STRENGTHENING EXTENSION RESEARCH

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RESEARCH IN EXTENSION: IT IS TIME TO INTROSPECT

Though the field of extension globally has moved beyond technology transfer to facilitation, learning, organising and building networks, extension research in India is still stuck in studying technology transfer, per se. Moreover, extension research has never received adequate attention from practitioners, managers and faculty in extension. Lack of adequate field-oriented research and poor professional standards in research have considerably eroded the credibility of extension research and practice. It is time to introspect and take corrective measures, argues RM Prasad.

In research, knowledge is acquired using scientific method. Scientific method is a body of approaches and tools for investigating a phenomenon and acquiring new knowledge as well as for verifying, correcting and integrating previous knowledge. It is based on gathering observable, empirical, measurable evidence, subject to the principles of reasoning. Growth of any discipline is directly proportional to the creation of knowledge in that discipline. Research is the means for creation of knowledge. Extension research proposes specific hypotheses as explanations of social phenomena and design studies that test these predictions for accuracy (Box 1).

The research process has to be objective so that the scientists do not bias the interpretation of the results or change the results outright. But as extension professionals have we paid adequate attention to extension research?

Extension research in India mainly faces two major challenges, namely inadequacy of research and poor professional standards.

Inadequacy of Research

We have to openly admit that we are not doing adequate research in extension. For instance organisations that have resources, mandate and personnel at the national level such as the National Institute of Agricultural Extension Management (MANAGE) or the ICAR (Indian Council of Agricultural Research) Extension Division have done very little research on extension. Extension research in ICAR research centres mostly revolves around transfer of specific technologies the centres have developed. There is no All India Co-ordinated Research in Extension, where as ICAR has several such projects in other disciplines.

Extension research undertaken by Deemed Universities and State Agricultural Universities in India is largely confined to research by the post-graduate (M.Sc and PhD) students. In this context, it is to be highlighted that under NATP and NAIP scheme of ICAR, there were some innovative and field oriented research projects in extension undertaken by our extension scientists. However, compared to research output of other disciplines, contribution of extension research has been very limited.

Poor Professional Standards

There has been a general decline in scientific rigour in most of the extension research. The following points illustrate why this is happening.

- In many cases, the problems selected for research in the field of Extension are based on convenience, easiness in conducting research

- and replica of studies already conducted elsewhere. Original, field-oriented and need based research for addressing the problems and the results of which could give directions for policy, etc are either lacking or are too little.

- In the case of post graduate (student) research, students often select research problems that have been studied earlier by other researchers, and pursue their research by changing the crop or locale or sampling unit of the previously studied problem. In many cases, even the results of the study and discussion are merely copied as such from the original.

- Ideally, the "review of literature" establishes the context of the research and introduces insights into the range of techniques and tools that are relevant for the topic under study. However, in practice, the literature review quite often lacks rigour and consistency, context and breadth, clarity and brevity and effective analysis and synthesis. This results in improper 'theoretical orientation' which affects the results of the research.

- Selection of a pilot site and conducting a pilot test using each data gathering method will help in obtaining better results. But, it is observed that in many cases, conduct of pilot study at the field level is not done, and is shown in the report as being done (just for the sake of reporting).

- The results of the study are often analysed without considering the suitability of the test and its relevance. Many of the extension researchers are interested in getting the results analysed using many tests and preparing large number of tables. However, in many cases, the results are not properly explained or interpreted. This often happens because the researcher feels that his/her quality of research can be enhanced only by using more number of statistical tests and presenting the results using many tables.

- Discussion on the results in large number of cases is quite shallow, superficial and not supported by theories or relevant concepts. The readability of the discussion chapter in many theses/ research reports is very poor and is merely a repetition of the findings in many cases.

- The research reports are prepared by the researchers in a routine and mechanical way, and many a times, it is observed that sincere attempt is not made to make the reports meaningful to the target users. The form, content and style of the research report should be chosen to suit the level of understanding, experience and interest of the targeted users as well as to make the readers to apply the findings in their respective areas. However, this is not seen in many of the research reports prepared by the extension scientists.

Box 1: Types of extension research

Exploratory research: Extension research has to move beyond exploratory research, which answers "What is where?" The results of exploratory research are however not usually useful for decision making by themselves.

Descriptive research answers the question "What is what?" Extension research employs three main types of descriptive methods- observational methods, case study methods and survey methods. Here, it is to be borne in mind that descriptive methods can only describe a set of observations or the data collected, but cannot draw conclusions from that data about which way the relationship exists.

Explanatory research has to be employed to know the cause and effect relationship. Though extension scientists use different statistical tools to explain the cause-effect interaction, in many cases, the relationships are not properly inferred and explained, which presents only loose inferences, which may not be valid.

Experimental research can be employed to present strong evidence for causal interpretation. One important feature that differentiates experimental research from explanatory research is that instead of simply measuring two variables, the researcher can manipulate one of them in the case of experimental research. Extraneous variables can also be controlled in experimental research. Extension, being a discipline which has drawn its contents from various other disciplines, there is much scope and space for inter-disciplinary research in extension. However, extension research hasn't exploited this possibility fully. Though the field of extension globally has moved beyond technology transfer to facilitation, learning, organising and building networks with a wide range of other agencies, extension research in India is still stuck in studying technology transfer. For instance, most of the research in extension in India conceive extension's role purely in terms of knowledge extended or transferred, whereas globally its role is increasingly recognised in terms of creating knowledge (Warner et al, 1998) strengthening innovation process (Sulaiman and Hall, 2002) and in participatory action research (Pretoda, 2009).

Another serious problem related to extension research is the limited presence of extension research in reputed peer-reviewed international multi-disciplinary journals such as Agricultural

Systems, Outlook on Agriculture or Rural Sociology as well as international extension journals such as Journal of Agricultural Education and Extension (JAEE) and Journal of International Agricultural and Extension Education. Even those who are engaged in quality research in extension pay very little attention to publishing their research outputs in some of these reputed journals.

Apart from these, lack of functional integration between extension research and field extension; low attention to professional ethics and standards; absence of inter-disciplinary research projects; continued use of outdated scales and tests and lack of drive to use advanced social science research methods have all led to declining credibility of this important and vibrant discipline.

Way Forward

- Identify new and relevant areas for extension research: Social capital, cash transfer, micro finance, convergence as a social process, management of CPRs, climate change adaptation, public private partnerships, livelihood analysis, organisational learning and agricultural innovation systems are some new areas that need adequate research.

- Extension research should cover all the following types of research and these include, basicresearch (inquiry focused on basic concepts and theories with a view to revisiting the existingconcepts/theories and developing new theories), developmental research (contributing to the development of the discipline by way of developing innovative methodologies, good practices, effective tools of measurement etc); adaptive research (studying the applicability and usefulness of the new practices, tools developed, etc and

testing their effectiveness); academicresearch (focusing on the process and methods of developing tests, scales and new approachesin the field of extension); applied research (focusing on the problems of conducting research in terms of data collection tools, measurement, experimentation, etc).

- Initiate network projects and coordinated projects for Extension research.

- Earmark 10 percent of the funds of MANAGE, Extension Education Institutes (EEIs) and State Agricultural Management Extension and Training Institutes (SAMETI) for conducting research on extension.

- Organise refresher courses on research methodology for teachers, scientists and doctoral students.

- Encourage and enforce a rigorous system for screening research articles/proposals, and organising peer reviews so as to conform to professional scientific standards in research.

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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, 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).

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 state wide assessment for agricultural science education. PhD Dissertation, Cornell University. 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 MalaysiaMathematics Student Teachers. *Procedia Social and Behavioral Sciences,* 8: 35–40

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.

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, and 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 ofcustomers perceived quality: A confirmatory factor analysis approach, *Journal of ServiceMarketing,* 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 factoranalysis of the TAC and TAT . *Computers in Schools,* 28: 1-25

- Davis, J.E. (1989). Construct validity in measurement: A pattern matchingapproach. *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 fromthe 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 logicmodelling 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. *Journalof 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 tounderstanding customer values of an on-line newspaper. *Brazilian AdministrationReview,*4(1): 1-20

- Gutman, J. (2006). Analyzing consumer orientations toward beverages through means–endchain 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). Productionsystem-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 soilfertility 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 etal., 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). Teacher's 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 seniorexecutives 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 purchaseorganic 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). Theperceptual basis of the modality effect in multimedia learning. *Journal of ExperimentalPsychology: 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 acquisitionof procedural knowledge: Some new evidence. *International Journal of AccountingInformation Systems*, 2: 103–124.

- Van Genuchten, E., Scheiter, K., and Schüler, A. (2012). Examining learning from text andpictures 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 ofextension 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 transformhuman 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 withappropriate statistical methods will help the extension researchers to conduct research effectively and efficiently.

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Venkatesh V, Morris M, Davis G and Davis F. 2003.User acceptance of informationtechnology: Toward a unified view, MIS Quarterly, 27: 425-478.

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NEGOTIATING REALITY: A PRAGMATIC APPROACH FOR CONDUCTING QUALITY EXTENSION RESEARCH

Extension scientists are often under stress due to the demotivating work environment and lack of technical guidance from the professional societies. But still one can conduct quality research in extension by following a pragmatic approach, argues, P Sethuraman Sivakumar

Research is the backbone for all disciplines and for the discipline of "extension", research plays an important role in standardizing relevant interventions to facilitate equitable development. As a "field-oriented" professional discipline, the extension research differs significantly from other social science research in terms of its content and methods. The extension research is an "applied problem solving" enquiry, conducted in complex environments created by the interplay of natural, social and biological forces. Researching a complex environment is a cumbersome task, which needs identifying and executing sound methods and techniques with reasonable precision and control. However, the current research tools in extension are outdated and their continued use has resulted in stereotypic and insignificant outcomes. Due to lack of practical significance and stagnation in theory development, extension research is often criticized by other agricultural disciplines as a "non-performing discipline". Extension scientists are often under pressure to deliver tangible outputs to show impact of technologies whereas the poor technology adoption is often the results of a number of factors including the weaknesses in field extension. Though there is no "magic wand" to deliver output in a short time, a systematic and pragmatic approach to extension research can contribute to development of relevant technologies and appropriate extension approaches. Only these can lead to enhanced credibility for extension discipline and at the same time contribute to better technology uptake.

The Problem of Extension Research

Varying Perceptions and contradictory demands: While "field-extension" is a responsibility of the state (governments), the front-line extension system (mainly Krishi Vigyan Kendra's and extension activities of ICAR and SAU centres) is expected to help the field functionaries by providing new approaches and "state-of-art" tools to improve the effectiveness of their extension work. While this is the accepted division of labour, many research managers have a different perception on the role of extension scientists. Many of them believe that the role of extension scientists is to promote technologies (developed at the respective research centres) in the field, rather than contributing to the effectiveness of the research projects through research and publications. The "field deliverables", are viewed in terms of the quantity and coverage of extension interventions or stakeholder participation over a period of time. These perceptual differences have created a stressful working environment where the extension

academicians/ scientists are overburdened to meet the immediate goals of their supervisors leaving aside their research ambitions.

Low quality of academic research: In the case of SAU extension research, which contributes morethan 60% of the total research conducted / papers published in extension journals, most of it focus on the "subject" of extension of as a field of academic enquiry and thereby contributing very little to improve the field extension activities. The academic research conducted at the SAUs is time-bound and repetitive, with both guides and students not-willing to venture into innovative topics/ methods fearing rejection at the viva-voce or at the review meetings. The extension journals too focus on the "volume" of publishing rather than improving the quality of research papers. In many journals, the peer-review process is carried out haphazardly with little focus on innovation and utility. Due to this most of the extension journals are rated low (<5.0) in the journal ratings determined by the National Academy of Agricultural sciences, New Delhi (NAAS, 2014). This trend is also similar for extension journals of International repute. With this limitation, the extension scientists and students face innumerable difficulties in applying for higher positions for their professional growth including scholarships and awards from reputed societies.

Box 1: Evolution of extension research in India

The foundations for extension research were laid out in the 1960s by the scientists working with the ICAR (Indian Council of Agricultural Research) and SAUs (State Agricultural Universities). Extension research methods during the 1960-1980s were drawn mostly from the psychology and sociology, with a strong psychometric orientation. The leading extension science journals at that time published high quality research papers and a few of these attracted International accolades. The quantitative research paradigm dominated by multivariate statistical modelling, brought a new scientific outlook for extension discipline during that time. Several scales and indices like socio-economic status (Trivedi, 1963), economic motivation scale (Supe, 1969), etc were developed during that period. Teacher-made knowledge tests and several scales pertaining to different aspects of extension were developed subsequently. Since the beginning, the classical test paradigm has been used for scale construction. With the advent of participatory methods, use of Participatory Rural Appraisal (PRA) methods has also been used in extension research. .

The current extension research is mostly non-experimental or descriptive in nature. It consists of(i) field studies (exploratory/hypothesis-testing), (ii) expost-facto research, (iii) survey research,(iv) content and readability/ comprehension analysis, (v) case study, and (vi) ethnographic studies (MANAGE, 2007). Studies on training - need analysis and effectiveness; knowledge, perception and attitude assessment on specific aspects; communication / information processing behaviour; adoption behaviour; constraint analysis; farmer involvement in extension programmes; gender mainstreaming and empowerment; and job satisfaction and productivity of extension personnel are widely undertaken now. Emergence of Information and Communication Technology (ICT), entrepreneurship, organizational management and impact assessment paradigms in the early 1990s have redefined the extension research. The extension research methods and tools which are currently in use are mostly borrowed from cultural anthropology, sociology, cognitive psychology, social psychology, educational psychology, marketing and computer science and engineering. The data generated by extension researchers is mostly ordinal or interval in nature, which cannot 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).

Lack of professionalism among professional societies: In the absence of motivating environment atthe workplace, talented extension scientists often look for innovative ideas and methods from professional extension societies. But the extension professional societies in India are mostly divided on the personal interests of few individuals, who consider bright young extension scientists as "threats" to their position. Extension is probably the only discipline in agricultural sciences, where the professional societies organize at least four specialised meetings every year, where the participants comprise mostly of extension scientists from a particular region or lobby. The "award syndrome", where over 50 extension scientists are awarded for best paper, best poster, best presentations etc or as promising young scientists in these meetings has also lowered the professional standards. A vast majority of the awards are given to "known people" based on personal relationships and the research quality takes a backstage in these events. Recognising an average or poor research worker creates frustration among promising extension scientists who loose motivation to do innovative research.

Need for a Pragmatic Approach

In general, extension research is conducted in 6 different settings:

- Research project in a research Institute or college,
- Student project in a college or research Institute,
- Field research in a Krishi Vigyan Kendra,
- Field research in a NGO,
- Field research in a state extension department and
- Field research in a agri-input/ marketing/ credit agencies

The number and volume of extension research vary among these settings. While the first three settings have a compulsive environment to deliver quality research output, the pressure to deliver is low among others.

In either case, the Indian extension scientist is under stress due to the demotivating environment within his organisation and due to lack of technical guidance from the professional societies to improve his/her research quality. He/she should normally belong to the following categories:

- A researcher who is burdened with field extension

- A researcher frustrated with too much documentation

- A researcher/academician overloaded with teaching

- A student who is under compulsion to complete his/her MSc or PhD within the prescribed duration or

- A subject matter specialist in a KVK or an NGO extension staff burdened with demonstrations and trainings

In this context, there is a need to look at some of the potential ways of conducting quality research at the individual level, without disturbing the routine schedule of activities expected within the organisation. Some of the potential ways forward are as follows:

Explore opportunities to conduct research in any mandated activity

Any mandated activity can produce quality research output. If someone is continuously engaged in teaching/ training/ exhibitions, they can concurrently do research on their routine activity. In case of exhibitions, high quality research were conducted on the contextual model of learning – learning in a free-choice settings (Falk and Storks dieck, 2005), exhibit labelling and visitor concept development (Falk, 1997) and impact of prior knowledge on learning at an exhibition (Falk and Adelman, 2003).

