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Research in Extension: New tools to reinvent its future

While research tools and techniques in core disciplines from which extension borrowed its research methods have evolved significantly, extension research still depends heavily on many of the outdated tools. Extension research has a lot to catch up if it hopes to address its declining credibility and improve its contribution to social science research, argues, Dr P Sethuraman Sivakumar.

Extension research is not a stand-alone phenomenon. It is multi-disciplinary in nature and helps extension science to grow stronger through sustained supply of vital elements (concept, tools, techniques and methods). The 'objective' and 'unbiased' information generated out of extension research is useful not only for planning and implementing extension interventions, but for other social science disciplines too. Extension scientists employ a variety of quantitative and qualitative tools to generate 'objective" information (Box 1).

Box 1: Methods and tools in Extension Research

Extension research is basically non-experimental or descriptive in nature. It consists of (i) field studies (exploratory/hypothesis-testing), (ii) expost-facto research, (iii) survey research, (iv) content analysis, (v) case study, and (vi) ethnographic studies (MANAGE, 2007). These methods employ a variety of data collection methods and tools, to generate the data. Method is a procedure, technique, or way of doing something, especially in accordance with a definite plan (*e.g.* personal interview), but tool is a devise that helps to collect the data (*e.g.* questionnaire). These methods and tools are mostly borrowed from cultural anthropology, sociology, cognitive psychology, social psychology, educational psychology, marketing and computer science and engineering. In the recent years, there is an increasing emphasis on using participatory methods and tools. The data generated by extension researchers is mostly ordinal or interval in nature, which can't be analyzed through parametric statistical analyses. Thus, extension researchers depend heavily on descriptive statistics (frequencies, percentages, mean, standard deviation *etc*), non-parametric inferential methods (chi-square, Friedman ANOVA, *etc*), and parametric inferences (correlation and regression).

With the advent of multivariate statistical methods, the social science research has witnessed a radical transformation. Traditionally, the data analysis is performed after collecting the data. These multivariate methods are not merely tools of data analysis, but they form integral part of every stage in data collection. For example, structural equation modeling, which is a combination of correlations, confirmatory factor analysis, path analysis and goodness-of-fit tests, provides detailed steps in constructing an attitude scale beginning from collection of statements to assessing reliability and validity. It is an integrated tool where all the analyses related to constructing an attitude scale are inbuilt and reduce the researchers' effort and time considerably. Conjoint analysis is another statistical method used for quantifying farmers' preferences of a particular technology. It estimates the farmers' "perceived utility" of a particular varietal attribute, and provides us with an ideal variety combining the preferred varietal attributes in a systematic way. If someone wishes to conduct a farmers attribute preference study, they can directly employ the steps in conjoint analysis for conducting research.

Many of the research tools we once borrowed from core disciplines such as sociology, social psychology, educational psychology, cultural anthropology *etc* are currently outdated. These core disciplines have witnessed considerable evolution in terms of their research tools and techniques, but extension research still use some of the outdated tools. Success in science does not depend on choosing a "right thing" out of few options, but it is about creating a "basket-full" of "right things" to choose from.

The following sections provide an idea about the research areas, methods and tools which can be employed in extension research. These areas provide new directions for extension research as well as ways of improving its scientific rigor.

New methods and tools

Multivariate statistical tools

Quantitative research in extension is heavily dependent on classical test theory, drawn mostly from Edwards' book which was published more than 50 years ago (Edwards, 1957). However, "psychometrics" (which is a measurement of knowledge, abilities, attitudes, personality traits, and educational achievements) has grown beyond classical test theory with the advent of modern multivariate statistical tools. New methods like Item-Response theory (including its variations), and Rasch model of measurement are becoming popular in psychology. The following websites provide basics of IRT and Rasch models.

