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Research project prioritization through training in analytic hierarchy process: case study of a village in Semi-Arid region of Central India

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Abstract

Agricultural scientists of various cadres were trained in analytic hierarchy process (AHP); later in interdisciplinary groups they prioritized the research interventions for solving the problem as given to them through a 'participatory case study' of a village. This case study is the abstracted draft report of the two agro-ecosystem field studies separately conducted by International Center for development oriented Research in Agriculture (ICRA), The Netherlands and National Academy of Agricultural Research Management (NAARM) in collaboration with Indian Grassland & Fodder Research Institute (IGFRI), a locally situated institution. First one is divergent and broad study of complete region, and second one is convergent and specific constraint-opportunity analysis of a village in zone-3 of ICRA study. The paper describes perceptions of off-site and on-site scientists of various cadres towards AHP, its application and analysis of prioritized group decisions.

Key Words: Group decision, livestock, participatory, resource allocation

Introduction

In the present time, prioritization based research agenda has become the necessity of most public institutions, where priority is not guided by economic profit only, rather various exogenous and endogenous factors play important role in decision making. But decisions are often not in line of decisions of primary stakeholders; it is especially true at micro-level (research project development) by agricultural scientists. Farmers' knowledge and resource set-up evolve their own expectations, and scientists' knowledge and institutional resources decide their own expected outcomes; in public institutions mismatch of these two is quite common. A scientifically proven instrument and process is required to facilitate interactive and common decisions for prioritization of research agenda and resource allocation to it; these decisions would be based on knowledge, experience and resources of farmers on one hand and of scientists' on the other hand. Unfortunately significant numbers of agricultural scientists are not aware of these methodologies therefore research objectives are often not in tune of farmers' goals. Mostly research objectives are based on single criteria like economic efficiency (Alston and Pardey, 1995), which are of limited importance (Bromley, 1990) certain other objectives are also important, therefore, Wood and Pardey (1994) favor economic-ecological approach.

During past, in public funded research, little attention is paid to the priority setting as process (Norton *et al*., 1992). At top level, priorities are guided by a few economic and social criteria; at lower (project selection and resource allocation) level, decisions of senior managers play significant role in directing priorities. Recently, key stakeholders like donors started putting pressure on issues like participation and group consensus in decision-making, which are not solely based on hard-core mathematical formulae. Such an approach with efficiency and non-efficiency criteria establishes a systematic priority setting process. Benefits of systematic and participatory are recognized but most public institutions do not like systematic priority setting (Mac Kenzie, 1996) because of various reasons including unawareness about methodologies. Analytic Hierarchy Process (AHP) a multi-criteria methodology by T.L. Saaty as discussed by Saaty and Kearns (1985) fits well into framework of systems oriented systematic priority setting, it is based on trade offs and relative importance of criteria and research alternatives as perceived by various stakeholders. AHP has discriminating potential, structured (Randolph *et al*., 2001), consider tangible and intangible values (Dyer and Forman, 1992) and arouse interest of uninterested through interactive group discussion (Hartwich and Oppen, 2000). Other major prioritization methods have certain limitations e.g. congruence method prioritize resource allocation to research area in proportion to the relative value of production (Anderson and Parton, 1983), cost-benefit ratio method function more in market framework, Domestic Resource

Cost ratio method is more or less type of cost-benefit ratio analysis.

AHP is not free of limitations, lots of research studies are available on this issue, but major limitation is that scholars are not aware of its methodology and application (Hartwich and Janssen, 2000) this is particularly true in case of scientists of National Agricultural Research System (NARS) of India. In agricultural research solitary prioritization studies of AHP applications are available, these are- technology choice by Ramanujam and Saaty (1981), biotechnology project selection in Chile by Braunschweig (2000), and resource allocation in agricultural research and development by Rohrback and Pingsun (1991). Other research papers available on AHP applications in agriculture mostly describe AHP methodology on the basis of hypothetical examples (Harker, 1989; Hartwich and Janssen, 2000) the actual studies are less available (Braunschweig, 2000). Plenty of AHP based prioritization studies are available in other management subjects such as- finance, marketing (Anderson et al., 2000), industrial project selection (Dey, 2002), information system project selection (Schniederjans and Wilson, 1991, and academic areas like career choice (Canada *et al.*, 1985), and performance evaluation (Chan and Lynn, 1991).