If someone works for a KVK or other field extension agency, he/she can conduct quality research while conducting FLD or method demonstrations. Method demonstrations can be researched using traditional media/ method comparison techniques (Crouch *et al.,* 2004) or its effect on learning motor skills (Ishikura and Inomata, 1995). The extension personnel engaged in capacity building work have wide array of choices from need analysis to ICT applications. Skill learning with sensory and motor tasks is a vital component of any training programme. Skill learning research (Scully and Newell, 1985; Willingham, 1998) can be conducted for farm machinery and other equipment studies.

Explore opportunities for collaborative multi-disciplinary research

Extension research conducted as part of a multi-disciplinary enquiry can solve problems much better. If an extension scientist is posted in a crop or animal / aspect specific Institute, it is good to get the mastery over the mandated subject before beginning any empirical enquiry. Understanding the mandated aspect will help to get deep insights into the forces that determine progress in the specific area. For instance, a post- arvest scientist develops a technology to produce functional pasta from any starchy crop; the extension scientist can help to determine its sensory acceptability by the potential consumers. Besides sensory testing, the extension scientist can test the product on a larger consumer sample and identify the potential market segments, estimate the market demand based on hedonic model and provide several market insights to and provide several market insights to the technology producer (Sivakumar *et al.,* 2008, 2010). This work can satisfy both producer (Sivakumar *et al.,* 2008, 2010). This work can satisfy both the post-harvest scientist and research managers besides helping the extension scientist to get few research papers in high-impact International journals.

In a participatory plant breeding research, the extension scientist can help the breeders to decide on the varietal attributes using preference studies (Sivakumar *et al.,* 2009). The conjoint analysis is a widely used preference or utility estimation method which has been successfully used to identify cattle attributes in West Africa (Tano *et al.,* 2013), Apple varietal preferences in UK (Manalo, 1990), and groundnut varietal attributes in Niger (Baidu-Forson *et al.,* 1997). These results will help the breeders to decide on the breeding objectives and develop varieties that can cater to the needs of the farmers. In a multi-disciplinary team, the extension scientist will also be credited with developing varieties/ products along with

biological scientists. There are several engineering or biology or chemistry or other discipline journals that publish extension research. Since these journals are rated high (Impact factor over 7.0), multi-disciplinary team work will provide high quality research publications. An exhaustive list of journals where extension scientists could publish has been compiled by AESA (Agricultural Extension in South) Network and this could be accessed at http://www.crispindia.org/Where%20we%20can%20publish%20extension%20research%20-%20Final%20Note%20%281%29.pdf

Using alternate research methods to study an established phenomenon

Most of the research methods used in extension science are borrowed from other social science disciplines such as psychology, cultural anthropology, sociology, economics, marketing and communication. Though the research practices in these disciplines witnessed a sea change in the last two decades with the emergence of state-of-art techniques, the extension researchers continue to use out-dated methods from these disciplines. Though the extension research themes became diverse over the years with wider scope, the research methods continue to be old and obsolete. This phenomenon resulted in poor quality research as indicated by stereotypical publications and duplicating results. For a more detailed discussion on new methods and approaches in extension research, see the AESA blog on this theme (Sivakumar, P S 2013).

Master the field of statistics

The goal of scientific research is to identify the hidden patterns in the observed data to make generalisations on the phenomenon under study. The knowledge and use of statistics helps in this. Quantification of relationships among a social phenomenon will provide several leads for further research, besides explaining the research questions under the study. In simple words, the mastery of statistics will not only improve the quality of the output, but also help in conducting a sound empirical research and enhancing the probability of getting the output published in peer-reviewed high impact journals.

There is a widespread perception among extension scientists that quantitative studies using statistics are theoretical in nature and that they do not lead to any meaningful interpretation. Using statistics is often perceived as a "suffix" phenomenon i.e. performing the statistical analysis after collecting the data. However, statistics provides us with the knowledge and tools for assessing complex natural phenomenon in a systematic and objective way.

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 modelling, 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 it reduce the researchers' effort and time considerably. Limited dependent models like logistic regression can be used to assess the effect of nominal and ordinal independent variables on a nominal dependent variable. For example, adoption studies (adopted/ not adopted) or acceptance of a food product (accepted/ not accepted) etc can be well-researched using these models. Multi-nominal and ordinal regressions can add one more category i.e. partially adopted into the logistic model.

Though extension scientists are increasingly using multivariate methods to increase the probability of their paper acceptance in journals, it is not sufficient to ensure quality. The statistical methods should be chosen based on the research problem, and there are several research papers published in high rated journals using simple statistics (Sharma and Joshi, 1995; Sivakumar *et al.,* 2009). Since most statistical analyses are based on the nature of data, precautions should be taken to use the right method for analysing the observed data.

Way Forward

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. Extension research needs

a face-lift to increase its impact and restore its credibility among research managers and other discipline scientists. The outputs from extension research should contribute to improve the efficiency of an existing practice. As extension science is an applied, problem-oriented field the 'scientific knowledge' (which includes theory) within extension should exhibit both 'scientific rigor' and the 'applied perspective' of the extension work. A pragmatic approach consistent with the mandate of the organization can considerably help in producing quality output.

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EXTENSION RESEARCH: RANDOM THOUGHTS FROM A WELL WISHER

Are we serious in undertaking research in Extension? Do we have a research agenda? As a discipline, are we using new concepts and approaches to better design our research? How policy relevant is our research? Do we only extend knowledge or do we also create knowledge? As extension professionals, we need to introspect on the status of our research and address many such disturbing questions, argues RM Prasad.

Our current research paradigm followed in most academic institutions tends to be linear in design, as given in Fig. 1 (Smith and Helfenbein, 2009).

In most cases, extension research looks at farmers or extension personnel as subjects and crop/farming system as settings of the study. The dissemination of research findings into the public sphere is very often limited to sharing of results with other scientists or students. Though farmer participatory research had become popular at least among some of the researchers, it is observed that in farmer participatory research, research or extension are too dominant, while farmers comply with the wish/request of extensionists/researchers to arrive at joint decisions on research topics, designs, analysis and dissemination of results (Katz et al, 2007)

What we should do?

• The concept of 'research' in extension needs to be broadened, recognising that beyond the public research and extension organisations, a range of actors have important and vital roles in the generation and dissemination of agricultural innovation. The Agricultural Innovation System (AIS) landscape has a wide range of actors going well beyond formal research and extension institutions, but the research in extension is still stuck with the typical actors and has not moved beyond R-E-F linkages. Of late, marketing is also added. Without a functional interface between the various actors, neither research will be able to make innovations that benefit farmers, nor can extension offer services that resolve all the problems of farmers.

• The understanding of innovation needs to change as it is increasingly recognised that non-technological innovations such as ways to access to more profitable markets, value chain development or organisation of producers are equally, if not more important than technological innovations.

• The practice of Extension has been described as 'knowledge applied' or 'knowledge extended'. What about 'knowledge created'? Of late, at least some of the extension researchers have begun to recognise Extension's role in 'creating knowledge' which is a welcome step. But this is yet to yield significant results.

• Research institutions need to provide researchers with the right incentives to engage effectively, enable them to contribute to policy and political processes and develop realistic expectations as to what they can collectively achieve.

Fig. 1: Current research paradigm followed in academic institutions

- Researchers need to alter their own mindsets, paving way for team research. This may mean working in inter-multi-and/or trans-disciplinary research teams, admitting to being part of a value based system. The research agenda is usually decided by the researcher, which also needs a paradigm change. Defining the research agenda is about defining the problem with research users, who they are- not just farmers, but scientists, entrepreneurs, environmentalists, policy makers, journalists, etc whoever is part of the 'innovation system' that affects research uptake and use.

- Knowledge brokering is absent in the current research system. This is a central component of knowledge transfer that involves bringing people together, helping to build links, identify gaps and needs, and sharing ideas. It encourages the use of research in planning and implementation and uses evaluation activities to identify successes or improvements. Thus it helps to bridge the gap between research and policy development.

- It is high time that our extension scientists give importance to translational research, which has gained popularity in medical research. Translational research is a process rather than a stage and it focuses on multi-disciplinary collaboration. Translation is the process of cascading global best practice and innovation and combining it with local knowledge, so crucial with the variation in soil type, water availability, climatic variations, etc. Translation aims at developing people to manage and lead land based and agri-food businesses in a more productive and sustainable way, which can only be achieved by exchanging knowledge and diffusing innovation that can be readily applied to the agro-food supply chain.

Box 1: Basic Research, Applied Research and Translational Research

Basic Research: The objective of basic research is to gain more comprehensive knowledge orunderstanding of the subject under study without specific application in mind. Understanding how a social process (eg: conflict) affects group behaviour is an example for basic research.

Applied Research: It aims at gaining knowledge or understanding from basic research to meet a specificrecognised need or to solve a specific problem. Finding a conflict resolution process for better functioning of groups is an example for applied research.

Translational Research: This can be considered as Applied research plus. This refers to the new scientificmethods and technologies, inter disciplinary approaches and collaborative institutional arrangements being developed to narrow the gap between basic science and its application to product and process innovation. Translational research encompasses scientific, technical, market and policy signals that arise from basic research to final consumers. Developing conflict resolution strategy for group behaviour in an organisation could be an example for translational research.

Translational Research in Extension

Two variants of translational research that can be used in extension research are:

A. Translating Research Into Practice (TRIP) –This is a research framework gaining importance inresearch projects associated with Medicine, Nursing, Communication, etc. This can be employed in Extension research also.

TRIP creates a space for collaboration, co-constructed inquiry that values and utilises the expectations of all stakeholders. This approach follows from what Lagemann (2008) refers to as 'problem finding research' that produces, or at least provides insights into 'usable knowledge'. Smith and Helfenbein (2009) present the recursive nature of translational research in Education (below), which can be used by the extension scientists.

B. Research into Use (RIU) Approach: RIU programme (http://www.researchintouse.com/) was designed to put the results of

agricultural and natural resources research into use to reduce poverty, promote economic growth and mitigate environmental problems. RIU had two objectives: a. Do everything to put new knowledge (generated in the previous research into use) and b. Use this as an action research case to learn from 'How to put new knowledge into use? Though the fact that RIU originated in a different context and is now closed, the interesting part for the researchers was the second objective, about learning from putting research into use (what works and what doesn't and what needs to be done to put new knowledge into use.
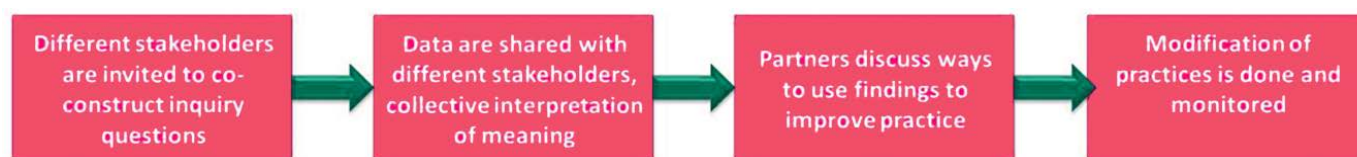
Fig. 2: Recursive nature of translational research in Education

The Centre for Science and Policy, University of Cambridge presents a review of different approaches for translation of research into practice innovation to support sustainable management of natural resources and the alleviation of poverty (Box 2).

Box 2: Translating Knowledge to Policy on Food Security in India

Outcome: In September 2013, the Government of India enacted the Indian National Food Security Bill, enshrining the legal right to food in the Indian Constitution.

Process: A long running campaign on the right to food used specific opportunities to pressurise the GoI to enact new legislation. The ability of key actors to influence the official policy process was facilitated by the use of Public Interest Litigation (PIL) and judicial interventions.

The identity and previous experience of the key actors were important factors. Specific pieces of research were commissioned to generate evidences in support of the proposed legislation The most influential research outputs were those that were easy to access, in terms of availability and cost Researchers, activists and policy actors worked together to build coalition of support for the new law.

Source: Centre for Science and Policy, University of Cambridge, 2014

Some of the applications of translational research in extension include:

Value Chain Analysis

Translational research has been successfully used for value chain analysis of important crops. Value chain analysis describes the activities that take place in a business and relates them to an analysis of the competitive strength of the business. The primary activities, support activities, enabling activities, etc by the different actors involved in value chain can be analysed and properly utilised through translational research.

Decision making by farmers

Extension workers sometimes try to 'push' farmers into accepting recommendations. However, when decisions about what to grow and how to sell are imposed, this rarely leads to success. Farmers do not 'own' such decisions, as they feel a low sense of responsibility. However, helping farmers to make their own decisions is more difficult and also a slow process. But in the long run, it will be more successful and sustainable. However, it is disappointing to note that extension researchers have not bestowed much attention to this. A farmer-centric analysis of decision making process and behavioural change of farmers through unpacking the 'black box' of decision making theories in agriculture is what is needed. Some of the issues to be addressed are:

- Understanding values of the decision maker
- Segmentation of farmers in terms of business engagement and adaptability
- Framework of decision making based on capacity, willingness and engagement
- Role of uncertainty and risk in decision making
- Information used by farmers for decision making
- Tactical, Strategic and Structural decisions by farmers
- Bias in decision making process
- Types of participatory research based on Locus of decision making

Here also, translational research can be successfully employed to apply and validate an effective methodology to deliver a robust evidence base for the decision making process by the farmers.

Meta-Analysis in Extension

Meta Analysis is about "conducting research about research". This refers to the methods that focus on contrasting and combining results from different studies, in the hope of identifying patterns among study results and sources of disagreement among those results. A meta analysis gives a thorough summary of several studies that have been done on the same topic/theme and provides the reader with extensive information on whether an effect exists and what 'size' that effect has. The main advantages of meta-analysis are that the results can be generalized to a larger population and that the precision and accuracy of estimates can be improved as more data is used.

Some of the applications of meta-analysis in extension could be:

a. Sustainable rural livelihoods (based on the results of NAIP research on sustainable livelihoods).

b. Climate change adaptation by farmers (based on the results of NICRA).

c. Social capital (based on various studies conducted on social capital, including SHGs, farmer organisations, etc).

d. Farmer Field Schools (based on different studies conducted on Farmer Field Schools).

Possible Actions?

• Can we look at Extension (as it exists today) and redefine it to the current context and use research findings/development in other social sciences to reinterpret it?

• Can the extension scientists of ICAR join hands and conduct network/ co-ordinated research projects?

• Can the extension scientists conduct Meta analysis on the available research studies on topics of relevance to the farming community?

• Can the extension faculty of SAUs take lead in preparing a Researchable Problems List for M Sc and Ph D students? Can they allot problems to students on selected two or three themes/ topics so that in one year, we will have more information about the research topic from various regions?

• Can we form ourselves into Community of Practice (CoP) to encourage shared learning on selected themes?

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EXTENSION RESEARCH AND TECHNOLOGY DEVELOPMENT

Though extension scientists in the NARS can potentially engage in useful research that can influence the technology development process, they are mostly engaged in organizing training programmes, conducting events, dealing with visitors to the institute and handling documentation responsibilities. Senior extension scientists, M J Chandra Gowda, Sreenath Dixit, R Roy Burman and P N Ananth reflect on this situation here and suggest how extension research can better contribute to technology development.

Technology is a design for instrumental action that reduces uncertainty in the cause-effect relationships involved in achieving a desired outcome. Technology embodies both software and hardware aspects, although software aspects are generally less visible than the hardware. In India, agricultural technologies are mostly generated by scientific research activities carried out by public (mostly ICAR Institutes and SAUs) and private R&D institutions (mostly manufacturers/producers of inputs). Besides, there are umpteen number of location specific technologies developed by practicing farmers.

The technology development process, in a formal set-up, consists of 6 stages viz., Problem – Research – Development – Commercialization – Diffusion & Adoption – Consequences (Rogers, 2003). Extension research has the potentiality and responsibility to contribute to this process directly as well as indirectly. Unfortunately, the extension stream in ICAR research institutes as well as state agricultural universities haven't been able to contribute in this area for various reasons. This is an attempt to discuss how extension research can re-catalyze agricultural technology development and utilization scenario in the country.

Technology Development Process

Problem Identification

The technology development paradigm as discussed above assumes that all research processes must necessarily start with indentifying the problem or need. There is a serious concern over the way problems are being perceived or research agenda is set in public agricultural research agencies. There is a general feeling that, at present, research projects are mostly designed based on review of literature, thrust areas decided by funding agencies and continuation of previously implemented projects in some other institutes.

