodology for the collection of ranks and scores from farmers belonging to different sectors of rural communities. A further aim was to evaluate the usefulness of nonparametric statistical tests in the analysis of ranks and scores from participatory research in terms of a) the relevance and usefulness of the results generated and b) their ease of use in a field situation in a developing country.

MATERIALS AND METHODS

Collection of data

Participatory Rural Appraisal (PRA) was conducted in six villages in West Bengal and four villages in Raichur District, Karnataka between March, 1998 and March 1999. Fieldwork was carried out in Karnataka in collaboration with the local NGO Samuha and in West Bengal in collaboration with the Eastern India Rainfed Farming Project (EIRFP). On the basis of a review of secondary data about the areas, villages were selected which had a greater number of small-scale farmer-managed water bodies with potential for aquaculture as well as high numbers of people belonging to lower income groups (such as the governmentally identified Scheduled Castes and Scheduled Tribes).

Following the recommendations of Shah *et al.* (1991) and Gosling & Edwards (1995), group meetings and discussions were arranged (at times suitable for villagers) in all villages. Separate meetings for men and women were held in an attempt to avoid men dominating the meetings. The meetings served to introduce the research team and to provide a forum for group discussions on topics such as the history of the village, the common crops, livelihood strategies of farmers and the indigenous knowledge of fish and aquaculture. A local facilitator (a EIRFP Community Organiser or an officer from the NGO Samuha) was assigned the special task of encouraging everybody present to participate in discussions. At the group meetings questions were put to village groups to identify parameters to be ranked or scored by individuals later. For example in the village of Pai Doddi (Karnataka), villagers were asked what types of meat they normally eat, and after a list of different types of meat had been established, individual villagers willing to participate in more detailed research were identified. Results from the men and women's group meetings were fed back to a plenary of men and women to ensure that everybody understood all parameters identified before ranking or scoring them.

Wealth ranking was carried out to establish the different wealth groups present in the village. According to Fernandez et al. (1995), wealth ranking is most successful when carried out in private by knowledgeable individuals of middle income. Thus older influential men and women with sufficient knowledge about the community were asked to categorise community households into different wealth groups. Subsequent interviews included individuals from the different wealth groups identified, different castes present in the village, men and women, and landed and landless. Farm walks and semi-structured interviews were conducted with these individuals (are we allowed footnotes in this journal?)[1], who also ranked and / or scored the parameters identified at the village group level. Cards depicting the different parameters were sorted in order of importance (ranked) by the villager. The cards were then mixed and scoring was carried out by distributing a fixed number of small stones (e.g. 5+4+3+2+1= stones for 5 cards) on the cards.

Initially all the parameters identified by the villagers in group meetings were both ranked and scored by individuals, and ranks and scores which did not correspond were discarded.

[1] Which are reported elsewhere

Statistical analysis

Three statistical tests suitable for the analysis of ranks and scores (Mood median test, Friedman two-way analysis of variance and Kendall coefficient of concordance) were used to analyse the ranks and scores collected.

Mood Median Test

To carry out the Mood Median test, the overall median of all ranks or scores is computed. For each parameter the number of observations less than or equal to the overall median, and the number of observations greater than the overall median are recorded. A Chi-square test for association is done on this table, and large values of Chi-square indicate that the null hypothesis is false. The test can be used on both ranks and scores, and no modification for tied ranks is needed. Only groups containing two or more observations (ranks or scores) can be included in the analysis. A summary of the procedures for using the median test is outlined in Box 1.

<Box 1>

Kendall Coefficient of Concordance

For the calculation of the Kendall coefficient of concordance, *W*, the data should be in form of ranks, and scores should therefore be converted to ranks prior to analysis. A modification of the test should be used in the case of tied ranks. A summary of the procedures for computing *W* can be found in Box 2.

<Box 2>

Friedman Two-Way Analysis of Variance

As is the case for the Kendall coefficient of concordance, data is ranked and the sum of the ranks calculated before the Friedman two-way analysis of variance is carried out. Box 3 provides a summary of the procedures for conducting the Friedman two-way analysis of variance.

<Box 3>

RESULTS AND DISCUSSION

Ranking and scoring exercises

Establishing ranking and scoring criteria at the village level aimed to ensure that no important parameters were left out. All villagers ranked / scored the same parameters, to facilitate later statistical analysis. An example of ranks from the village Pai Doddi can be seen in Table 1, and the results of Mood median test, Kendall coefficient of concordance and Friedman two-way analysis of variance tests can be seen in Table 2.