Utility and validity of AHP is well documented and unquestioned but unawareness among agricultural scientists is also well recognized, therefore during 2000, author introduced AHP in various training programs of National Academy of Agricultural Research Management (NAARM) to serve as new prioritization methodology for selecting research alternatives and finalizing resource allocation to different research portfolios. Traditional statistical measurements are not part and parcel of it, and core principle is human perceptions based judgment values that are given by the decision makers, these values are reflections of their knowledge, experience and systems thinking. Therefore, introduction of AHP raised some apprehensions about its establishment as systems oriented prioritization methodology in agricultural research, thus present assignment was done with the objectives of evaluation and validation of AHP as systems and systematic agricultural research prioritization strategy through knowledge enrichment of individuals and groups and studying their resultant actions. Hypotheses of the study is that AHP can function as instrument to develop integrated decision support system by linking resource and knowledge based decisions of farmers and scientists.

Methodology

Approach of the study was imparting training on Analytic Hierarchy Process (AHP) and facilitating group decision-making on the provided participatory case study of a village. Multidisciplinary groups of scientists of five disciplines (agricultural economics, animal sciences, agronomy or agro-forestry, crop production or crop improvement and soil & water conservation) were constituted amongst the batches of trainees of different training programs conducted at National Academy of Agricultural Research Management (NAARM) during 2001-2003. These scientist are off-site and further categorized into junior, middle & senior level with job experience of 1-2 years, 5-9 years and >10 years respectively; in each of these categories three groups were used and facilitated to complete prioritization exercise of participatory case study, this exercise was done at NAARM. Similarly multidisciplinary group of on-site scientists are drawn from Indian Grassland and Fodder Research Institute (IGFRI, Jhansi) which is just 6 km away from the 'participatory case study' village, these scientists have complete knowledge about village and region (hard and soft system) and function as control, therefore only one group each of senior level and middle level (junior level scientist were not considered to function as control) scientists were trained in AHP and later they completed decision making process through AHP exercise at IGFRI.

Decision making aid and process

AHP was used as multi-criteria multi-level decision making tool. The output oriented three hour interactive session on AHP in a problem solving mode was consisted of equally distributed sessions on- 1. Understanding of AHP through interactive class lecture, 2. Discussing in a group of five trainees on a provided 'participatory case study'. On the basis of expertise, experience and agreed indicators, the members either individually or in group give judgment values to the criteria with respect to goal, and to the broad research alternatives with respect to each criterion, and 3. Finding out local priority and global priority using Microsoft excel spreadsheets, revising judgment values if needed to keep Consistency Ratio (CR) ≤ 0.20.

Participatory case study

Draft of two reports, one explaining complete region and another explaining hard systems and soft systems of village were provided to the trainees. These studies reflect design stage of Nancy et al. (2003), where problems and opportunities are identified, prioritized and potential solutions to the prioritized problems are determined. Potential solutions (these are broad research alternatives and not synonymous with research projects) and criteria were short listed at village level study. Harker (1989) suggest this approach for convenience of pair-wise comparisons through AHP. Randolph et al. (2001) believe that already developed framework (in present research work the 'participatory case study' perform this function) make AHP more relevant, such provisions of case study also offer a scenario for the decision makers. Chen Kuang et al. (2002) report the use of scenario in AHP based study for observing group effect.

Group decision-making process

The complete study was done at two stages; at first stage through participatory study (Soam et al., 2003) problems are identified and translated into research alternatives, which are to be evaluated through criteria identified by farmers, scientists and other stakeholders; Bockstaller et al. (1997) also report that end users are expert in providing agro-ecological indicators. In the second stage (concerning the present research article) group of on-site and off-site scientists prioritize already identified research alternatives through already identified criteria, and use AHP as decision aid process.