Bi-monthly workshops, a successful mechanism of NARP (National Agriculture Research Programme) days, had a give-and-take symbiotic purpose, wherein the researchers used to get first-hand feedback on burning issues and the development departments used to get technologies and advisories for communicating the same to farmers. Bi-monthly workshops may not exist now, even if exist, these have become routine, ritualistic and have lost the sting. Extension researchers must explore new arrangements to get the flow of farmers' problems into technology development process. Some of these are discussed in Box 1.

Ex-ante analysis of ground realities related to a researchable issue ensures integration ofusers' orstakeholders' perspectives in the research stage.

Most of the internationally funded projects insist on an ex-ante analysis, preferably carried out by a socio-economist, who is also a part of the project team. On the contrary, very few ICAR and SAU projects follow multi-disciplinary team approach with socio-economist as part of these teams. A mechanism has to be put in place to ensure that the socio-economic perspectives are built into the technology development process. Extension faculty may be weak (in terms of numbers as well as professional competency) in certain institutes. In such cases, efforts have to be made to strengthen their capabilities to contribute to the research process.

Box 1: Accessing farmers problems and linking it to research

The ICAR has a netion-wide network of Krishi Vigyan Kendras (KVKs) and majority of them located in remote areas, thus having close proximity to farmers. KVKs are identifying farmers' problems through district diagnostic surveys, rapid rowing surveys and regular field visits. Thousands of farmers visit KVKs in pursuit of solutions to their problems. Though these are documented in KVKs, researchers in NARS are not properly using these. There is a huge scope for systematizing the flow of researchable issues, particularly to ICAR and SAU research stations and also get back to farmers within a reasonable time limit. Extension research that enables pooling and up-linking of researchable issues to the larger system of NARS is a challenging and daunting task. The Promotion and Uptake Pathways (PUP) of technologies generated by the research system will be an emerging area of research for extension itself.

Kisan Call Centres (KCC) of Department of Agriculture and Cooperation, Ministry of Agriculture, Government of India, function on 16 x 7 basis across the country. Kisan Call Centres are receiving about 6 lakh calls a month or about 20000 calls a day. At least half of these calls are genuine and real indicators of problems of various kinds – mostly pest & disease outbreak, climate/weather related events, input availability, water and soil management etc. But, there is no mechanism to get these problems conveyed to research systems on a real-time basis. A software and network driven mechanism needs to be put in place so that these problems are automatically categorized according to the domain of each Institute and

Research fallinto their **(basice-&mailapplied)** box for use in research activities. Accessing the data base of farmers' problems,including the personal and demographic details, from the Ministry of Agriculture, is a precursor to the whole process

Development

This stage deals with putting new ideas in a form that is expected to meet the needs of potential users. The concept of 'social construction of technology' argues that technology acceptance is shaped by social factors. Technology is a product of society and is influenced by the norms and values of a social system. For example, an oilseed crop variety that is not accepted by oil mill industries will never see the light of day. The social construction of technology is yet to get its due share in the technology development process. For institutionalizing the social construction of technology, nation-wide research in extension needs to be built into research agenda of the entire NARS (Box 2). The present structure of ICAR and SAUs has not been encouraging for extension research to facilitate the technology application process. Most of the extension scientists are deployed in routine works such as organizing training programmes, conducting events, managing visitors to institutes, handling documentation responsibilities etc.

Paddy Task Force promoted by KVK Malappuram, Kerala

KRISHI SAHAYI

Registered Society under KVK guidance

EMPOWERMENT OF TRIBAL WOMEN THROUGH MASS PRODUCTION OF BIOCONTROL AGENTS, KVK WAYANAD

Commercialization

From the extension research point of view, commercialization of a technology can be facilitated by identifying its potential application zones. Under NARP, the entire county was categorized into 127 agro-climatic zones. Each agro-climatic zone is not only vast (the country has 640 districts, an average of 5 districts per agro-climatic zone), but also vary widely in their micro-situations. Soil conditions vary by tens-of meters than kilometers. High degree yield variation exists across regions and between farmers. Part of the variation is being explained by climatic, edaphic and management factors. But variability exists despite similar climatic and edaphic factors and the reasons range from non-adoption of technologies to lack of support systems. Yield gap analysis is a known and well accepted practice to ascertain the scope for introduction of new technologies to a given agro-climatic situation (Box 3).

Box 3: Yield Gap Analysis

Analysis of yield gaps is also a continuous process, as adoption of technologies may vary from season to season and hence, the yield gap levels may also likely to change. It is, therefore, essential that extension research must standardize the ways and means to accurately and continuously assess yield gaps for all major crops and agro climatic zones. Recently, the Working Group on Agricultural Extension constituted by the Planning Commission (Government of India) has indicated the following broad levels of yield gaps:

Gap-A: Genetic potential yield - Maximum yield at the Research farm
Gap-B: Maximum yield at Research farm - Maximum yield under FLDs
Gap-C: Maximum yield in FLD -Maximum yield on farmer's fields
Gap-D: Maximum yield on a farmer's field- District average
Gap-E: Maximum yield on a farmer's field-Average yield in a group of villages around
Gap-F: Maximum yield on a farmer's field- Average yield of farmers in the same village

Farmers manage their each piece of land differently. In such situations, it is foolhardy to think and recommend technologies very generically. What is needed is technology mapping and indexing (Box 4) which needs a strong and viable partnership between research, extension and local institutions. Mechanisms, are therefore, needed to institutionalize this concept through strategic and translational extension research.

Box 4: Technology Mapping

Technology mapping has been used here in two senses. In the first case, a technology is tested for its applicability/suitability in as many locations as possible through technology assessment process being carried out by Krishi Vigyan Kendras. Second and most important dimension is mapping of all relevant and suitable technologies to a particular micro situation, which may give us the Technology Availability Index to that micro-situation. A similar mapping may also be used for indicating technology adoption. A comparison between technology availability and technology adoption maps throw out technology gap for each micro situation. The challenge lies in not only the preparation of such maps and indices, but also in updating and digitizing them for wider utilization on a continuous basis.

Commercialization of technologies doesn't always happen through commercial organizations. It could be achieved through small organizations as well. Successful promotion of paddy

mechanization by a group of trained and equipped women group in Kerala known as Paddy Task Force is an example of how small organizations can commercialize a technology. Production and supply of bio-products viz., *Trichoderma, Pseudomonas* by tribal women groups in *Waynad* district of Kerala for use in controllingwilt disease in pepper, and mass multiplication of *Acerophagus* predator against papaya mealy bug in tapioca in *Namakkal* and neighbouring districts in Tamil Nadu are some other examples.

At a time when rural youth are shying away from agriculture, attracting and retaining rural youth in agriculture is a researchable area for extension. Agri-entrepreneurship is an achievable proposition since the characteristics of entrepreneurs are not inherited but can be developed through systematic motivational training and capacity building. Farm and non-farm business opportunities that ensure more employment and income to rural youth need to be tested and applied through partnership approaches. Developing entrepreneurial motivation training modules, designing appropriate strategy to develop entrepreneurship and agri-business models and agri-based business models for peri-urban systems should be an agenda for extension research.

Diffusion and adoption

Extension services in India are pluralistic in nature, with multiple service providers under both, organized and unorganized sector. Convergence between and among stakeholders in agricultural research and development has become a buzzword, but we still need to identify the limitations and constraints in developing linkage and convergence at the ground level. In the Development Departments, majority of the states have their staff up to block level only. Several positions below block level (which is often called the cutting-edge level) remain vacant. Extension personnel who are in position, perform multiple roles, and hence have very limited time and resources for extension education. Most of the times, they are pre-occupied with implementation of government schemes linked to subsidies and subsidized inputs.

Research on designing and validation of alternate extension approaches, identifying potential partners and mechanisms to achieve sustainable partnership has attained greater significance. The effort of Division of Agricultural Extension, IARI in this regard through developing linkage with branch post masters at village level is very pertinent. About 1.55 lakh post offices exists in India and out of these more than 90 per cent are

rural. Each of these branch post offices cater to six to sixteen villages and the branch post masters are generally resident of that area and practice farming. Capacity building of rural branch post masters for technology dissemination has been experimented and found successful.

Critical inputs like quality seeds of improved varieties can also be delivered to the farmers through this channel. Another Institute which has equally strong presence in the village level is Milk Cooperatives. These can be potentially used as Extension Outreach Centres. Such innovative experiments can prove research in extension meaningful.

Use of ICTs

Information and communication technology (ICT) tools are proving to be an important mechanism to maintain continuous contact with the farmers. Very little evidence is available on the utility of these ICT tools in improving technology adoption. Application of ICT tools have been limited by the constraints both from the demand and supply sides. From demand side, the major limitation is that not all farmers can be reached through language other than their local dialect. Many women farmers who are the actual practitioners and users of the agricultural technologies in real field situations are yet to accept ICT tools for communicating with extension system. On the contrary, supply side has the limitations of lack of connectivity and power availability in rural areas, non-availability of gadgets that support local language etc. Research on strategies and avenues that stimulates use of ICTs for extension, keeping in view these supply and demand side constraints, needs priority attention.

Content management

It is very important in any information and communication intervention. The localization and customization of content is influenced by the way the content is accessed from different sources, assessed to a particular context and delivered in the form and style acceptable to end users. Participation of local farmers in developing these modules is also a key factor as the farmers identify themselves with the situation and the technology. Participatory content development is being attempted in many rural settings and programmes (eg. Digital Green, Community Radios etc). However, there are no easy ways to tap, track and put to use the available information and knowledge (tacit as well as explicit, formal as well as informal). Research based efforts are needed to put in place data warehouses, repositories, search engines and social & technical networking to harness the unearthed potential of ICTs for agricultural development.

Extension Management

The management efficiency of extension and development organizations has to be increased to accelerate the process of development. There is a need to analyze the drivers and processes of innovation and institutional development, devise strategy for sustainable institutions and synergetic convergence, assess the effectiveness of extension models and approaches and develop training modules for enhancing management competencies of extension professionals.

Social mobilization for technology uptake

Group approach to extension has become inevitable considering the widening and unmanageable ratio of farmers to extension workers, which is the result of increased number of holdings on one hand and non-filling-up of vacant posts of extension personnel on the other. Farmers' groups are being formed by many agencies, but are not being nurtured properly to facilitate uptake of emerging agricultural technologies for enhancing their entrepreneurship prospects. Delineation of the factors responsible for successful group mobilization and documentation of good extension practices (GEP) for technology application, group action, empowerment and capacity building are other promising areas for extension researchers.

Consequences

Commercialization of any technology leads to consequences for its adopters/users. These consequences have, in the past, been skewed towards elite sections of the society. Even the change agents, who are recruited to serve the entire community, have a tendency to work with progressive farmers. It's a challenge to develop technologies which are scale-neutral and diffuse them into the social system in such a way that use of such technologies leads to greater equity in the socio-economic consequences. There is a need to bridge the time gap in the technology uptake between "innovators" and "laggards". Even more desirable is to eliminate the late adopter categories. Extension research that facilitates development of scale-neutral technologies is as much important as that of extension tools and methods that empower small and marginal farmers to accept and benefit from such technologies. Extension research in this area is urgent as well as important. Undertaking tracer studies is one such option in this context (Box 5).

Box 5: Tracer Studies

In order to ascertain the successful cases of technologies which have been developed and disseminated with greater degree of equity, "tracer studies" may be very appropriate. These tracer studies are very useful in a detailed study of successful innovations and possibilities of replicating the best of such innovation development processes by scientists of NARS. There are certain weaknesses in tracer studies. These tracer studies are always retrospective in nature, study only the innovation development process but not the consequences part, use limited sources of information for data collection and give a notion that all innovations are developed in a planned manner. It's a challenge to design and carry out tracer studies overcoming limitations and use the results for generating and disseminating technologies resulting in achieving equity.

Acceptance and continued use of many technologies depend on the prevailing development policies, climate/weather parameters, availability of inputs, supporting factors like market, institutions, credit availability and user/consumer preferences. The extension researchers may have to constantly watch the suitability of earlier recommendations to changing circumstances. The changing climate and market forces may necessitate frequent recall of technologies with new/ alternate technologies suitable to different micro-situations. It is interesting to know the impact on credibility of change agency if innovation discontinuance is desired for a previously recommended innovation. Research is needed to understand the concerns while handling such tricky situations.

Feminization of agriculture has become a reality and has implications for technology application, but the problem is yet to be taken cognizance of by the extension researchers. Gender empowerment is essential to face paradigm shifts in agriculture. Conscious and concerted efforts and research are required to push forward the processes that would help, generate and promote technology, policies and institutions based on participatory assessment of gender needs, roles and resources.

Way Forward

Most of the evidences to substantiate the importance of extension research for agricultural development have been only anecdotal. Though the field of extension globally has moved beyond technology transfer, extension research in India is still stuck in need assessment of farmers and constraint analysis. As extension discipline has drawn its contents from various other disciplines, scope and space for interdisciplinary research is very high. There is an urgent need for a strong extension research to generate acceptable proof of contribution of extension research to agricultural development.

Technology development that is happening in informal sector, by farm innovators, entrepreneurs etc. have strong fundamentals as they are essentially problem-solving in nature. However, these innovations fail at commercialization and dissemination stages for lack of support from formal systems. Thus, extension research needs to work with both formal and informal R&D set up so that research for development becomes a reality. Extension research has to be more inclusive in order to ensure that problem-solving agricultural research generates results that are not only commercialized and widely disseminated, but also have equity concerns.

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ACTION RESEARCH– A PROFESSIONAL DEVELOPMENT APPROACH FOR STUDENTS AND TEACHERS

Agricultural extension professionals lag behind in conducting innovative research and generating new knowledge, mainly because of their dependence on conventional research methods. In this blog, Sagar Wadkar, Birendra Kumar, and P Sethuraman Sivakumar highlight the need for promoting action research in extension –as a process to build the empirically-based research capacity of students and teachers– along with a strategy to create and maintain positive social, economic and environmental change.

Farmers in developing countries face several new challenges. These include dealing with uncertain markets and weather, declining land and water availability and their deterioration, and increasing cost of inputs compared to declining income from farming. Extension professionals need to be more realistic and technically competent to address many of these issues. Extension professionals need an empathetic lens to see and understand the target clientele/community better. They should have the ability to analyse a particular issue or field situation from a historical, political, socio-cultural and economic point of view. However, the existing curricula in general and research methodology courses in particular, offer a theoretical orientation for doing research. We need pragmatic orientation to develop this competency for understanding communities, their dynamics and environment.

The extension research was initiated under the influence of a diffusionist approach with emphasis on 'why don't' they adopt innovation, and 'who' adopts and 'why', finding the critical variables that fuelled transfer of technology approach. However, the Master's and Doctoral researches in extension are discipline-focused, oriented towards knowledge acquisition in aspects related to extension rather than skills development and field application/intervention. Research methodology courses currently orient extension students on scientific ways of conducting research. They are taught scientific methods of problem formulation, collecting data, analysing it and reporting. Accordingly, they do research, collect data and analyse it in ways that enable them to describe situations as they exist and/or report impact of any intervention, package of practices, etc., and come up with a 'list of recommendations' for others to implement. This process develops their competency in doing research, but they cannot change field situations and thus produce reports that have minimal application in the field. Adversely it also does not set them apart from other students doing similar academic studies. Sivakumar and Sulaiman (2015) observed that currently extension research in India is not providing any substantiative input for extension policy or in generating good practice of extension. Due to lack of practical significance and stagnation in theory development, extension research is often criticized by other agricultural disciplines as a 'non-performing discipline' (Sivakumar 2015).

Therefore for universities to be more consistent with stated institutional mandates, which emphasise problem solving for communities and national development, empirical research needs to be balanced through the integration of more development-oriented and participatory action

research that enable them to generate empirical data, which further can be used to solve farmers' problems.

The committee on doubling farmers' income (MoA&FW 2017) has also suggested identifying the location-specific problems of farmers, and accordingly the research priorities of post-graduate and doctoral scholars must be guided. Thus, there is a need for application of action-oriented methodologies to make extension research more field-oriented, problem-focused and ethically satisfying.