<Table 1>

<Table 2>

Both ranking and scoring were done in order to compare the two and to ensure that villagers understood the exercises. Any confusion or lack of understanding of the methods should be detectable by comparison of ranks and scores, and if the two did

not correspond results could then be discarded. However, both ranking and scoring all parameters proved very repetitive and time consuming with the result that farmers started to lose interest. In this regard, Gosling & Edwards (1995) and Farrington *et al.* (1997) recommend that individual interviews should not exceed 45 minutes, and questions should not be repeated. It is therefore suggested that rather than carrying out tedious exercises to establish the reliability of the data, it may prove easier to ask informal questions as part of the semi-structured interview to double-check information such as the relative importance of the different uses of water.

Scoring was chosen over ranking because it contains more information (Maxwell & Bart, 1995; Lawrence *et al*., 1997). However farmers found it conceptually more difficult to assign values to parameters by dividing a number of stones between cards than to sort them in order of importance. Unlike scoring, ranking forces farmers to chose between parameters that may hold for them the same importance; an issue often raised during the exercises. However this is avoided, if midranks are used for tied ranks where villagers indicate that a number of parameters are of similar importance.

Data analysis

Table 1 would indicate that villagers agree that irrigation is the most important use of their water bodies in Pai Doddi.

The Mood median test establishes if villagers assign the different parameters the same importance (in ranks or scores). The null hypothesis that all medians are equal is tested by determining if the distribution of values either side of a common median differs for two or more unrelated samples (Cramer, 1997). The Mood median test is quick and easy to perform using either a pocket calculator or a statistical program such as Minitab. However this test assumes that the samples are unrelated, whereas in fact the same villagers rank or score all parameters.

Statistics that can determine the level of agreement between villagers for related samples include the Kendall coefficient of concordance and the Friedman two-way analysis of variance by ranks.

The Kendall coefficient of concordance, W, provides an indication of the association between several rankings of different parameters. W ranges between 0 and 1, with 1 designating perfect concordance, and 0 indicating no agreement or independence of samples (Gibbons, 1971). If W is close to 1 it indicates that villagers agree on the relative importance of different parameters. In order to find the true ranking of the objects, Kendall (1970) suggests that parameters be ranked according to the sums of ranks. Whilst this method is useful for providing an overall picture of the relative importance of different parameters, it does not provide any indication of which values are significantly different.

The Friedman two-way analysis of variance tests the null hypothesis that the samples have all been drawn from the same population or populations with the same median. The test determines whether the rank totals for each parameter differ significantly from the values, which would be expected by chance.

The Friedman two-way analysis of variance and the Kendall coefficient of concordance are linearly related (Siegel & Castellan, 1988), and as such provide

similar results. An extension of the Friedman test does however allow multiple comparisons of different ranks, thus enabling the user to identify significant differences between the importance of parameters ranked. As is the case for the Kendall statistic, data have to be converted to ranks prior to analysis, and modifications exist for tied ranks. Both tests are easily calculated on a pocket calculator, or using a simple spreadsheet, and the Friedman test is furthermore available in Minitab.

The three tests can all be used to analyse ranks and scores. Because the Mood median test cannot incorporate information for related samples, it is recommended that the Kendall coefficient of concordance or the Friedman test be used in preference to the Mood test. Of these only the Friedman test allows a follow-up comparison between individual parameters, and it is therefore recommended that this test be used for the analysis of ranks or scores.

For both the Kendall coefficient of concordance and the Friedman two-way analysis of variance scores must be converted to ranks prior to analysis, and the extra information contained in the scores is therefore lost. Thus scores offer no extra advantages over ranks if these tests are used. However if scores show a normal distribution they can be analysed using parametric tests such as analysis of variance.

Key recommendations

1. Introduce research team and research objectives at a village meeting at a time suitable for villagers. Ensure that both men and women participate by separating the meeting into two different venues, one for men with a male research team and one for women with a female research team. Feedback the results to a plenary of men and women to ensure that everybody understands the parameters identified. If possible aim to include people from all social (income and caste) groups. For this a facilitator specifically assigned to the task of engaging more quiet individuals in the discussion may prove useful.
2. Identify parameters for ranking and scoring exercises at group meetings. Carry out wealth ranking with individuals knowledgeable of the village households. Also identify villagers willing to participate in individual interviews, and ensure that all geographic areas, social groups, castes etc. are represented amongst these individuals.
3. Rank criteria identified at group meetings with individual villagers. If a villager indicates that several parameters have the same importance, use midranks for the tied ranks.
4. Analyse ranks using the Friedman's statistic. Use modifications for tied ranks if appropriate. If significant differences are found, use the pair-wise comparison extension of the Friedman test to determine which differences are significant. If no agreement amongst villagers is found, try the Friedman test for different sub-groups (e.g. gender, caste, wealth groups) to test for agreement within these.
5. Triangulate information obtained (e.g. group meetings versus individual interview, husband versus wife, ranking versus interviews etc.).