- The basics of item response theory
  http://info.worldbank.org/etools/docs/library/117765/Item%20Response%20Theory%20-%20F%20Baker.pdf
- Item Response Theory and Rasch Models
  http://www.sagepub.com/upm-data/18480_Chapter_13.pdf
- The application of IRT and Rasch model for scale construction can be found from the following papers.
- **Rivera, J.E. (2007).** Test item construction and validation: Developing a statewide assessment for agricultural science education. PhD Dissertation, Cornell University. Avl in:http://dspace.library.cornell.edu/bitstream/1813/3496/1/9-10-06.pdf
- **Baranowski, T., Missaghian, M., Watson, K., Broadfoot, A., Cullen, K., Nicklas, T., Fisher, J., and O`Donnell, S**. (2008). Home fruit, juice, and vegetable pantry management and availability scales: A validation. *Appetite*. 50:266-277
- **Khairani, A. Z. B., and Razak, N. B. A. (2010)** Teaching Efficacy of Universiti Sains Malaysia Mathematics Student Teachers. *Procedia Social and Behavioral Sciences*, 8: 35–40

Estimating construct validity

Construct validity indicates how well a scale measures or correlates with the theorized psychological construct. In extension research, the construct validity is measured by correlating the scale scores with a known scale which measures the similar or related construct. However, this method is tedious as it takes lots of time and energy in collecting data using these two scales. Modern multivariate models like structural equation models and its variations can estimate the construct validity of a research instrument/ attitude scale through confirmatory factor analysis. Statistical software like SAS (PROC CALIS procedure), AMOS, LISREL are widely used for structural equation modeling. Other methods like Multitrait-Multimethod Matrix (MTMM) and pattern matching can also estimate the construct validity accurately.

The following papers will provide an idea of applying these methods for construct validity estimation:

- **Suresh Chander G.S., Rajendran C. and Anantharaman R.N., (2002),** Determinants of customers perceived quality: A confirmatory factor analysis approach*, Journal of Service Marketing,* 16(1): 9–34.
- **Shattuck, D., Corbell, K. A., Osborne, J. W., Knezek, G. and Christensen, R. (2011)** Measuring teacher attitudes toward instructional technology: A confirmatory factor analysis of the TAC and TAT . *Computers in Schools*, 28: 1-25
- **Davis, J.E. (1989).** Construct validity in measurement: A pattern matching approach. *Evaluation and Program Planning*, 12(1): 31–36.

Analyzing user decisions

Most of the farmers' decisions are taken in uncertain situations. They use multiple criteria to analyze a technology and take appropriate decision on using the technology. For example, a farmer may choose either of the following decisions while deciding on adopting a variety based on its characteristics (*e.g.* high-yielding, disease resistance, cooking quality *etc.*). He/she may decide to (i) Fully adopt the variety (ii) Partially adopt the variety now, and full adoption at a later stage (iii) Rejecting the variety. These decisions are often measured through three point rating scale. In other situations, the farmer may express his agreement to a variety of attitude statements on a five-point Likert-type summated rating scale (*e.g.* attitude towards GM crops).

Both cases represent an uncertain situation, where the farmer is presented with a technology and he/she decides to use a technology to the "extent" which he/she feels comfortable. This decision is "approximate" and taken based on the "perceived benefits" and "range of choices" available to them. In these cases, fuzzy logic can effectively be used to interpret the farmers' decision behavior.

The following papers will provide an idea of application of this method:

- **Ghosh, S., Singh, R., and Kundu, D.K. (2005).** Evaluation of irrigation-service utility from the perspective of farmers. *Water Resources Management*, 19: 467–482
- **Bosma, R., Kaymak, U., Van den Berg, J., Udo, H., and Verreth, J. (2011).** Using fuzzy logic modelling to simulate farmers` decision-making on diversification and integration in the Mekong Delta, Vietnam. *Soft Computing* 15(2): 295-310.
- **Jaya, S., and Das, H., (2003).** Sensory evaluation of mango drinks using fuzzy logic. *Journal of Sensory Studies*, 18: 163-176

Measuring perceptions

Understanding users' perception of a technology/ method/initiative is necessary for facilitating adoption. Perceptions indicate the users view of a technology/method/initiative, which is formed based on his previous experiences. In extension research, perceptions are measured using summated-rating or other rating scales. However, methods which can measure these aspects objectively are currently available. Means-ends chain analysis, developed by Gutman (1982) is a popular qualitative research method of measuring the perceptions, which is used widely in marketing research. The means-end theory sustains that the way consumers relate to products can be represented by a hierarchical model of three interconnected levels: product attributes, consequences of use and personal values.