Action Research

Action Research (AR) is a process of action inquiry that follows a cycle in which one improves practice by systematically oscillating between taking actions in the field of practice, and inquiring into it. The basic action inquiry cycle is about planning for improvement in the practice, acting to implement the planned improvement, monitoring and describing the effects of the action, and then evaluating the outcomes of the action (Tripp 2005). Thus, it is carried out for people, with people and by people, and begins with a systematic investigation of the problem in order to formulate the right questions based on interactions with stakeholders. Unlike academic research, it calls for more engagement with the field. Action is designed to solve problems being faced, and research verifies the efficacy of the action.

It is often considered as social research for social change[1], which demonstrates working towards a resolution of the impetus for action with the reflective process of inquiry and knowledge generation, so as to generate new practices (Somekh and Zeichner 2009). A more succinct definition of AR is:

"…aims to contribute both to the practical concerns of people in an immediate problematic situationand to further the goals of social science simultaneously. Thus, there is a dual commitment in action research to study a system and concurrently to collaborate with members of the system in changing it in what is together regarded as a desirable direction. Accomplishing this twin goal requires the active collaboration of researcher and farmers, and thus it stresses the importance of co-learning as a primary aspect of the research process. "(Thomas et al. 1986).

This approach was found to be effective in helping and empowering farmers, especially when educational institutions, non-governmental organisations, and farmers work together.[2] Kurt Lewin, who first pioneered the action research concept (Box 1), viewed it as a cyclical, dynamic, and collaborative process; and since then action research and its variations have been adopted in a variety of disciplines, including education, psychology, community health sciences, and more recently in rural development.

How is it different from Traditional Research?

AR emphasises problem solving through 'learning by doing'. It focuses on practice of enquiry through concurrent activities. But it is not simply a problem-solving activity. There is dual commitment in action research – to study a system and concurrently to collaborate with members of the system in changing it, in what is together regarded as a desirable direction. Several attributes separate action research from other types of research. Firstly, it focuses on turning the people involved into researchers too. Secondly, it has a social dimension. The research takes place in real world situations and aims to solve real problems. Thirdly, the initiating researchers make no attempt to remain objective, but openly acknowledge their bias to the other participants. Owing to these attributes and other principles it is not possible to place action research in a positive paradigm, especially since the paradigm is based on objective reality and relies heavily on quantitative measures. Action research shows a number of perspectives within the interpretive paradigm. Though this paradigm relies on qualitative measurement, it still retains the ideals of researcher objectivity and researcher as passive collector and expert interpreter of data. Therefore, it is also not the right paradigm for action research. Affiliation of action research lies with the paradigm of praxis. Praxis is the art of working upon the conditions one faces in order to change them. Knowledge is derived from practice and practice informed by knowledge in an on-going process – this is a cornerstone of action research. It also rejects the notion of researcher neutrality, recognizing that the most active researcher is often one who has most at stake in resolving a problematic situation. Thus AR employs recognised research techniques

[1]Greenwood and Levin. (1998.) Introduction to action research: Social research for social change. London: Sage.

[2]Suvedi M and Ghimire RP. (2016.) In search of an alternative agricultural extension strategy: An action research on off-season vegetable production in Nepal. Journal of International Agricultural and Extension Education 23(2):50-62.

to inform the action taken to improve practice, requires action in the fields of both practice and research, so to a greater or lesser extent, it will have characteristics of both routine practice and scientific research. The following table shows how action research stands in relation to some of the differences between these two (Table 1).

Box 1: Origin of action research

As per evolution, four main streams emerged– traditional, contextural, radical, and educational action research (O'Brien 2001).

Kurt Lewin[3] and Traditional Action Research

A German social and experimental psychologist, Lewin coined the term AR[4] and characterized AR as an alternative to the norms of decontextualized research. Instead of focusing on surveys and statistical methods, action research's purpose is to improve social formations by involving participants in a cyclical process of fact finding, planning, exploratory action, and evaluation. Lewin has introduced four types of AR – Diagnostic (to identify a problem and help generate proposed solutions that would be acceptable to those involved in an existing problem situation (people involved in this AR may not themselves be directly affected by the problem); Participant (those affected by a problem are involved from the beginning in finding a solution. This type of AR, tends to have only limited local application and limited generalizability); Empirical (involves accumulating and recording day-to-day lived experiences within groups in order to build generalizable knowledge);and Experimental (using controls to test hypotheses in quasi-experimental conditions. Of all the varieties of AR, this AR has the greatest potential for the advancement of scientific knowledge; however, it is the most difficult form of AR to carry out successfully). Further he conceptualized all kinds of social change as a three-step process: preliminary diagnosis & data gathering (unfreezing) > action planning and co-learning (changing) ☐ integration of desired condition in existing structure (refreezing).

Eric Trist[5] and Contextural Action Research

A social psychiatrist engaged in applied social research, Trist tended to focus more on large-scale, multi-organizational problems, which led to the founding of contextural action research, also referred to a 'action learning'. It entails reconstituting the structural relations among actors in a social environment, where all concerned parties and stakeholders participate so as to understand the working of the whole.

Paulo Freire[6] and Radical Action Research

Freire,a Brazilian educator and philosopher, pioneered the Participatory Action Research (PAR) methodology, a subset of radical action research, which has a strong focus on emancipation and the overcoming of power imbalances. This method grew out of his critical pedagogy and emancipating theology ideas. He further emphasized the significance of critical consciousness for social change, where oppressed groups can take up their own action for their self-upliftment. The two branches of this school are PAR and Feminist Action Research.

John Dewey[7] and Educational Action Research

An American educational philosopher, John Dewey believed that development practitioners, and professional educators, should engage in solving community problems by professional development, curriculum development, empowerment and action learning. Dewey's problem solving model (known as reflective thinking) is popular and he affirms that in practice, educational action research influences the quality enhancement of teaching and learning. This evolved into the living theory approach – to justify the practitioners' educational influences in their own learning by asking "How am I improving what I am doing?" (Whitehead 1989; McNiff 2002).

[3]Lewin K. (1948.)Resolving social conflicts: Selected papers on group dynamics. Ed. Gertrude W. Lewin. New York: Harper & Row.

[4]Lewin K. (1946.) Action research and minority problems. Journal of Social Issues 2(4):34-36.

[5]Trist Eric. (1977.)A concept of organizational ecology. Australian Journal of Management 2(2):161-75.

[6]Freire P. (1970.)Pedagogy of the oppressed. New York: Seabury Press.

[7]Dewey J. (1929.)The quest for certainty: A study of the relation of knowledge and action. New York: Minton, Balch and Company.

Table 1: Differences between routine practice, action research and conventional research

S. no.	Routine Practice	Action Research	Scientific Research
1	Habitual	Innovative	Original, resourced
2	Continuous	Continuous	Occasional
3	Responsive, contingency driven	Pro-active, strategically driven	Methodologically driven
4	Individual	Participatory	Collaborative/Collegial
5	Naturalistic	Interventionist	Experimental
6	Unexamined	Problematized	Commissioned
7	Experienced	Deliberative	Argued
8	Unarticulated	Documented	Peer reviewed
9	Pragmatic	Understood	Explained/Theorised
10	Context specific		Generalised
11	Private	Disseminated	Published

(Source: Tripp 2005)

The process of Action Research

Extension researches are applied in nature, meaning that the findings need to be useful for changing behaviour of the clientele group. However, in reality the methods used are no different from the other social research methods except that the problems are field-oriented mostly. Inclusions of action research in education and management have the logic of relevance and applicability. It is a process to conduct research in a natural setting, and learns from the findings that go on to improve the situation. Here action and research go hand in hand. Research is conducted to solve a problem being encountered by the practitioners and then the researcher takes efforts to understand and conceptualize the problem and form hypothesis for alternatives. Then s/he takes actions systematically to solve the problem. Along the way s/he also collects data to measure the impact of the action. It is a cyclic process of action and reflection. The best part of the research is its focus on applicability of the solutions. It is so different from academic research that many academicians may refuse to accept it as research, but the relevance of the methodology may motivate them to use it to learn from everyday action and practice. Thus, it deals with two things: action (what you do) and research (how you learn about and explain what you do). The action aspect of action research is about improving practice. The research aspect is about creating knowledge about practice. The knowledge created is your knowledge of your practice (McNiff and Whitehead 2010). A few examples of conventional extension research questions and action research questions are displayed in Table 2.

However, action research is very challenging and difficult to do. Normally academics accustomed to conventional data-based research may find the whole exercise unpalatable and unresearch-like due to the uncertainties regarding conceiving, conducting, reporting and publishing such research.

Various scholars have explained action research as emancipatory research, collaborative inquiry, and action inquiry, but all are variations on a theme. There are many models and guidelines for engaging in the action research methodology

Table 2: Differences in conventional and action research questions

S. no.	Conventional extension research	Action research
1	What is the relationship between adaptor characteristics and adoption of improved	How do I influence the farmers so that they adopt the improved technology?
2	Does the leadership style influence the extension worker's productivity?	How do I improve the leadership style of extension managers so as to improve worker productivity?
3	Does the extension intervention (FLD, etc.) improve the farm income?	How can I increase the farm income by implementing A specific extension intervention?

(Box 2). Some of the different developments of the basic action inquiry process include: action research (Lewin 1946), action learning (Revons 1971), reflective practice (Schon 1983), action design (Argrys 1985), experiential learning (Kolb 1984), the PDCA cycle (Deming 1986), PLA, PAR, PAD, PALM, PRA,[8] etc. (Chambers 1983), deliberative practice (McCutcheon1988), praxis research (Whyte 1964; 1991), appreciative inquiry (Cooperrider and Shrevasteva 1987), diagnostic practice (generic in medicine, remedial teaching, etc.), action evaluation (Rothman and Dosik 1999), soft systems methodology (Checkland and Holwell 1998), transformational learning (Marquardt 1999), as a helix (Stringer 2008), and e 'learning by doing' (O'Brien 1998).These models are developed and customized to particular uses, practices, participants, and situations, which have different outcomes that are likely to be reported in different ways to various audiences.

Box 2: Models of Action Research

1. Various models that can be used to conduct action research. These are as follows:
2. Stephen Kemmis (1982): a basic model - plan, action, observe, and reflect;
3. Gerald Susman (1983): a circular model - diagnose, action plan, take action, evaluate, and specify learning;
4. Eric Trist and Fred Emery (1959): a search conference – collaborative group model – pre-conference, group work 1 (scanning the issue), group work 2 (desired future), group work 3 (options for change), presentation plenary after each group work and post conference;
5. Mertler and Charles (2011): a cyclical and iterative model -
   - Planning stage: Identifying and limiting the topic; gathering information; reviewing related literature; developing a research plan;
   - Acting stage: Collecting data; analysing data;
   - Developing stage: Developing an action plan;
   - Reflecting stage: sharing and communicating results; reflecting on the process.

Role of the Action Researcher

The role of a researcher in action research is to produce a mutually agreeable outcome for all participants. To accomplish this he may play different roles at various stages of the process. These are planner, leader, catalyser, facilitator, teacher, designer, listener, observer, synthesizer and reporter.

The main role, however, is to nurture local leaders to the point where they can take responsibility for the process. In many action research situations, the researchers' role is primarily to take the time to facilitate dialogue and foster reflective analysis among the participants, provide them with periodic reports, and write a final report when the researchers' involvement has ended.

Implication of AR in Agriculture and Rural Development

It is a well-recognised fact that there is weak coordination and linkage between research, education, extension, and farmers. Extension researchers are not aware of field challenges and problems, therefore their research lacks in relevance, offers limited information and very little knowledge sharing between stakeholders. On the other hand, (participatory) action research enables bridging of these gaps and collaborates with farmers in key activities including technology selection, dissemination, evaluation (Case Study 1), value-chain analysis (Case Study 2),and convergence of schemes and programmes for its effective implementation (Case Study 3),thereby breaking the traditional one-way relationship and fostering shared visions and actions among stakeholders.

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1. Linking research institute with post offices for dissemination of agricultural technologies: An action research project

The aim of this action research project conducted by the Indian Agricultural Research Institute (IARI), New Delhi, was to establish linkage with Post Offices for dissemination of agricultural technology and package of practices. In the first phase of the study, an exploratory and descriptive study was conducted on the possibility of establishing linkages with post office in dissemination of IARI technology. During the course of this process the post offices and their personnel at district, block, and villages levels in Sitapur district of Uttar Pradesh were contacted, and the trends in post office workings in the last 10 years was assessed. In Phase 2, suitable crops and their varieties were identified and disseminated through the postal network; then performance was assessed. Performance of these crops was assessed in terms of area coverage, yield obtained, total quality of produce generated for further use, and their economics for high volume-high value and low volume-high value crops. Post office personnel's and farmers' perceptions (n=200) were ascertained and correlated to see the degree of convergence. As a result, the AR team including post office personnel, conclusively decided to disseminate IARI's quality seed and related package of practices through Post Offices.

In 2011–12 Rabi season, 1014 farmers under seven post offices in two blocks, namely Sidhauli and Kasmanda, covering 30 villages were reached through this approach. It was observed that more than90% of the farmers received the seed of wheat, paddy, pigeonpea, bajra (pearl millet), mustard, bottle gourd, pumpkin, and okra crops sent through post offices within 4–6 days of despatch from IARI. At the evaluation stage, a survey was conducted with certain identified farmers to analyse their feedback regarding IARI seeds, seed despatch mechanism and related issues. The performance of IARI crop variety was found superior as compared to prevailing popular varieties. Farmers, as well as village post office personnel, found this approach very effective and a successful means for making the improved agricultural technologies available in the rural areas in fairly less time and cost. In the final stage, the capacity building of farmers and post office personnel was done so as to raise their level of agricultural knowledge; and cost sharing for high volume crops further helped to improve the sustainability dimension of this approach. This AR helped to generate a new empirical model of transfer of technology through post-offices, and helps to strengthen backward linkages with research institutes.

(Source: Dubey et al. 2012)

Agriculture and rural development is based on local resources, bio-physical properties, and more importantly, the capabilities of people as key resources. AR helps to utilise these local resources and capabilities and offers a practical approach to innovation and support, and facilitates change processes concerning issues of sustainability of livelihoods. These aspects are highlighted in Case Study 2 (below).

2. Improving income for walnut growers in Kishtwar, Jammu and Kashmir, through better marketing linkages and value addition at the source

Jammu and Kashmir (J&K) State contributes almost 98% of the total walnut production in India. In the state, Kishtwar district is the major contributor, and offers huge potential for high incomes to farmers. However, factors such as a large number of middlemen, lack of market information and connectivity, and low value addition at source have prevented the benefits of these endowments from reaching the actual growers of this region. Farmers lost up to 38% of their potential income in the year 2013-14. In this backdrop, action research was undertaken with the focused objective of increasing per capita income of walnut growers through effective post-harvest management. The study was divided into three major parts. In part 1asituation analysis was carried out to understand the context and identification of the problem. This was performed by narrowing it down to the commodity–Walnuts, then value chain analysis and the opportunity therein; and finally identification of villages for which a rank-based ordinal approach was adopted, then the Panchayat with the top score was selected based on quality and quantity of walnuts, and ratio of small farmers to large farmers.

In the second stage, analysis of the existing walnut-marketing channel was assessed; walnut growers were sensitised and mobilised towards post-harvest management, their capacity built to undertake different functional roles (as monitors, harvesters, collectors, processors and transporters) for primary processing at the source, and finally the per capita gain in income was calculated and revealed, and the process documented. As a result, a village, 'Sigdi', was identified for the study. The potential of gain from the last

selling prices of producers per kg was found to be 31%for shelled walnuts and 47% for kernels. Therefore it was decided to have manual cracking of walnut at household level, then at district level grading, segregation, quality inspection and packing was done, and finally transportation of packaged kernels and shelled walnut to the local and national market. All these efforts resulted in: dissolution of the information barrier, increased value due to processing, and higher offer prices in the new market. Consequently the average earning for 297 households of the village increased by 28% in addition to perceivable improvement in the status of women. The action research approach adopted by the team (growers, panchayat representatives, and district officials) and convergence displayed by the various government functionaries truly reflect the essentials of a successful intervention. This approach helps to organise farmers so as to strengthen their organizational and entrepreneurial capacities. It was also observed that in the absence of this foundational phase, farmers will not develop the necessary ability to function as genuine partners in value-chain analysis.