The observations, which inform this work, come from fieldwork carried out with our collaborators, Samuha in Karnataka and with the Eastern India Rainfed Farming Project (EIRFP) in West Bengal. We gratefully acknowledge research funds from NRSP High Potential Systems Programme for the work in eastern India and DFID Aquaculture Research Programme for the work carried out in Karnataka. We would especially like to thank, Mr J S Gangwar (KRIHBCO, EIRFP Manager) and Mr Steve Jones (Centre for Development Studies) and Mr T Pradeep (Secretary SAMUHA) for agreeing to collaborate and for their excellent support. We would like to acknowledge the crucial facilitation and field support provided by our colleagues. In particular, Virendra Singh, Gautam Dutta, Smita Shweta, Brajendu Kumar, Mr Gulshan Arora, Mr Natarajan, Pinki Singha, Ms Subudra, Ms Jheenook at EIRFP, Francis Murray (IoA) and Mr S K Somashekar, Mr Raghu Kumar, Ms Gouri, Ms Veena, Ms Brema, Ms Gheeta, and Mr Sangappa at SAMUHA. Whilst many of the above contributed to the ideas of the paper the views expressed are those of the authors and do not necessarily reflect those of DFID, SAMUHA or EIRFP.

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TABLES AND BOXES

Table 1: *The number of villagers in Pai Doddi village assigning the ranks from 1 (least important) to 5 (most important) to the different uses of their water bodies.* R_j / R_i *denotes the sum of the ranks, and N the total number of villagers ranking.*

Rank	Livestock consumption	Irrigation	Clothes washing	Household use
4	xxxx	xxxxxx		x
3	xxxxx	xxx	xx	x
2	xx	x	xxx	xxxxx
1		x	xxxxxx	xxxx
R_i / R_j	35	36	18	21
N	11	11	11	11

Table 2. *Results of the statistical analysis of the data shown in Table 1.*

Test	Result
Mood median test	$\chi^2 \geq 17.816$ for $df = 3$ has probability of occurrence below .001. Since this p is smaller than a significance level of $\propto = .05$, on the basis of these data, the null hypothesis that there are no significant differences between the importance of the four different water uses can be rejected.
Kendall coefficient of concordance	$W = 0.431$ showing that the rankings are not independent or that the farmers are applying essentially the same standard in ranking the four parameters. According to Kendall (1970) the best approximation to the 'true' ranking of parameters may be taken to be the order of the various sums of ranks R_i. If this method is used, we can conclude that the order of importance is irrigation > livestock consumption > household use > clothes washing, where > = more important than. The closeness of the sum of the ranks for irrigation and livestock consumption would indicate a less significant difference than for example that between livestock consumption and clothes washing.
Friedman two-way analysis of variance	$F_r = 14.24$ for $df = 3$ is significant at between the .01 and .001 levels. If a significance level of $\propto = .05$ is used, the null hypothesis can be rejected, and it can be concluded that respondents agree that there is a significant difference between the importance of the different uses of their water bodies. If the value of F_r had been smaller and H_0 accepted, we would conclude that there is poor agreement between respondents about the importance of use of waterbodies. In that case it may be possible to identify sub-groups within the community (e.g. men and women, different castes or wealth groups) within which agreement can be found. The results indicate that at least one of the water uses is perceived by the villagers to be more important than at least one other food type. The significance of individual pairs of differences can be tested using the extension of the Friedman test. If the $\propto = .05$ level of significance is used, the critical difference is 15.97, and it can therefore be concluded that there is general agreement between the villagers interviewed that irrigation is significantly more important than clothes washing, and that livestock consumption is significantly more important than clothes washing. Despite the evidence from Table 1 that both irrigation and livestock consumption are more important uses than household use, this difference is not significant at the $\propto = .05$ level.

Box 1. *Summary of the procedure for carrying out a Mood median test.*

1. Determine the common median of the ranks or scores in the k groups (ranking parameters)
2. Assign pluses to all scores above that median and minuses to all scores below, thereby splitting each of the k groups of scores at the common median. Cast the resulting frequencies in a $k \times 2$ table.
3. Using the data in that table, compute the value of χ^2 as given by

$$\chi^2 = \sum_{i=1}^{r} \sum_{j=1}^{k} \frac{(O_{ij} - E_{ij})}{E_{ij}} \quad (1)$$

Where O_{ij} = observed number of cases categorised in ith row of jth column
E_{ij} = number of cases expected under H_0 to be categorised in ith row of jth column, and

$\sum_{i=1}^{r} \sum_{j=1}^{k}$ directs one to sum over all cells.