The following papers will provide an idea of application of this method:

- **De Souza Leao, A.L.M., and de Mello, S.C.B. (2007).** The means-end approach to understanding customer values of an on-line newspaper. *Brazilian Administration Review,*4(1): 1-20
- **Gutman, J. (2006).** Analyzing consumer orientations toward beverages through means–end chain analysis. *Psychology & Marketing*, 1(3-4): 23-43.

Livelihood analysis

Livelihood analysis is performed using qualitative methods like PRA, and the results are summarized to provide an overview of the livelihood system. The PRA is primarily a "planning method" which aids in collective decision making for developing a viable intervention to improve the life quality of the community. The PRA methods/tools are not "objective" research methods, which are often used to generate a "pooled perspective" of a given problem from a "group" of respondents (> 5 respondents for many tools). Recent developments in participatory research have brought several hybrid methods that integrated the quantitative tools with participatory methods. Few methods are listed in the website of Statistical Service Centre, University of Reading, UK.

(**http://www.personal.reading.ac.uk/~snsbarah/partiandstats/home.html**).

The following papers will also provide an idea for integrating quantitative tools with participatory methods:

- **Sivakumar, P.S., Nedunchezhiyan, M., Paramaguru, S., and Ray, R.C. (2009).** Production system-specific differences in farmers' demand for greater yam (*Dioscorea alata*) varietal attributes in Orissa State, India. *Experimental Agriculture,* 45: 1–14.
- **Babulo, B. Muys, B., Fredu Nega, Tollens, E., Nyssen, J., Deckers, J., and Mathijs, E., (2008).** Household livelihood strategies and forest dependence in the highlands of Tigray, Northern Ethiopia. *Agricultural Systems,* 98(2): 147-155.
- **Tittonell, p., Muriuki, A., Shepherd, K.D., Mugendi, D., Kaizzi, K.C., Okeyo, J., Verchot, L.,**

Coe, R., and Vanlauwe, B. (2010). The diversity of rural livelihoods and their influence on soil fertility in agricultural systems of East Africa - A typology of smallholder farms. *Agricultural Systems*, 103(2): 83-97

Technology adoption process

Diffusion of innovations is widely researched area in extension science and a good number of papers emerged from Indian sub-continent in the last three decades. Though the Roger's classical paradigm of technology diffusion has provided deeper insights into the process of technology spread, its longitudinal nature has constrained the extension researchers to examine this model critically to derive newer insights. Several technology acceptance of adoption theories and models like Theory of Reasoned Action (Ajzen and Fishbein, 1980), Theory of Planned Behaviour (Ajzen, 1985), Technology Acceptance Model (Davis, 1989), Unified theory of acceptance and use of technology (Venkatesh *et al.,* 2003) are developed by social and cognitive psychologists to examine the process of technology acceptance (intention to use and actual adoption) in a given period of time.

These models provide the flexibility to assess the technology adoption process at a particular time-period through cross-sectional studies. These models are extensively used in marketing and information system research.

The following papers can be useful to understand the application of these models for conducting cross-sectional research in technology adoption process:

- **Pynoo, B., Tondeur, J., Braak, J.V., Duyck, W., Sjinave, B., and Duyck, P., (2012).** Teachers' acceptance and use of an educational portal. *Computers & Education* 58: 1308–1317.
- **Pijpers, G.G.M. and Montfort, K.V. (2005).** An investigation of factors that influence senior executives to accept innovations in information technology. *International Journal of Management,* 22: 542 – 555.
- **Voon, P.J., Ngui, K.S., and Agrawal, A. (2011).** Determinants of willingness to purchase organic food: an exploratory study using structural equation modeling. *International Food and Agribusiness Management Review,* 14(2): 103-120.

ICT applications in extension

The research on ICT application in extension is still at infancy stage in India. Many of the recent papers in this theme lack empirical evidence and the investigations only deal with the periphery of the problem. There is a need to work on designing of instructional systems and their impact on learning process using objective research methods. For instance, research should investigate how the mental processes affect the comprehension of information as well as how the users evaluate and

utilize the information supplied. Few aspects on ICT which needs to be investigated to improve its effectiveness in extension delivery are

ICT utilization

ICT utilization indicates the intention and extent of utilizing ICT tools in extension. Information system acceptance is a psychological phenomenon which is extensively studied using technology acceptance models (discussed earlier in the blog along with references).