(Source: Sharma 2017)

Action research engages the researcher in a collective action approach and enables them to implement the programmes and schemes efficiently and thus develop new solutions that can change existing practices. They can moreover then test the feasibility and features of these new solutions, innovations, products, services, etc. (Case Study 3)

Case Study 3

3. Improving efficiency of skill development schemes: Action research in Naxal-affected Narayanpur district of Chhattisgarh

The aim of this AR was to improve the efficiency of the skill development scheme in order to provide suitable livelihood opportunities to prospective youth. This study analysed the three major skill development programs – Mukhya Mantri Kaushal Vikas Yojana, Deen Dayal Upadhyay Gramin Kaushal Yojana and; Rural Self Employment Institute– implemented in Narayanpur district under the aegis of the Chhattisgarh Skill Development Authority. The study divided into four major parts: a) Situation analysis to assess skill demand was conducted through a survey to understand the employment status in the district and demand for skill courses among the potential youth (age group of 14 - 45 years); b) Skill gap analysis to ascertain prospective employment opportunities in the district and State were mapped with the help of local administration, local employers, entrepreneurs, government officials, and upcoming industries in the district; c) Content analysis of selected schemes were carried out to understand the provisions under each scheme; and d) accordingly a perspective plan for the effective implementation of these schemes was prepared and executed. The AR team has a proactive role in all phases of the AR process, comprising District Skill Development Authority and its enabling agencies, 35 anganwadi sevikas, 52 saksharata preraks, 38 vocational training providers, 26 private employers within the district, all facilitated by a Rural Development Fellow as the Researcher. Thus it is suggested that there is need for convergence of the relevant schemes at the district level for its effective implementation. Any scheme or program should not be implemented as a standalone plan, but it should be part of a larger framework that includes education, people's development, livelihood security, employment generation and socio-economic integration of society, for its effective implementation.

(Source: Patki 2017)

Potential of AR in Extension

Action research has immense potential in extension. In general, most research problems in extension are complex in nature, calling for multi-disciplinary collaborative action. As extension research strives to advance knowledge, one has to master the skill while solving the problem. A few examples of action research in extension science are shown in Table 3.

A few research papers on Action Research

The following research papers examined action research approaches on various aspects related to agriculture; and then were published in highly-rated and peer-reviewed international journals.

Distance education

- Nunes JMB and McPherson MA. (2003.) An action research model for the management of change in continuing professional distance education. Innovations in Teaching and Learning in Information and Computer Sciences (ITALICS), 2(1). (Citescore2017- 0.27).

- McPherson MA and Nunes JMB.(2002.) Supporting educational management through action research. The International Journal of Educational Management 16(6):300-308. (CiteScore 2017:1.16).

Table 3: Examples of action research in extension

S. no.	Research problem	Objectives of research	Type of action research	Variables	Who will conduct the research and outputs
1	The vegetable farmers are suffering from unstable market prices of seasonal vegetables. The aggregators, who collect vegetables directly from farms are exploiting the farmers by paying a lower price. The farmers' share in the consumer price is estimated at 55% despite their proximity to Delhi. There is a need to design sustainable value chain interventions in order to enhance the welfare of vegetable farmers.	To enhance livelihood of farmers through sustainable value chain intervention **Steps** 1. Selection of value chain; 2. Mapping of value chain; 3. Assessment of value chain to identify intervention points; 4. Develop a competitiveness strategy; 5. Design and implement value chain interventions; 6. Monitoring and evaluation; 7. Institutionalisation – Creating Farmers' Organisations, like FPO, etc.	**Participatory value chain intervention** Mixed methods research design • Multi-disciplinary – Economics, extension, seed technology, food technology, agronomy; • Type of user involvement – Collaboration; • Integration of research with extension work – involves creation of farmers' groups/ FPOs, demonstration of technology, training of stakeholders, farmers' seminars/ workshops, market linkage, and entrepreneurship development.	• Variables - Marketing channels, market-related operations, value chain actors and processes, interconnections and flows, current technologies and problems, profit at each level, price spread, share in consumer rupee, interventions, entrepreneurship orientation of farmers, entrepreneurial eco-system; • Methods – PRA, focus groups, market survey, document analysis, participatory observations; • Major statistical tools – network analysis; regression.	**Who** Two PhD student theses, or three to four MSc theses, by splitting the research components. **Outputs** • Research papers in quality peer-reviewed journals; • Development of an extension model with reasonable replicability; • Improving adoption of University-developed technologies; • Suggestions to University to modify existing technologies or develop need-based technologies; • Demonstrating the University's role in socio-economic development of the population it serves.
2	The state government has announced a programme on peri-urban agriculture with a focus on promoting home gardening in cities. The idea was to increase the availability of safe and nutritious vegetables in cities while maximising the green cover to combat pollution. As a part of the programme, the Universityis	To develop a course management modelto provide quality learning experiences **Approach** Development of an integrated learner-centred model for course improvement, tutor development, course management strategies and infrastructure evolution.	**Distance Education Management Action Research** Mixed methods research design - • Multi-disciplinary – Extension, Computer Science/ Engineering, Horticulture; • Type of user involvement – Collaborative – implemented through aLearner Club created for study **Steps** 1.Creation of Learner Clubs;	• Variables - specific topics desired by learners, type of information/ skill desired, preferred learning mode/ -media; learner characters – learning style (cognitive, visual, auditory, kinaesthetic and tactile);current knowledge/skill levels, education, motivation to learn; feasibility studies of home gardening at their place; availability and access to seeds and other inputs	**Who** Two PhD student theses or three to four MSc theses, by splitting the research components. **Outputs** • Research papers in quality peer-reviewed journals in computer based learning or distance education; • Development of a distance model with reasonable replicability; • Improving adoption of University-developed vegetable technologies and systems;

designing a distance education course on vegetable-based home gardening, targeted towards housewives and retired people in urban areas. The course will be delivered through the existing distance education system of the University. The extension department is tasked with designing the educational management approach for the specific course.

Models
1. Educational Management Action Research model (McPherson & Nunes 2002)
2. Educational Systems Design Framework (Nunes 1999)

2. Diagnosis – Identification of learning needs and learner characteristics;
3. Action planning –Instructional design by combining pedagogical model with suitable educational setting; field testing of learning paths;
4. Action taking – Managing course delivery;
5. Action evaluation – Formative and summative evaluations on learning achievement

(customised to home garden needs); tutor selection and training, learning paths; learner feedback
• Methods – Participatory workshops with learners and tutors; participant observations; focus groups discussion; experiment (to assess user learning with different learning paths/ designs)

• Demonstrating the University's role in socio-economic development of the population it serves.

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Way Forward

Putting people at the centre of development is the key to sustainable development. In a changing development scenario, extension professionals need to be competent in both technical areas of their field as well as in process skills. Farmers' problems are multi-dimensional, it demands multi-disciplinary research and convergence of all relevant stakeholders (currently missing in most

extension researches), whereas action research encourages agricultural stakeholders to keep an eye on changes and modify their approach and programs to suit the changing contexts.

However, currently MSc and PhD research is limited by institutional mandates and protocols with a pre-determined approach, which needs to be reviewed if action research is to be encouraged. Action research provides a unique opportunity for students to look at how participatory methods can be translated from theory into practice, how they become institutionalized, and its impact on diverse farming communities. The knowledge gained and generated in the process helps academicians, extension professionals and development practitioners to enhance theoretical understanding of how increasing peoples' participation leads to increased empowerment and decision-making. Further, this process of participation brings change in people and nurture a sense of belonging and ownership towards developmental efforts, thereby leading to sustainability of the intervention undertaken. The students with these new skill sets are expected to become development facilitators and/or managers of rural innovation, who can simplify complex development processes. We should encourage extension researchers, especially PhD scholars, to undertake action research on contemporary issues– this change may call for the capacity building of faculty inaction research methodology.

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31

SAMPLE SIZE FOR EXTENSION RESEARCH – QUANTITATIVE STUDIES

Non-availability of sound guidelines for sample size estimation is the primary factor affecting the quality of extension research in the country. In this blog, P Sethuraman Sivakumar presents guidelines for choosing adequate sample for extension research.

Sample size is of primary importance for any applied scientific research as it directly influences the validity and generalisability of the research findings. . In extension science, empirical research is expected to yield sound extension tools and techniques to help the field functionaries effectively implement extension programmes. However, the empirical extension research is often conducted with smaller samples, which is confined to a specific geographical or demographical population (Sivakumar and Sulaiman, 2015). Social science studies conducted with inadequate sample sizes are vulnerable to inconsistencies. Such studies are likely to produce contradictory findings when conducted on the same research problem on an identical population (Johnson and Lauren, 2013). Though there are many factors responsible for the small sample extension research, the non-availability of sound guidelines for sample size estimation is the primary factor affecting the quality of extension research in the country. The purpose of this blog is to describe the sample size estimation process and provide guidelines for choosing adequate sample for both the quantitative and qualitative studies in extension research.

Sampling Strategy

The strategy is the plan devised by the researcher to ensure sample chosen for the research work represents the selected population. Choosing an appropriate sampling strategy is a key aspect of the research design. Robinson (2014) proposed a four-point sampling process for systematically selecting adequate samples for obtaining quality results.

1. **Define a sample universe:** Establish a sample universe,specifically by way of a set of inclusion and/or exclusion criteria. Inclusion criteria specifies the attribute(s) that respondents must possess to qualify for the study and the exclusion criteria stipulate attributes that disqualify a case from the study. For example, in a research investigation focusing on the "Information source utilisation of Bergrowers", the inclusion criteria is "Ber grower (Current/ past specified in years)", while the exclusion criteria is "growers of other crops". During the selection, the homogeneity of the samples i.e., demographic (e.g. youth), geographical (e.g. Maharashtra or Tamil Nadu), physical (e.g. female workers), psychological (progressive farmers) and life history (e.g., migrant workers) should be considered.

2. **Deciding on sample size:** The size of a sample used for a quantitative or qualitativeextension research is influenced by both the theoretical

and practical considerations. The theoretical considerations for quantitative studies include the nature of problem, the population size and the type of analytical strategies used; while qualitative investigations focus on the saturation and redundancy of the data collection methods (Robinson, 2014). The practical aspects include the time and resource availability, researcher capability and purpose of research work (e.g., for dissertations or sponsored research).

3. **Selecting a Sample Strategy:** The popular sampling methods in quantitative research areprobabilistic and non-probabilistic sampling, while qualitative research uses random/convenience sampling and purposive sampling strategies. After deciding on the sampling strategy, the respondents required for each sample category (e.g., strata) is decided from the overall sample size.

4. **Sourcing sample:** When the sample universe, size andstrategy are decided, the researcher needs to recruit the participants from the real world. Voluntary participation, recruiting students from the subject pools, advertising in social and print media for recruiting community members, online surveys with jackpot provisions are few ways of recruiting participants for research work. In this phase, the researcher should follow ethical guidelines (if suggested by the ethics committee) in advertising, selection and handling participants, confidentiality of research data, compensating participants for their time and effort, etc. However, the extension research in India is conducted without following any ethical practices as suggested by various "Human Subject Research" regulatory agencies. The ignorance and non-compliance with International ethical guidelines poses serious problems when the research outcomes are published in peer-reviewed international journals.

## Sample Size Estimation for Quantitative Extension Research

In the quantitative extension research, the samples are drawn through either probabilistic or non-probabilistic sampling techniques and stratified random sampling is widely used by the researchers. Though the sampling methods specify few guidelines on the number of samples to be selected, the sample size is dependent on various other factors like type of study, nature and size of the population and choice of statistical analytical methods for the study. Other factors which help in deciding the sample size include the following:

- Confidence level at which the results are interpreted,
- acceptable levels of sampling errors and precision of the results expected,
- effect sizes required,
- variance and standard deviations of the primary variables reported by the past work.

In case of self-report methods, the expected response rates also influence the sample size since poor response rates are likely to reduce the sample numbers required and affect validity of the research.

The following are the factors to be considered while selecting the sample size for a quantitative study:

1. **Type of research investigation and test population:** The type of research investigation whether descriptive and observational or experimental, determines the number of samples required for the work. The descriptive studies employ minimal statistical estimation procedures like proportions and Chi-square tests, and sample size estimation procedures are described in the following sections. For experimental studies involving human subjects (e.g., knowledge gain from a multimedia instruction), the sample size depends on the design – replication, randomisation and stratification. The test population size also plays a crucial role in sample size estimation and the quantitative methods often require samples representing a maximum of 5% of the total population (Henry, 1990). The study population size can also be derived from past studies and secondary data sources (e.g. agricultural census). If the population size isunknown, the sample size can be estimated using the modified procedures as described in Box 1.
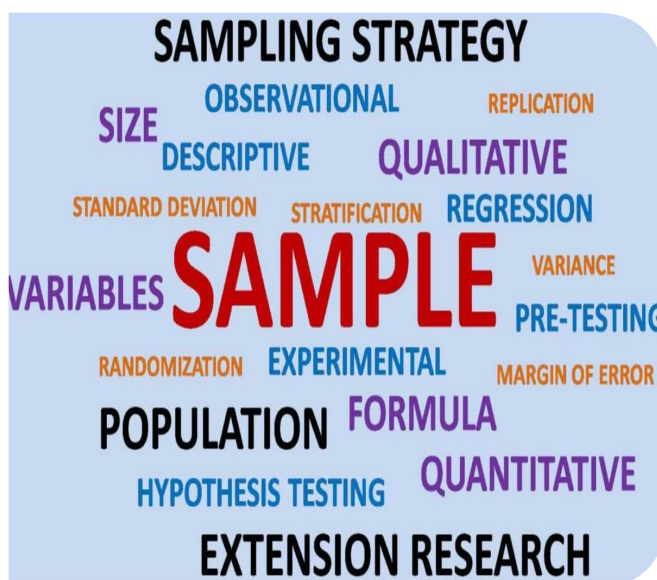
Table 1: Necessary Sample Size to Detect a Given Effect Size for Simple Linear Regression, ANOVA (t-test), and X² Analyses (? = 0.05 and ? = 0.20).

Multiple regression		ANOVA and t test	
Correlation coefficient (r)	Reqd. Sample size (N)	Eta (η)	Reqd. Sample size (N)
0.10	782	0.10	396
0.15	346	0.15	176
0.20	193	0.20	99
0.25	123	0.25	64
0.30	84	0.30	44
0.35	61	0.35	33
0.40	46	0.40	25
0.45	36	0.45	20
0.50	29	0.50	16
0.55	23	0.55	14
0.60	19	0.60	11
0.65	16	0.65	10
0.70	13	0.70	9
0.75	11	0.75	8

(Source: Gatsonis and Sampson, 1989)

2. **Primary variable(s) of measurement:** A research investigation may use a variety ofdependent and independent variables. For estimating the sample size, the researcher should decide the primary variables (dependent and few significant independent variables) to be included in the study. After deciding on the primary variables, the sample sizes are estimated separately for each primary variable or combinations using the formulae given in the Box 1. For example, if a researcher wishes to conduct a study on the factors influencing adoption of IPM for tomato crop, he/she should review the past studies to know the primary independent variables influenced adoption (e.g., gender, educational status, scientific orientation etc). Using the estimates of those variables (e.g., educational qualification correlation coefficient with adoption), the researcher can decide on the sample size using Table 1. After estimating the sample size for all primary independent variables individually, the researcher must choose the largest estimated sample size for the investigation.

3. **Acceptable Margin of Error – confidence intervals and confidence levels:** The margin of error is the error theresearcher is willing to accept in the study. The margin of error depends on the confidence interval, which is a measure of probability that a population parameter will fall between two set values. In any empirical research, we are selecting samples to estimate few numerical values for describing or analysing certain attributes of the respondents. The confidence intervals provide a range of values which represent a population parameter (e.g. adoption level of a crop variety or animal breed in the full population of the farmers in the real world) and tell us this that these values are true with a probability level (eg., 90%, 95% or 99%).