The onsite scientists work as panel of expert (Mayer and Butler, 1993); off-site scientist do not belong to study region but they were provided complete information and document, the information generated by them is used for comparison and validation (Bockstaller and Girardin, 2003). Woolley and Tripp (1994) reported that the planning tool is not substitute for intuition, experience and intelligence; the scientist groups use these qualities in decision-making and generation of information that can be extrapolated to similar agro-ecological areas. Thus information so generated by the off-site scientists may increase the chances of extrapolation. In all 55 scientists participated in prioritization process through AHP, the scientist groups are codified as Onsite Middle level scientists- LM; Onsite Senior level scientists-LS; Offsite Junior level scientists- three groups- OSJ-I, OSJ-II, OSJ-III; Offsite Middle level scientists- three groups- OSM-I, OSM-II, OSM-III; Offsite Senior level scientists- three groups- OSS-I, OSS-II, OSS-III.

These groups used ‘participatory case study’ as the working document where the problem is decomposed into hierarchy. *Problem*: Infertility and low productivity in cattle and buffaloes; 2. *Goal*: Increasing fertility and productivity in cattle and buffaloes; 3. *Criteria*: Economic Sustainability (ES), Environment Conservation (EC), Enhanced Farmers’ Resources (FR), and Farmers’ Preferences (FP); 4. *Broad areas identified for research interventions*: Increasing Fodder availability from Private lands (IFP), developing large-scale Community Fodder production system on Wastelands (CFW), and scaling up efforts for Genetic Conversion of Animal (GCA).

Results

During training sessions and group working some qualitative observations were made such as AHP is easy to understand, three-hour session is sufficient for understanding, group work and decision-making involving four criteria and three alternatives. The quantitative results are discussed in following paragraphs and the detailed interpretations are discussed under the part of discussion.

Perceptions about criteria

Comparative rating of criteria by on-site scientists (see table-1) with respect to goal reveals that senior-level scientists (LS) give highest weight to FP, middle-level scientists (LM) give lowest rating to this criteria while highest weighted criteria is FR; ES is second most important to both of them. Average order of importance by on-site scientists is FR>FP>ES>EC. Assumption can be made that in view of them the goal can be achieved through those means which enhances resources of farmers and which are in line of farmers’ preferences.

Various levels of off-site scientists behave differently amongst themselves and differently from on-site scientists. Senior-level scientists (OSS) give highest weight to EC (on the contrary on-site scientists give least weight to EC - probably due to their past on-field experiences), it is followed by FP, and in the last FR & ES are given equal weight. It is assumed that off-site senior scientists favour those interventions, which protect environment and are in line of farmers’ preferences. The order of importance of criteria by middle-level scientists (OSM) is ES>FR>FP>EC, junior-level scientists (OSJ) give similar trend except that they prefer FR a little to ES. Assumption is that OSM and OSJ group of scientists would prefer options, which provide economic sustainability and enhances farmers’ resources.

Synthesis of global priorities

All the three broad areas of research interventions can be applied to achieve the goal but the relative importance can be judged on the basis of systems thinking reflected by individual and group perceptions of the decision makers. The systems thinking is evolved by the expectations of key stakeholders and their preferences, past experiences and future prospects for systems development.

Global priorities of on-site senior and middle level scientists are quite common and in complete agreement with each other (see table-2), they observe priorities in following order of importance- IFP>CFW>GCA. For resource allocation they favour 51-57% resources for IFP, 34-36% for CFW and only 7-11% for GCA. Among off-site scientists, senior level scientists (OSS) are almost in agreement with onsite scientists; middle level scientists (OSM) and junior level scientists (OSJ) are in agreement with each other where they assign priorities in the order of importance of CFW>GCA>IFP (except GCA, quantitative differences are 13-14% only) but these scientists are in complete disagreement with onsite scientists and off-site senior level scientists.