Instructional design and its impact

Instructional design plays a crucial role in determining the effectiveness of multimedia applications developed specifically for technology transfer. Though few Indian studies have examined the effectiveness of multimedia based extension applications like Interactive Multimedia Compact Disc (Anandaraja *et al.,* 2006), CD-ROM (Rajula Shanthy, and Thiagarajan 2011) and e-agriculture prototype (Saravanan, 2012), the role of instructional design was not examined critically. Since these ICT applications are targeted to improve the users' knowledge, skill and positively enhance their intention to use the technology/ aspect, instructional design plays a crucial role in determining the effectiveness of these applications. Few areas which needs attention by ICT researchers are

Modality and cueing – Studying the effects of modality (written/spoken text), text organising strategies (controlling the reading rate, rereading key text segments, reading backwards, skipping less essential text, or jumping back and forth between text segments *etc.*) and visual cueing (using non-content information like arrows, colors *etc.* in the instructional material to help learners select, organize, and integrate information in their working memory) in a multimedia learning system.

The following papers will provide an idea about this research area**:**

- **Crooks, S.M., Cheon, J., Inan, F., Ari, F., and Flores, R. (2012).** Modality and cueing in multimedia learning: Examining cognitive and perceptual explanations for the modality effect. *Computers in Human Behavior*, 28: 1063–1071.
- **Rummer, R., Schweppe, J., Furstenberg, A., Scheiter, K., and Zindler, A. (2011).** The perceptual basis of the modality effect in multimedia learning. *Journal of Experimental Psychology: Applied*, 17(2), 159–173.

Effect of knowledge and task characteristics on learning- Assessing the impact of design on users' knowledge levels (factual, conceptual, procedural and meta-cognitive knowledge) and developing suitable tools to measure these knowledge levels in multimedia learning environments is necessary. Task characteristics like task complexity, task uncertainty can also influence the learning from multimedia and internet.

The following papers will provide an idea of implementing these aspects in ICT research:

- **Mascha, M.F. (2001).** The effect of task complexity and expert system type on the acquisition of procedural knowledge: Some new evidence. *International Journal of Accounting Information Systems,* 2: 103–124.
- **van Genuchten, E., Scheiter, K., and Schüler, A. (2012).** Examining learning from text and pictures for different task types: Does the multimedia effect differ for conceptual, causal, and procedural tasks? *Computers in Human Behavior*, 28: 2209–2218.

Conclusions

Extension is a unique discipline among social sciences as it has evolved from "field practices" that are implemented to improve the quality of life of rural communities. So, research "output" in extension should contribute to improve the efficiency of an existing practice. While several other disciplines consider theories as the pillars on which their subject matter is built upon, there is a widespread opinion among extension scientists and professionals that extension research should be "applied" in nature and therefore its focus should not be on developing theories and models that are purely academic. However, theories guide the growth of any discipline and the empirical research helps to improve generalizations of theories and enhance 'replicability' of the practices. Therefore, it is crucial for extension science to establish its own theories to sustain in the long-term.

The perspective taken here is that extension science is an applied, problem-oriented field, and 'scientific knowledge' (which includes theory) within extension should exhibit both 'scientific rigor' and the 'applied perspective' of the extension work. Theory-driven empirical research in extension should be distinguished from research in other fields based on the substantive content of the problems studied and methodological innovations. Research is the lifeline of any professional discipline and the quality of research output is one of the important indicators of the growth of discipline. So there is an essential need to show our research capacity and prove that extension is a scientific discipline, not merely a "work" based profession.

Way forward

- *Changing the mindset of extension researchers* is the first step towards the progress of extension research. Professional societies in extension should take a lead in this effort.
- *Exploring the research world of other science disciplines* like marketing, cognitive psychology, educational psychology, social work, chemistry, food science *etc* with an "investigative eye" will enrich our basket of research tools.
- *Focus on theory* - Theory is the foundation for the success of any effort that aims to transform human conditions through technological solutions. Any field-effort which is guided by theory, will not only solve the problem, but also provide valuable insights into this process.
- *Employing Multivariate Research Methods* which integrate data collection tools with appropriate statistical methods will help the extension researchers to conduct research effectively and efficiently.

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