These probability levels are called as confidence levels. In any descriptive or analytical study, the confidence intervals are presented along with the mean and standard deviation of a specific attribute or variable. The confidence interval provides a range of values around the mean (both + or - mean) which represent the value of marginal error. It is necessary to decide on the allowable margin of error prior to the survey for calculating the appropriate sample size. It is decided by scanning through the past research studies on the same topic and identifying the reported mean values of primary variables. For example, if a researcher wishes to conduct a study on "Effectiveness of the training programme" with "Knowledge gain" as the primary variable, he/she should

find the knowledge gain mean values reported from the past studies and decide on the value to be used for sample size estimation. In social research, a maximum of 5 percentage points around the mean is used as marginal error (Krejcie and Morgan, 1970).

The confidence level indicates an alpha error value in hypothesis testing. The alpha (α) or type I error is a false-positive error of rejecting the null hypothesis that is actually true in the population, while the beta (β) or type II error indicates a false-negative error of failing to reject the false null hypothesis. Statistical power is probability of correctly rejecting the null hypothesis and is represented as 1 - ?. During sample size estimation, we are trying to reduce the alpha error by selecting a lower significance level of either 0.05 (95%) or 0.01 (99%) of the test. While an alpha level of 0.05 (5% probability for error) is acceptable for most social research, 0.01 (1% probability for error) is preferred when critical decisions are taken using the research results. As indicated in the previous paragraph, the confidence intervals are always expressed with a specific confidence levels (alpha error). The □ error is not as serious as □ error, but it is of particular concern when interpreting the results of a negative study, without statistical significance (no statistical significance or there is small significance and the test is unable to detect it). Statistical power for any sample estimation is conventionally set at 0.80 i.e. □ = 0.20.

4. **Effect size:** The effect size represents the size of theassociation between variables or difference between treatments the researcher expects to be present in the sample. If the researcher expects that his/her study to detect even a smaller association or difference between variables with precision, then he/she may need a larger sample size. For example, the knowledge gain from multimedia extension module can be detected precisely when the researcher tests the module with a large sample. In descriptive studies, the association or difference between the variables is reflected by the amplitude of the confidence interval calculated in the estimation. The effect sizes can be estimated from the reported values of association or effect from previous studies using Cohen's D, odds ratio, correlation coefficient and eta square methods. In general, the effect size (Cohen's d) of 0.2 to 0.3 is considered as "small", around 0.5 a "medium" effect and 0.8 to infinity, a "large" effect (Cohen, 1988). As a thumb rule, the associations or differences between variables reported in the past studies

with "small" effect, require a large sample size for further studies.

Various online effect size calculators are available in the Psychometrica website (http://www.psychometrica.de/effect_size.html).

5. **Variance or Standard Deviation:** When the variables analysed in the study are of aquantitative nature, their variability (variance or standard deviation) is considered for sample size estimation. Variance is a measurement of the spread between numbers or observations in a data set and is a square of standard deviation. The variance measures how far each number or observation in the data set is from the mean.

Cochran (1977) listed ways of estimating population variances or standard deviations for sample size estimations: (1) Select the sample in two steps, i.e. select the first sample and estimate the variance through pilot study and use the estimated value for the selection of sample size estimation for the main study; (2) use data from previous studies of the same or a similar population; or (3) estimate or guess the structure of the population assisted by some logical mathematical results. If the researcher finds difficulty in obtaining variance values from the previous study, he/ she can use an arbitrary value of 50% (Krejcie and Morgan, 1970).

In case of descriptive studies involving proportions, the researcher must specify the response distribution (labelled as p in the sample size formula) i.e., the expected proportion of the population that have the attribute the researcher is estimating from the survey. This proportion can be obtained from past studies, a pilot study or through other secondary sources. For example, if a researcher wishes to assess the gender differences in effectiveness of training on vegetable cultivation, he/she should review past studies to know the gender difference values (e.g., percentage of females who are satisfied with training). If this proportion is unknown, it should be arbitrarily set to 50% for use in the equation 1a. In case of descriptive studies involving means, the response distribution is replaced by variance or standard deviation (s^2 in Equation 1b).

Calculation of Sample Size

The sample size estimation follows the various aspects discussed in the previous section. Considering the complexity of sample size estimation, a simple of way of deriving sample size based on the nature of the research investigation (pre-testing phase, descriptive and analytical or hypothesis testing) and type of

statistical tests planned for the study.

1. **Pre-Testing (of Research Instrument):** The pre-testing of the research instruments is akey phase of any social research study. The main purpose of the pre-test is to verify that the target audience understands the questions and proposed response options are used as intended by the researcher, and the respondents are able to answer meaningfully (Perneger *et al.,* 2015). Identification of problems in the instrument —e.g., unclear question, unfamiliar word, ambiguous syntax, missing time-frame, lack of an appropriate answer—lead to a modification of the instrument. The sample size for the pre-test in extension research is often decided based on few flexible criteria, without following any rigorous procedures.

Past studies indicated that a sample size of minimum 30 respondents to achieve a reasonable statistical power to detect problems in the instrument (Perneger *et al.,* 2015).

2. **Descriptive studies:** Descriptive studies are conducted to explore and describe a testpopulation or their attributes in a systematic way. These studies are designed to estimate population parameters from sample which do not involve testing hypotheses. The data generated through these studies are described by presenting frequencies, proportions and means. The sample size estimation procedures for descriptive studies proposed by Rodríguez del Águilaa, and González-Ramírezba (2014) are described in Box 1.

Box 1: Sample size estimation procedure for descriptive studies

A. For finite populations (known population size)

Studies involving categorical variables

When the descriptive studies involve categorical variables, the researcher can estimate only proportions of particular attribute Eg. Studies aim for describing a system (e.g. crop or animal production systems, ITK documentation). The sample size for studies involving categorical variables can be computed by the following formula (Rodríguez del Águilaa, and González-Ramírezba, 2014).

$n=(t_\alpha^2*p*q*N)/((N-1)*e^2+t_\alpha^2*p*q)$ Equation 1a

Where n = Sample size to be estimated; t_α = value of the normal curve associated to the confidence level; p = expected percentage of population having a particular attribute; q = (p-1); e = accepted margin of error (usually between 5 and 10%) and expressed as percentage and N = Population size

Studies involving interval or continuous variables

For the descriptive studies involving interval or ratio variables, the descriptive like mean, mode, median and Standard Deviation can be computed. The sample size for such studies can be estimated using following formula:

$n=(t_\alpha^2*s^2*N)/((N-1)*e^2+t_\alpha^2*s^2)$ Equation 1b

Where n = Sample size to be estimated; t_α = value of the normal curve associated to the confidence level; s^2 = variance of the variable for which we want to estimate the mean; e = accepted margin of error (usually between 5 and 10%) and expressed as percentage and N = Population size

Correction for estimates exceeding 5% of total population

If the calculated sample size exceeds 5% of the population size, Cochran's (1977) correction formula should be used to calculate the final sample size.

$n1= n_0/((1+n_0/N))$ --- Equation 2

Where N = Population size; n_0 = required return sample size according to Cochran's formula given in equation 1a or 1b; n^1 = required sample size because sample > 5% of population

Correction for response rate

The response rate is a crucial aspect in any research study involving surveys requiring voluntary participation of the respondents. Poor response rates often reduce the sample size and hamper the accuracy of the results. Salkind (1997) recommended oversampling i.e. increasing the sample size to the extent that will account for anticipated poor return rate. Oversampling can be achieved through four methods: (1) take the sample in two steps, and use the results of the first step to estimate how many additional responses may be expected from the second step; (2) use pilot study results; (3) use

responses rates from previous studies of the same or a similar population; or (4) estimate the response rate through a systematic study. When the response rate is calculated by using any one of the above methods, the final sample size may be calculated using the following formula:

$n_2 = n_1/(\text{Anticipated return rate})$

Where n^2 = sample size adjusted for response rate; n_1 = required sample estimated from equations 1a or 1b or 2.

B. For infinite populations

In the case of infinite populations (population size unknown), the size of the population exerts no influence and the formulae referring for proportions and means are simplified.

Estimation of proportion (Categorical variable)

$n = (t_\alpha^2 * p * q)/e^2$

Estimation of a mean (Continuous variable)

$n = (t_\alpha^2 * s^2)/e^2$

where n = sample size to be calculated; p = expected percentage of population having a particular attribute; q = 1 − p; s^2 = variance of the variable for which we want to estimate the mean; e^2 = accepted margin of error; t_α = value of the normal curve associated to the confidence level.

After calculating the sample size, please estimate n2for correcting the response rate

3. Analytical studies involving hypothesis testing

Correlation and multiple regression

Regression analysis is used to examine the relationship between two interval- or ratio-scaled (continuous) variables. To estimate the minimum sample size for the multiple regression analysis, it is essential to understand the previously reported relationship/association between the dependent and independent variables. For example, if a researcher wishes to identify the factors which determine adoption of a biopesticide, he/she has to derive a value of association from the adoption level and independent variables like extension orientation, innovativeness, environmental consciousness etc from the previous studies. The association is represented by the "reported values of correlation coefficient (r)" between the adoption and independent variables. When the correlation coefficient is identified from previous studies, Table 1.

Gatsonis and Sampson, 1989) may be used to estimate required sample size (Weller, 2015). The table provides the sample size requirements for a given effect size (Correlation coefficient r) with default values of ? = 0.05 and ? = 0.20. The first column contains the minimum correlation that can be detected and the second column contains the minimum total sample size necessary to detect it.

In case of several independent variables used in a single study, the researcher may calculate sample sizes for all independent variables and choose the largest sample for the study. If the researcher is expecting a higher correlation between the dependent and independent variables from his/her study, the sample size can be selected based on the assumed value. The same procedure can be used for selecting sample sizes for the study involving estimation of Pearson correlation coefficient.

In case of research themes with no prior work or the correlation coefficients are not reported in the past studies, the method suggested by Maxwell (2000) may be followed. In this method, the correlations between the variables of interest are assumed as "medium", (r = 0.30 between dependent and independent variable) and the sample size is determined based on the number of independent variables for a default effect size of 0.80. Table no. 2 provides the required sample sizes derived using Maxwell's method (Maxwell, 2000).

Logistic regression is a limited-dependent variable model and the sample size estimation procedures are described in Box 2.

ANOVA and t test

An ANOVA (Analysis of Variance) test compares a single categorical independent variable (nominal, binary or ordinal) with more than two interval-scaled dependent variables. This is also called a one-way ANOVA, indicating only one independent variable. A special case of a one-way ANOVA occurs when the independent variable has only two categories. This comparison is often called a t-test, because the hypothesis test for difference between the two means uses the t probability

distribution (Weller, 2015). The extension studies involving testing of effectiveness of multimedia on knowledge gain with same test group (pre-post test with paired "t" test) and analysing differences in the socio-economic and psychological attributes of adaptors, partial adopters and non-adopters (ANOVA) are examples of these analyses.

In t test and ANOVA analyses, the nominal to interval variable associations are analysed and the association or effect size can be calculated through eta (η) coefficient. The range of η is from 0 to 1, with a larger value indicating a stronger association (Weller, 2015). Columns 3 and 4 in Table 1 indicate the eta values and corresponding sample size requirement for ANOVA and t tests (Hays, 1963). Note that these estimates assume equal group sizes. The sample size estimation procedures for t test and ANOVA using online calculators is described in Box 3.

EXPLORING RESEARCH

NEIL J. SALKIND
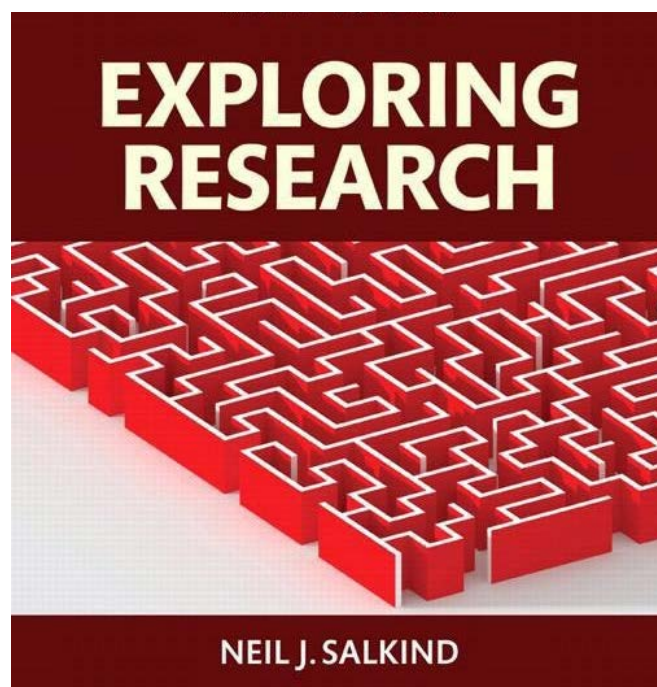
Table 2: Necessary sample sizes based on the number of independent variables for multiple regression (r = 0.30; Power = 0.80)

Number of independent variables	Required sample size
2	141
3	218
4	311
5	419
6	543
7	682
8	838
9	1009
10	1196

(Source: Maxwell, 2000)

Box 2: Sample size estimation for logistic regression

The sample size estimation for logistic regression is a complex process and four different approaches are proposed for the calculating adequate sample.

1. Method of confidence intervals – A univariate method which is suitable when the estimates are derived for a single variable.

2. Method of sample size evaluation in logistic regression – A simple and easy to use univariate method, which computes power, sample size, or minimum detectable odds ratio (OR) for logistic regression with a single binary covariate or two covariates and their interaction. The algorithm for this computation was developed by Demidenko (2007) and a sample size calculator is available at http://www.dartmouth.edu/~eugened/power-samplesize.php. Though this method was developed for medical studies, the calculator can also be used for extension research as the logic of variable selection and interpretation are similar in both cases.

3. Cross-validation – The cross-validation approach estimates the sample size by observing potential overfitting (Motrenko *et al.,* 2014). Though this method is not associated with any model, it is complex and difficult to use by the amateur researchers.

4. Kullback – Leibler divergence method - This method compares different subsets of the same sample by using the Kullback–Leibler divergence (Perez-Cruz, 2008) between probability density functions of the model parameters, evaluated at similar subsets. It allows us to estimate the sample size for the multi-attribute sample set.

Box 3: Sample size estimation for "t" test and ANOVA using on-line calculators

In general, the extension studies involving t test and ANOVA published in the peer-reviewed journals rarely report the eta squared values, making it difficult for the aspiring researchers to decide on sample size for future studies. However, Table 1 provides the sample size estimates for corresponding eta values. This problem can be solved by calculating eta squared values using the effect size calculators (http://www.psychometrica.de/effect_size.html). The eta squared values can be converted to eta values for estimating sample size. To estimate the eta value, the following procedure may be adopted.

In case of t test, collect the t value along with sample size of each group (in case of independent t test where sample sizes of both groups are different) along with correlation coefficient between the selected variables (in case of dependent t test – paired t test). And then calculate d and r from the test statistics of dependent and independent t-tests by using the calculator no. 4 on the Psychometrica website. Repeat the procedure for all possible independent variables. When the d values are obtained, use the calculator no. 11 and apply transformation of the effect sizes d, r, f, Odds Ratio and η^2. This way eta square value for each independent variable can be estimated and converted it as eta by taking square root of each value. The required sample sizes can be chosen from Table 1 and select the largest sample size for the study.

In case of ANOVA, collect the F value, sample size of treatment and control groups from past studies and use calculator no. 5 to compute d from the F-value of Analyses of Variance (ANOVA). Repeat the procedure for all possible independent variables. When the d values are obtained, use calculator no. 11 to apply transformation of the effect sizes d, r, f, Odds Ratio and η^2 to estimate eta square value for each independent variable and convert it as eta by taking square root of each value. The required sample sizes can be chosen from Table 1 and select the largest sample size for the study.

Factor Analysis

The Exploratory factor analysis (EFA) and Principal Component Analysis are two commonly used factor analytical methods for scale construction in extension research. This multivariate technique should be used with the large sample size (over 100) for obtaining reliable estimates (Kline, 1994). In data reduction studies like attitude scale development, the researcher should follow the minimum respondent to variable ratio of 20:1 (i.e. 20 respondents per item selected for scale construction) (Hair *et al.,* 2010). Selecting a large sample conforming to recommended respondent to item ratio, will increase the factor commonality besides decreasing the item loading value for selecting significant loadings in a particular factor (Hair *et al.,* 2010). Table 3 provides the criteria for identifying significant item loadings on factors based on the sample size chosen for the study.