Inter and intra group variations

A research intervention for IFP is the first priority for on-site scientists and off-site senior level scientists, and they favour larger share of resources for this intervention, they also favour fare share for CFW but least resources for GCA. Off-site middle level and junior level scientists on the other hand gives least priority for the research interventions for IFP and favour larger share of resources for CFW and fare share for GCA.

Table-1: Weight given by scientist groups to the criteria

Criteria	Weight given by individual groups of on-site scientists and their average			Average weight given by off-site scientist groups (3 groups for each)		
	LS	LM	Average	OSS	OSM	OSJ
ES	0.265	0.240	0.252	0.158	0.369	0.312
EC	0.104	0.113	0.109	0.384	0.111	0.164
FR	0.123	0.576	0.350	0.156	0.338	0.348
FP	0.508	0.070	0.289	0.303	0.182	0.176

Table-2: Global priority of broad areas for proposed research interventions

Research interventions	Priority value given by individual groups of on-site scientists and their average			Average of priority value given by off-site scientist groups (3 groups for each)		
	LS	LM	Average	OSS	OSM	OSJ
IFP	0.579	0.515	0.547	0.515	0.243	0.113
CFW	0.342	0.366	0.354	0.393	0.445	0.578
GCA	0.079	0.119	0.099	0.092	0.312	0.309

Table-3: Global Priority (GP)- comparative analysis of CR, revision of judgments and their effect on proposed areas of research interventions

Scientist Groups	Inconsistent CR (% of matrices+)	To get CR ≤ 0.2 (%of judgments revised)	Post revised change in GP (average of groups)			
			Change in order of priority	Research interventions- change in quantitative values		
				IFP	CFW	GCA
On-site	62.5	25.0	No	0.040	0.006	(-) 0.046
Off-site-OSS	41.6	30.5	No	(-) 0.009	0.026	(-) 0.017
Off-site-OSM	8.3	2.7	No*	(-) 0.005	0.072	(-) 0.067
Off-site-OSJ	41.6	16.6	No	(-) 0.003	0.026	(-) 0.024

+ Total 8 matrices for on-site scientist groups and 12 for each group of off-site scientists
* No change in average but in case of OSM-I group, GP-III changed to GP-I and *vice versa*

For off-site scientists three groups for each level of scientists were studied, as shown in figure-1, the intra group variations among them are quite conspicuous. Among the middle level scientist, two groups favour larger share of resources for CFW and fare share for IFP, while one group is in consultation with one group of junior level scientists who favour larger share for GCA and fare share for CFW and least for IFP. All groups of junior level scientists favour least share of resources for research interventions for IFP.

Discussion

It is observed that some issues of limitations of AHP discussed by various scientists such as 'its time consuming' (Hartwich and Janssen, 2000) 'tiresome task of pair-wise comparisons and keeping consistency' (Davey and Olson, 1998) are reduced by short listing of criteria and researchable options at the farmers' level. Therefore followed two stage process i.e. design stage and evaluation stage; such an approach is in consultation with Harker (1989). Field study reports are found to bridge the gap between farmers and scientists as reported by Randolph et al. (2001), who opine that already developed framework helped in more relevance of AHP. The division of decision-making at two levels created structured and organized communication as suggested by Anders and Muller (1995). Nancy et al. (2003) advocate essentially facilitation of joint decision-making in Natural Resources Management (NRM) research because it must be done in a way, which reduces the chances of suppression of farmers' opinion by the scientists' opinion. For ensuring those ways, Hartwich and Janssen (2000) suggest two different stages for judging the criteria and research alternatives by different actors; in the present study farmers screened alternatives to achieve the goal, criteria are identified jointly but both of these were evaluated by the scientists because they have to carry research under their constraint and opportunity scenario, and also follow policy issues and economic-ecological systems approach as suggested by Wood and Pardey (1994), but AHP as decision aid links it to farmers' knowledge, resources and expectations. Latest reported relevant innovations in AHP process include 'function decomposition' approach by Bohanec and Zupan (2004), which make AHP even more convenient and fruitful.