Determine $df = k - 1$.

4. Determine the significance of the observed value of χ^2 by reference to a table of critical values of Chi-square (as found e.g. in Siegel & Castellan, 1988). If the associated probability given for values as large as the observed value of χ^2 is equal to or smaller than $\propto$, reject H_0 in favour of H_1.

Box 2. *Summary of procedure for computing the Kendall coefficient of concordance.*

1. Construct a $k \times N$ table, where N represent parameters being ranked and k the number of farmers assigning ranks.
2. For each column, calculate the sum of the ranks, R_I,.
3. Calculate the square of each of these sums, R_i^2.
4. If there are no ties, calculate W using

$$W = \frac{12\sum R_i^2 - 3k^2N(N+1)}{k^2N(N^2-1)} \qquad (2).$$

where
k = number of judges
N = number of objects being ranked
$N(N^2 - 1)/12$ = maximum possible sum of the squared deviations (the numerator which would occur if there were perfect agreement among the k rankings and the average rankings were 1, 2, …, N.
and $\sum R_i^2$ is the sum of the squared sums of ranks for each of the N objects or individuals being ranked

5. If the ranks have ties, assign midranks and compute W using

$$W = \frac{12\sum \overline{R}_i^2 - 3N(N+1)^2}{N(N^2-1) - (\sum T_j)/k} \qquad (3)$$

or

$$W = \frac{12\sum R_i^2 - 3k^2N(N+1)^2}{k^2N(N^2-1) - k\sum T_j} \qquad (4)$$

where

$$T_j = \sum_{i=1}^{\vartheta j} (t_i^3 - t_i) \qquad (5)$$

where t_i is the number of tied ranks in the ith grouping of ties, and ϑ_j is the number of groups of ties in the jth set of ranks. ΣT_j is the sum of the values of T_j for all of the k sets of rankings.

6. If $N \leq 7$, a table of critical values for the Kendall coefficient of concordance W (as can be found in e.g. Siegel & Castellan, 1988) gives critical values of W for significance levels $\propto = .05$ and $\propto = .01$.
7. If $N > 7$, use

$$X^2 = k(N-1)W \qquad (6)$$

8. to compute X^2, which is approximately distributed as chi square. Test the significance of this for $df = N - 1$ by using a table of critical values of Chi-square (as found e.g. in Siegel & Castellan, 1988). If W is larger than the critical value found by using either of these two tables, reject H_0 and conclude that the rankings are not independent.

In order to find the true ranking of the objects, Kendall (1970) suggests that parameters be ranked according to the sums of ranks.

Box 3. *Summary of procedure for computing the Friedman two-way analysis of variance.*

1. Arrange the ranks in a two-way table having N rows (farmers) and k columns (parameters).
2. Determine the sum of the ranks in each column (R_j).
3. Calculate F_r using

$$F_r = \left[\frac{12}{Nk(k+1)} \sum_{j=1}^{k} R_j^2 \right] - 3N(k+1) \qquad (7)$$

where
N = number of rows (farmers)
k = number of columns (parameters ranked)
R_j = sum of ranks in the jth column

$\sum_{j=1}^{k}$ = sum of squares of the sums of ranks over all conditions.

if there are no ties or

$$F_r = \frac{12\sum_{j=1}^{k} R_j^2 - 3N^2k(k+1)^2}{Nk(k+1) + \frac{(Nk - \sum_{i=1}^{N}\sum_{j=1}^{\vartheta i} t_{i.j}^3)}{(k-1)}} \qquad (8)$$

where ϑ_I = the number of sets of tied ranks in the ith group
$t_{i,j}$ is the size of the jth set of tied ranks in the ith group.
if there are tied ranks in any row.

4. For small N and k, critical values of F_r can be found in a table of the Friedman two-way analysis of variance by ranks statistic, F_r (as found e.g. in Siegel & Castellan, 1988). For large N and / or k, use a table of critical values of Chi-square (e.g. as found in Siegel & Castellan, 1988) to find the associated probability from the χ^2 distribution, with $df = k - 1$.
5. If the probability is equal to or less than $\propto$, reject H_0.
6. If H_0 is rejected, use multiple comparisons

$$|R_u - R_v| \geq z_{\alpha / k(k-1)} \sqrt{\frac{Nk(k+1)}{6}} \qquad (9)$$

where $|R_u - R_v|$ = the differences between all pairs of parameters
and z can be found in a table of critical z values for #c multiple comparisons (as found in e.g. Siegel & Castellan, 1988), with #c = $k(k-1)/2$. For larger #c values use a table of probabilities associated with the upper tail of the normal distribution (as e.g. found in Siegel & Castellan, 1988) to determine significant differences between parameters.