Table 3: Criteria for choosing significant item loading on each factor

Sample size	Minimum value of item loading in a factor/ component in the rotated component matrix (Significance value)
350	0.30
250	0.40
200	0.45
120	0.50
100	0.55
85	0.60
70	0.65

(Source: Hair et al., 2010)

Way Forward

Selecting adequate and representative sample is a key component of extension research. This paper has elaborated the sample size estimation process for quantitative extension research. Though sample size depends on the nature of research problem and population, the choice of statistical analytical

procedures plays a crucial role in selecting the samples. The sample size estimation methods described in this paper are compiled from various published sources and the extension scientists can use them effectively for conducting quality research. The decision on sample size for the extension study depends largely on the past works. Most sample size formulae described in this blog demand the coefficients reported from past studies. However, the extension studies published in India haven't reported many coefficients that are essential for estimating sample size for future studies. A good publishing practice involves describing, analysing and reporting the science in a proper way which helps in advancing the knowledge besides guiding the future researches.

Online sample size calculators

A downloadable Excel file containing the macros to estimate sample size for descriptive studies (both categorical and continuous variables) developed by the author is available at https://drive.google.com/file/d/0BzwtVQNW-WqfYTYzSkVmZ3FDekk/view?usp=sharing

Other portals that offer "Ready-to-use calculators" to estimate the sample size for extension studies are as follows:

- National Statistical Service, Australia - http://www.nss.gov.au/nss/home.nsf/pages/Sample+size+calculator
- Raosoft Inc. - http://www.raosoft.com/samplesize.html?nosurvey
- Epi Tools - Sample size calculations - http://epitools.ausvet.com.au/content.php?page=SampleSize
- Psychometrica - http://www.psychometrica.de/effect_size.html

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NEW ADVANCES IN EXTENSION RESEARCH METHODOLOGIES

To improve the rigour of extension research, one should use new and effective research methodologies. Here P Sethuraman Sivakumar discusses some of the new approaches in extension research.

Extension is a multi-disciplinary science engaged in solving complex problems in agriculture. With increasing complexities in farming, environment and social system, extension has to achieve multiple development goals ranging from sustainability to increasing farm income and enhancing sector competitiveness. In other words, extension in the current context must reinvent itself from its primary goal of "stretching out" the university science to generation, adaptation and application of new knowledge.

Extension research is the backbone of the "extension discipline". As a "field-oriented" professional discipline, the extension research has relied heavily on exploration, facilitation and appraisal/assessment by employing qualitative and quasi-quantitative methods. The extension researchers' perception of a "field oriented discipline" has largely affected his/her selection and use of methods, resulting in "less significant" outputs. Though the extension research was envisaged to develop sound methods and models to help the field functionaries for effective delivery of extension services, very little progress has been made in the past six decades. Absence of a "rigorous approach" for advancing the extension science is the primary reason for these lacunae and there is an urgent need to look into the "mechanics" of conducting extension research.

The purpose of this blog is to assess the existing research approaches in extension with a focus on its methods, tools and techniques so as to suggest new and effective alternatives to derive quality research outputs. The approach followed in this blog is based on the following assumptions:

- Extension is an applied social science with a structured way to address the needs of stakeholders
- Extension research focuses on development of methods to improve field extension
- Most extension research problems are multi-dimensional in nature
- Generalizing results is the key for advancement of any professional discipline
- A systematic, empirical approach can help to produce tangible outcome while advancing theory

Current State of Extension Research in India

Narrow focus on the research problem

Most extension problems are multi-dimensional in nature, caused by the interplay of physical, chemical, biological and human factors. For example, non-adoption of a rice variety by a specific group of farmers could be due to its

disease susceptibility, consumer dislike of taste/texture or high milling cost. The extension research is expected to use a variety of methods from cultural anthropology (e.g. Participatory Rural Appraisal (PRA), consumer psychology (e.g. hedonic testing), agricultural engineering (e.g. milling studies) and economics (e.g. Benefit-cost analysis) to solve this issue. However, the existing research on adoption focuses only on identifying the problems and assess their relative importance using extension research methods – PRA and adoption indices, without integrating methods from other sciences to establish the cause-effect relationship in an objective way .

Little or no utility to the significant stakeholders

The outcomes of extension research benefits a diverse user group comprising of farmers, small scale industries, traders, input and marketing agencies, academicians, scientists and students besides helping policymakers to decide on critical policy issues. However, the current extension research is often confined to academic journals and professional groups without benefiting its intended users (Prasad, 2014). For example, the attitude scales developed at the academic and research institutions offer little help to the extension field functionaries and policy makers to improve their decision-making.

Heavy reliance on exploratory approaches

The extension research is considered as largely "ex-post facto". Experimental or hypothesis testing approaches were often viewed as luxury by academicians and scientists. In a field-oriented discipline, this absence of the "manipulative capacity" produces results with limited ability to generalise. For example, the impact assessment of technology or educational interventions is often conducted "ex-post facto" without assessing the situation prevailing before the intervention. Though extension interventions are primarily "experimental" in nature, which are implemented using a specific combination of actions to produce desirable outcomes, using the "post-assessment" approach may not produce accurate results.

Inappropriate methods and techniques

Choosing a "right" research method for a specific research problem is a concern in the extension science. The academic research constitutes over 60% of the total extension research output delivered in a calendar year, in terms of the research papers published in peer reviewed journals. As the PhD and MSc research is time-bound and conducted in a limited resource environment, they follow a tested and popular research approach with limited scope

for experimentation. Using similar methods for a variety of research problems may bring inappropriate results. For example, the marketing behaviour studies employ same methods for studies across a variety of field and horticultural crops, livestock etc. Though the crops differ in terms of duration, method of cultivation and methods of marketing, the researchers follow same tests, scales and schedules for all these studies. Besides, there is tendency among innovative and enthusiastic researchers to rush into innovative research areas or using new methods without gaining adequate insights into the requirements and assumptions of these methods, resulting in a misfit into the research problem and reporting spurious relationships in a subjective way.

In view of the above problems or lacunae, there is a need to analyse the research approaches to identify sound alternatives to improve the quality of research outcomes.

Advanced Methods

Assessing the technology performance and effects

Assessing the technology performance and effect is crucial for extension managers, scientists and policymakers. The assessment helps in (1) deciding the effect of agricultural technologies on the target population, (2) setting research and development priorities and (3) formulating strategies and policy decisions to facilitate innovations and technology. The technology performance is often assessed through diffusion paradigm by quantifying technology adoption at different stages, while the effects are quantified by impact assessment.

Roger's Classical Normal Distribution Model

The adoption and diffusion research in extension has focused mostly on the Classical Normal Distribution Model following s-shaped curve proposed by Rogers (Rogers 1983). A large number of extension research studies were conducted on the communication channels (e.g. development of communication strategy – audio-visual aids, mass media and interpersonal channels, and testing their effectiveness), innovation (e.g. assessment of suitability), and effects on the social system (e.g. adoption and impact). Though past studies have fostered the understanding of innovation diffusion in agriculture, several research gaps remain. Very few research works focused on the technology diffusion over time linking the innovation diffusion with new technology performance. Besides, the Roger's model is simplified representations of the reality of diffusion processes (Roling, 1988) which has little ability to predict future adoption of innovations (Mahajan *et al.,* 1990). Research studies conducted on high-

tech products (Moore, 1991), environmentally sound manufacturing technologies (Sroufe et al, 2000) and classroom response systems (Towns,

Fig. 1: Chasm in the diffusion process

(Source:http://eavoices.com/)

2010) reported the presence of a "chasm" between early adopters of the technology and rest of the adopter groups.

Despite all limitations, Roger's model is widely used in the diffusion of innovations research. Using a longitudinal research design with a cohort approach helps to assess the technology adoption across time. An IFPRI research on long-term impacts of vegetable and polyculture fish production technologies on a variety of measures of household and individual well-being in Bangladesh is a classic example of this approach (Kumar and Quisumbing, 2010).

Alternate adoption models

Few alternative adoption/diffusion models (described in Table 1) provide wide options to enrich conceptual clarity and methodological rigor to extension research. These methods provide flexibility to assess adoption through cross-sectional approach.

Table 1: Alternate models to study diffusion and adoption of agricultural innovations

Theory or model	Proposed by	Features	Applications
Concerns-Based Adoption Model (CBAM)	Hall and Loucks (1978)	Explains how an individual's concerns influence his or her integration of an innovation in a classroom or work setting	Teachers' use of action research (Khoboli and O'toole, 2012); technology change and adoption (Davis and Roblyer, 2005).
Technology Acceptance Model (TAM)	Davis et al. (1989)	An information systems theory that models how users come to accept and use a technology.	ICT Adoption Behavior of Rural Young Entrepreneurs (Zaremohzzabieh *et al.,* 2015)
Bass model	Bass (1969)	Cumulative adoption model based on S curve Assumes that the speed and timing of adoption depends on innovators' or imitators' degree of innovativeness and the degree of imitation among adopters	Adoption of pesticide use by Nigerian cocoa growers Akinola (1986). Agricultural change at farm and regional level (Wossink, 1993)

Assessment of effects of extension intervention

Assessing effect of an intervention on the target group is a crucial component for establishing the utility of an intervention. According to World Bank, impact assessment is intended to determine more broadly whether the program had the desired effects (positive and negative) on individuals, households, and institutions and whether those effects are attributable to the program intervention (Baker, 2000). In the National Agricultural Research and Education System (NARES), the impact assessment is used to assess the socio-economic effects of an intervention, problems associated with technologies and user systems, and setting research and development priorities. While the agricultural economists followed a quantitative scientific statistical approach, the extension professionals focused on the "social and behavioural effects" of the

intervention. The common impact assessment paradigms followed in social sciences are displayed in Box 1.

An innovative impact assessment approach developed by Ms. Susanne Neubert of German Development Institute, Germany, MAPP (Method for Impact Assessment of Poverty Alleviation Projects, 1998) combines a quantitative approach with participatory assessment to derive tangible results to address the needs of managers and policy makers. In this method, the impact is assessed through a series of workshops with stakeholder representatives. It has wide applications to analyse complex development goals like poverty reduction, democratization, good governance, economic and sustainable development. A detailed description of various impact assessment methods used in socio-economic research can be found at http://are.berkeley.edu/~sadoulet/papers/deJanvryetal2011.pdf

A quantitative or "scientific" statistical method

Addresses a fundamental question: *What would the situation have been if the intervention had not takenplace?*

Uses and experimental approach - Comparing program participants (treatment group) with a control or comparison group.

Weaknesses – Quantification of impact without exploring the reasons; high cost and requires specialised expert skills

Qualitative method

Inductive approach derived from sociology and anthropology

Using qualitative tools like key informant interviews, participants' observations, case studies, focus group discussions, etc

The results are location-specific and cannot be generalised.

Participatory learning and action method

Involves stakeholders in all stages of the evaluation or assessment, such as determining the objectives of the study, identifying and selecting indicators to be used, and participating in data collection and analysis etc

Assume that the beneficiaries are empowered through the research process itself Methods and tools - participatory appraisals, action learning methods, etc.

Prediction and forecasting

Predicting the future of a technology using the forecasting procedures helps in (1) assessing the demand of the technology at specific time period, (2) understanding the impact created or expected by the stakeholders and (3) identifying the need for developing and refining technology. In general, a prediction is deriving an outcome based on deductive logic or beliefs while forecast is a means to validating a prediction based on an analysis of varying factors and patterns. Though the prediction and forecasting are largely quantitative, conducted mostly by economists, they are equally important for extension science as well.

There are many overlapping forms of forecasting technology developments and their impacts, including technology intelligence, forecasting, road mapping, assessment, and foresight. Several technology forecasting methods have been developed over the years and it is essential for any forecaster to match the method with the purpose with logic and commonsense to derive accurate estimates. The forecaster has to judiciously select a technique or a combination of techniques depending upon the methodology and end objective in view. The technology forecasting techniques traditionally used to derive technology performance estimates are summarised in Figure 2.
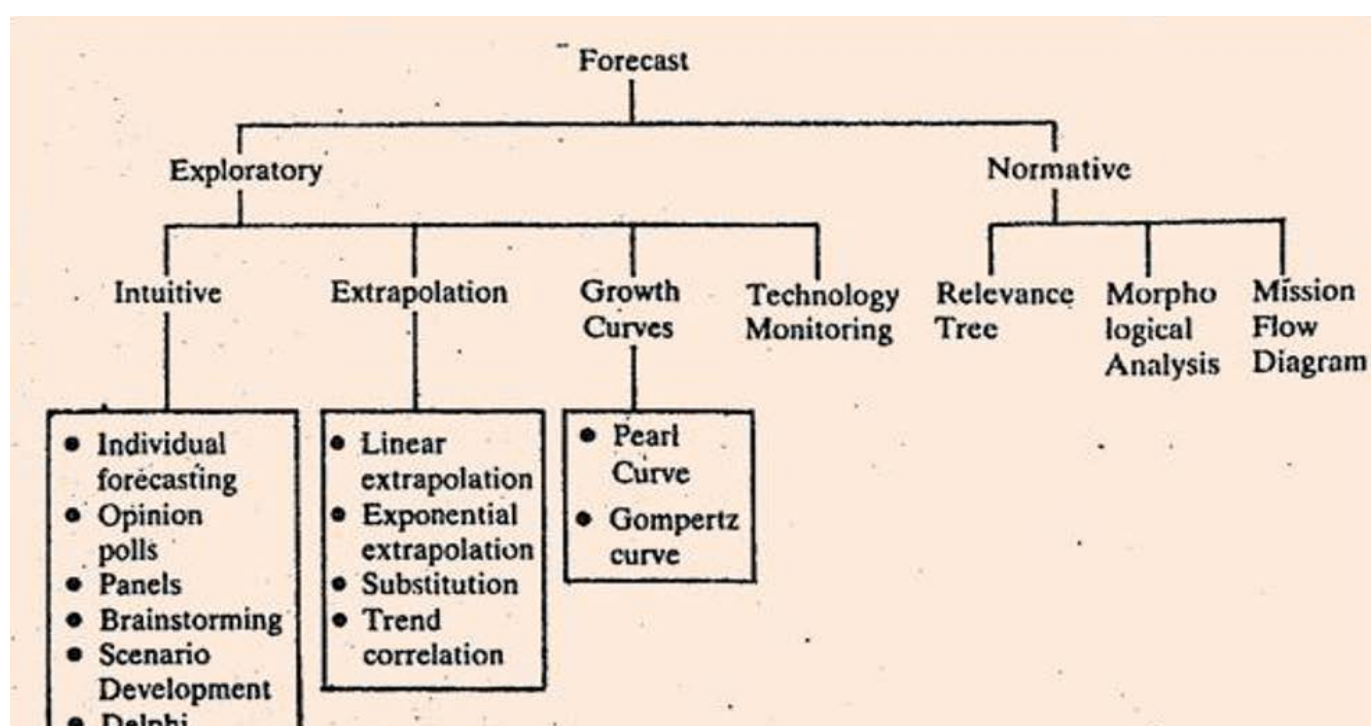

Fig. 2: Summary of technology forecasting methods

The Massachusetts Institute of Technology (Firat *et al.,* 2008) identified nine families of forecasting methods (Box 2). Though many methods are quantitative in nature which demands high-level mathematical/statistical skills, few of them are relatively easy to understand and use. A few prediction and forecasting tools that are relevant for extension professionals are discussed below.

Judgemental forecasting

The judgemental forecasting methods including Delphi and scenario analysis can be effectively used in extension research. These forecasting methods are used in ambiguous situations where

the information on past performance of a technology or a service is not available. For example, if a food technologist wishes to assess the market demand for a novel food like gluten-free pasta, where the data on the market demand of pasta is either not available or not accessible, the extension professional can help to estimate the approximate demand by using the judgemental methods. These methods rely on expert opinion who uses incorporate intuitive judgement and opinions to derive subjective probability estimates.