AHP served as medium of group discussion, which is observed as strongest component of it, group members conducted interactive discussions before arriving on assigned judgment values through consensus. Table-3 presents the variation in perceptions of various scientist groups towards prioritization of research alternatives or interventions (sometimes it is used to allocate the resources between prioritized proportions). It is observed that in the initial effort, on-site scientists and off-site senior level scientists had higher inconsistent matrices. Therefore to bring consistency, revised judgments were also higher than others. It is assumed that it was due to more interactive discussions or due to influence of higher relative decisional powers of group members on AHP process as reported by Van Den Honert (2001). Further research is needed to establish these relationships.

Post revision changes reveals differential inter and intra group perceptions of different scientist groups, after revised judgments, on-site scientists favour a shift towards IFP and off-site scientists favour CFW. With regard to global priorities, AHP facilitated recording of differential perceptions of various groups. As explained earlier and given in table-2, the off-site seniors (OSS) are in agreement with on-site scientists (LM & LS); off-site middle (OSM) and junior (OSJ) level scientists are in agreement with each other but contrastingly differ from previous two groups. LS, LM and OSS feel that GCA is not appropriate solution and less than 10% resources can be allotted to this option. For these groups, increasing fodder availability from private lands (IFP) is the first priority with approximate allocation of 51-54% of resources; developing large scale community fodder production systems on community wastelands (CFW) is comparatively less preferred with approximate 35-39% of resources; probable reason for that is less chances of success of CFW to achieve desired goal, this assumption is outcome of experiences of these groups regarding- wide spread traditional grazing practices in the study area, lack of social fencing, negative experiences of government projects, and positive experiences of efforts to improve fodder availability from private lands. It seems OSJ and OSM groups wished to enhance resources of farmers in the form of improving animals through direct means and supporting fodder availability through developed wastelands.

Coherence in perceptions of set of groups and their contrasting perceptions from other set of groups could be fall out of their collective memory. Paul et al. (2004) reports the way people conceive the past and reflect concerns of the present, it influences degree of group consensus and speed of decision-making. Another outcome of the present study is the coherence of decisions of on-site scientists and off-site seniors, it means the locals are the best judges but knowledgeable and experienced outsiders may be involved in local decision-making if provided relevant and proper information through reports and discussion sessions; it is in agreement with Mayer and Butler (1993) who report the functioning of panel of expert by submitting output of real world data to them. Therefore, collectivistic and individualistic values, which paved the way for constructive controversies is in agreement with Tjosvold et al. (2003).

Conclusion

The present work is the second part of the study, which is conducted at two stages i.e. farmers level and scientists level, AHP efficiently served as device to link policies, knowledge and resources of farmers and scientists and deciding priorities and develop resource allocation plan in systems manner. The results are beyond doubt as locals completely agree and informally other local senior scientists are in support of results. Further confirmation is based on the agreement of AHP outcome with the recommendations of International Center for development oriented Research in Agriculture (ICRA), it made through conducting a systems oriented in-depth study in the region during 1998. AHP is easy to understand and facilitates collective thinking through fusion of individual and group opinion, it brought transparency and decision makers felt more confident of their decisions afterwards. Systems orientation, opportunity of participation of stakeholders and amalgamation of economic-ecologic parameters are other benefits of AHP recognized during this study. Non-local scientists of middle level and junior level could not provide results that are appropriate in time and space; probable reasons for this are insufficient knowledge about the region and scope of researchable options, and lack of systems thinking. Non-local seniors are in conformation with on-site scientists it means results of prioritized decisions can be applicable to other regions of the country with similar agro-ecosystem and farming situation. Another important lesion learnt is that while selecting the decision makers for AHP, utmost care must be taken about appropriate knowledge base and experience of them.

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