Delphi method

Delphi is a popular judgemental method, developed by RAND Corporation in Santa Monica, USA during 1950s. The Delphi uses a convergent approach to develop expert estimate on a particular aspect (e.g. demand of a technology, price, cost of a project, etc) using a two or three stages assessment, where experts' opinions are collected and information is combined, and then returned to the experts for re-evaluation A classic example of Delphi study is the USDA forecasts for soybean and corn prices (Isengildina et al, 2004). Delphi method was also used for strategic planning (Rikkonen *et al.,* 2006), identify locations for Agricultural Service Center (Zangeneha

et al., 2015) and need assessment for crisis communication (McGuire *et al.,* 2012).

Recently, the computer based real time or almost real time Delphi is gaining popularity owing to its cost and time saving processes. The dissensus-based Delphi, an exploratory variant of the classical Delphi, focuses on divergent approach where a variety of opinions or estimates are derived through expert consultation on a particular issue for on a bipolar distribution (e.g. high to low, good to bad) (Steinert, 2009). This method was developed by Turoff in 1970 which is widely used in policy analysis. Two examples of dissensus delphi are argument Delphi (Kuusi, 1999) and disaggregative Policy Delphi (Tapio, 2003)

Scenario analysis

Scenario analysis is a process of analyzing possible future events by considering alternative possible outcomes. It is useful to generate a combination of an optimistic, a pessimistic, and a most likely scenario of any commodity or aspect. This is an important tool in the world of finance and economics, and is used extensively to make projections for the future. "Scenario planning" was developed in the 1950s (Kahn and Wiener 1967) and it has been used in the area of sustainable development (Rotmans et al. 2000). The scenario analysis is used successfully to assess the impact of water and agriculture policy scenarios on irrigated farming systems in Italy (Bartolini *et al.,* 2007) and participatory water management planning in France (Graveline *et al.,* 2014).

Scenarios are arrived at by a team composed of key decision makers, experts, and stakeholder representatives during two or three one-day workshops held over a period of weeks or months. The flowchart depicting the steps in scenario analysis is given in Figure 3. Scenario analysis involves constructing or developing scenarios (steps 1-4 below), and integrating the content ofscenarios into decision making (steps 5-8 below).
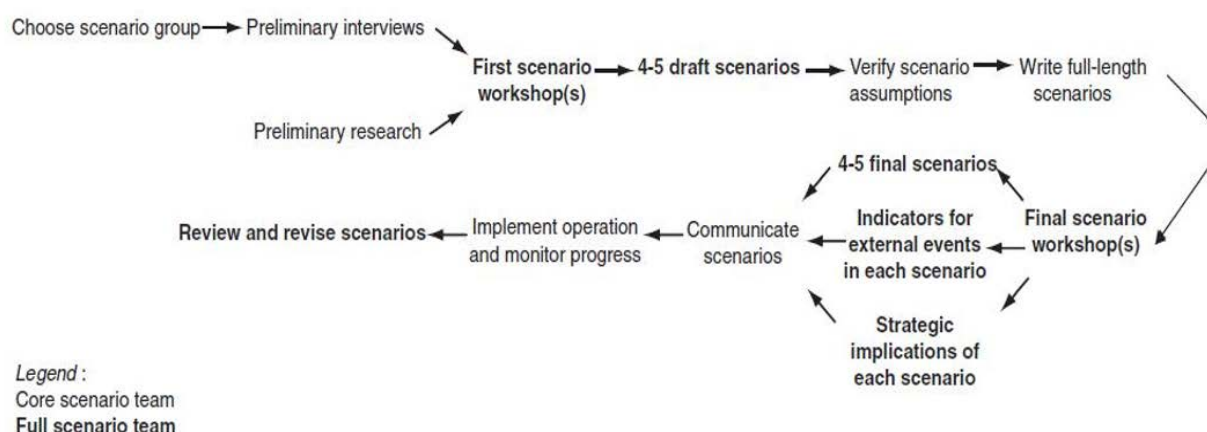
Fig. 3: Steps in scenario analysis

Box 2: Family of forecasting methods

1) Expert Opinion
- Delphi (iterative survey)
- Focus Groups [panels, workshops]
- Interviews
- Participatory Techniques

2) Trend Analysis
- Trend Extrapolation [Growth Curve Fitting]
- Trend Impact Analysis
- Precursor Analysis
- Long Wave Analysis

3) Monitoring and Intelligence Methods
- Monitoring [environmental scanning, technology watch]
- Bibliometrics [research profiling; patent analysis, text mining]

4) Statistical Methods
- Correlation Analysis
- Demographics
- Cross Impact Analysis
- Risk Analysis
- Bibliometrics [research profiling; patent analysis, text mining]

5) Modeling and Simulation
- Agent Modeling
- Cross Impact Analysis
- Sustainability Analysis [life cycle analysis]
- Causal Models
- Diffusion Modeling
- Complex Adaptive System Modeling (CAS) [Chaos]
- Systems Simulation [System Dynamics, KSIM]
- Technological Substitution
- Scenario-simulation [gaming; interactive scenarios]
- Economic base modeling [input-output analysis]
- Technology Assessment

6) Scenarios
- Scenarios [scenarios with consistency checks; scenario management]
- Scenario-simulation [gaming; interactive scenarios]
- Field Anomaly Relaxation Method [FAR]

7) Valuing/Decision/Economics Methods
- Relevance Trees [futures wheel]
- Action [options] Analysis
- Cost-benefit analysis
- Decision analysis [utility analyses]
- Economic base modelling [input-output analysis]

8) Descriptive and Matrices Methods
- Analogies
- Backcasting
- Checklist for Impact Identification
- Innovation System Modeling
- Institutional Analysis
- Mitigation Analysis
- Morphological Analysis
- Road mapping [product-technology road mapping]
- Social Impact Assessment
- Multiple perspectives assessment
- Organizational analysis
- Requirements Analysis [needs analysis]

9) Creativity
- Brainstorming [brain writing; nominal group process (NGP)]
- Creativity Workshops [future workshops]
- TRIZ
- Vision Generation
- Science Fiction Analysis

Way Forward

The quality of extension research depends on its methodological rigor and ability to produce results that can be generalised across the similar socio-economic systems. Though the current extension research focused on diverse areas with a variety of research methods, they are inadequate to deliver results that are significant, tangible with wide applicability.

The first part of this blog paper has discussed about the weaknesses and limitations in the existing research approaches in general, with an emphasis on methodologies and suggested alternative methods for adoption and diffusion research, impact assessment and forecasting. In the second part of this blog series, I will discuss the recent developments in the scale construction and questionnaire optimisation, perception/preference measurement, ICT/communication research and consumer studies.

Integrating new methods into the existing extension research paradigm requires a strategic approach comprising of organising capacity building programmes at the university or research institute level (to equip the budding and mid-career extension professionals with state-of art research skills); improving the quality of academic research by diversifying research themes and methods, enhancing the quality of research publications in the peer-reviewed journals through rigorous review process and reorienting the extension research courses by incorporating new research methods and techniques.

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DO NETWORKS MATTER? A RETROSPECTIVE ON THE POTENTIAL APPLICATIONS OF SOCIAL NETWORK ANALYSIS

Social Network Analysis (SNA) is arguably the latest trend and buzzword among social science practitioners. With its strong theoretical and empirical rooting in sociology and graph theories, it could answer many research questions within a system. It is no secret that modern social media channels such as Facebook and LinkedIn have their theoretical backing from SNA. In this blog post, Subash SP and Sreeram Vishnu try to highlight some of the potential applications of SNA in agricultural sciences.

Information is the new gold, it is the new oil. Anyone who controls information has access to great wealth and power.

(From Killswitch: The battle to control the Internet (2005) directed by Ali Akbarazadeh)

In today's world, almost everyone leads a networked life; from simple, direct communication networks based on our acquaintances and relationships, to internet-mediated social networks which link human beings virtually across the globe. These networks are playing a crucial role in deciding the kind of knowledge one can have, the resources one can access, the opportunities one can explore and the extent and nature of contacts one can create. Can we tap into the potential information embedded in these networks and relationships, in case of agriculture?

Yes!! We surely can, if we apply Social Network Analysis (SNA). SNA is a methodology to map and qualify actors (nodes) and their relationships within a network. It allows for accounting the "flow". This flow can be a resource (e.g. commodity or information); a service (credit or input); or a relation (kinship or friendship). Mapping and quantifying this information can yield potential benefits to a social scientist as it gives rich inputs about the position of a farmer in his/her social network. Invariably, it decides his/her access to various resources and information.

Initially SNA was used in the fields of sociology, psychology and anthropology. With the advancement in graph theory (mathematics) and computing knowledge, SNA tools have been developed to map and quantify networks. The network perspective is becoming a key approach in social and biological sciences (Borgatti and Li, 2009). In this blog post, we provide insights into the application and scope of SNA in agricultural research and extension.

Evolution of SNA

The origin of SNA dates back to ancient Greeks, but major developments occurred in the 1930s. Figure 1 depicts the lineage of SNA. For further details about the history of SNA, please read the book (Scott, 2000). SNA, in its current form, is an amalgamation of socio-metric technique and graph theory. It has evolved through various phases and, over time, has turned into a data analysis technique with wider applications.

Application of SNA in Social Sciences

SNA is more about the social relations and interactions among people in a group rather than about the individual actor as followed by most of the other social science techniques. This
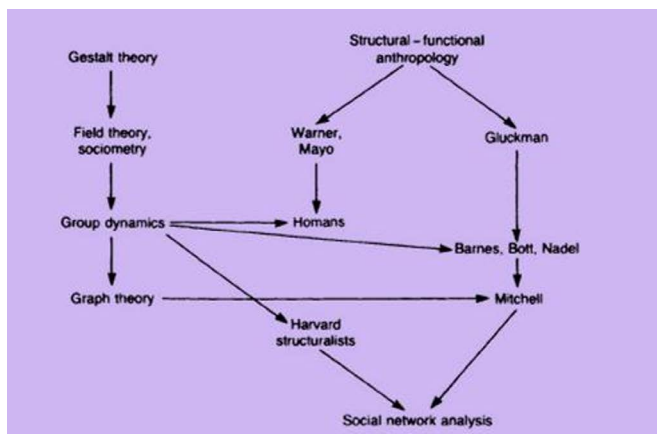
Fig. 1: Lineage of Social Network Analysis (Scott, 2000).

focus of the interactions is more pragmatic as it can answer many difficult research questions on the capabilities and resource access of the actors within a system. Just as the location of a building in a city decides its access and potential, the position of an actor in a system can predict the possible resources and capabilities that he could access and benefit from. It could even answer the cognitive aspects of behaviour including the learning or adoption behaviour of the actors which is shaped by the interaction with other actors or their influence within the system. The rate of technology adoption within a system is dependent upon many social factors, for instance, influence of neighbours, cliques, relatives, progressive farmers and reference groups. This argument is empirically proven as it is supported by many research studies in various contexts.

One of the major imperfections of the diffusion of innovation model of the Rogers (2003) was the individual blame bias. Simply stated, this argument says that for technology rejection/discontinuance decisions, it is always the individual who is blamed rather than the system of which he is a part. In other words, if the shoe does not fit there is something wrong with one's foot! This is because a social science researcher always takes an individual actor as the unit of his study. Whereas, in reality, there may be several other reasons, such as resistance from his social system or its inefficiencies which prevent an actor from adopting an innovation or continuing its use. This can be known only if we study the social system, particularly the social network of the concerned actor. This is what a SNA should try to figure out.

Further, SNA is applicable wherever there is a flow of something or where connections can be established among the units of a network. This something can be a resource (a commodity such as milk) or a service (credit) or even a relationship (information dependency). It has potential applications in various research themes: value

chain analysis (Lazzarini, 2001; Borgatti and Li, 2009), technology adoption studies (Matsuskhe, 2008; Magnan *et al.,* 2015) and impact analysis (Ekboir *et al.,* 2011).

## Utility of SNA in Mapping Various Networks: A Few Examples

Ekboir et al. (2011) used SNA to monitor changes in a research network to understand the process, innovation, opportunities and challenges. A network of 92 researchers depicting 624 collaborators in 302 organisations for the CGIAR Research programme on Roots, Tubers and Bananas (RTB) was mapped (see Fig. 2). This helped in understanding how the programme is moving in its impact pathway, its partnerships, collaborations and interactions. This is important in framing strategic management and adaptive measures.
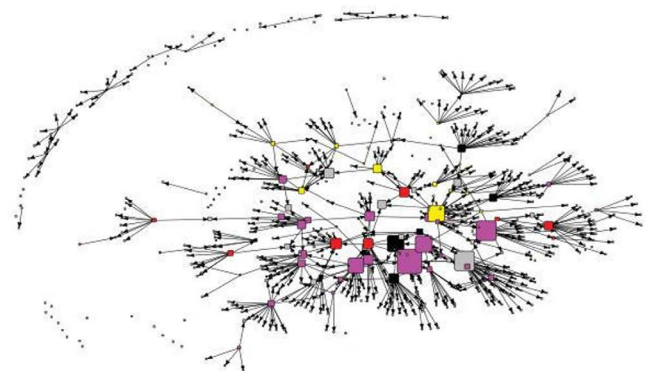
**Fig. 2:** Intermediation (betweenness) of CGAIR centres (Ekboir *et al.,* 2011)

Note: Nodes colour-coded by centre affiliation: yellow = Biodiversity, black = CIAT, pink = CIP, red = IITA, grey = other centres.

Lazzarini et al. (2001) introduced the concept of netchain to depict the interrelationship between horizontal and vertical networks in a value chain. Netchain is name given to horizontal ties between firms with layers of vertical ties (see Fig. 3).
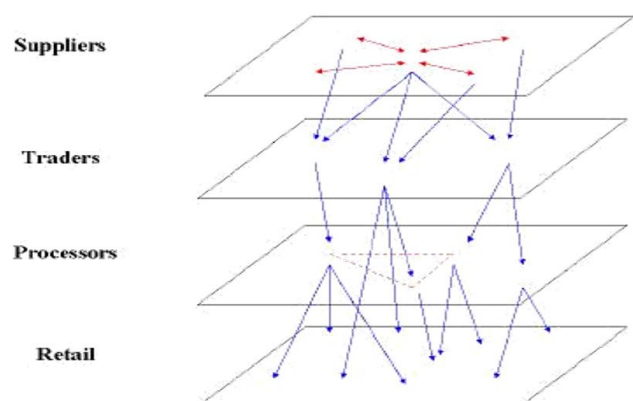
**Fig. 3:** Netchain (Lazzarini *et al.,* 2001)

Magnan et al. (2015) used gender-disaggregated social network data from Uttar Pradesh to test the gender-specific network effects on demand for laser land levelling (see Error!Reference source not found.).
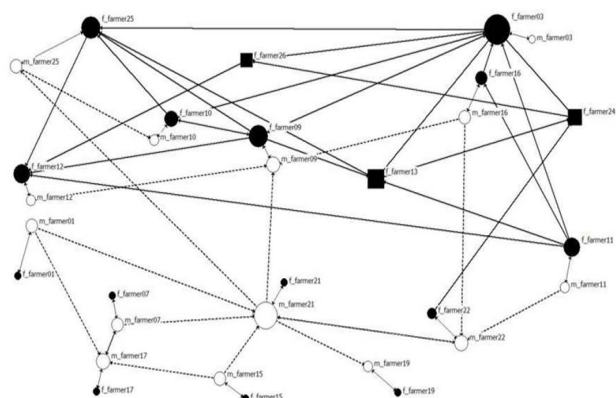
Fig. 4: Gender-specific social network

They found that though the factors determining male and female networks are similar, there is little overlap between them. The study also provided some evidence of female network effects on household technology demand and suggested leveraging female networks for extensive dissemination of technology. The study has also emphasised that small farmers mainly rely on social networks for information; hence, public and private efforts should be relayed using social networks for transmission of technology to a large number of farmers.

Thuo et al. (2013) used SNA to visualise patterns of groundnut farmers' networks with regard to information sources, productivity support and local group affiliations. Their main concern was to understand the role of strong and weak ties in enhancing the productivity of groundnut farmers by providing them the requisite information. Network mapping demonstrated the flow of information on groundnut from a variety of sources, including the strong and weak ties. It also revealed that the network structures can vary considerably even among farmers in similar geographic regions producing similar crops. The network map is shown in Figure 5.
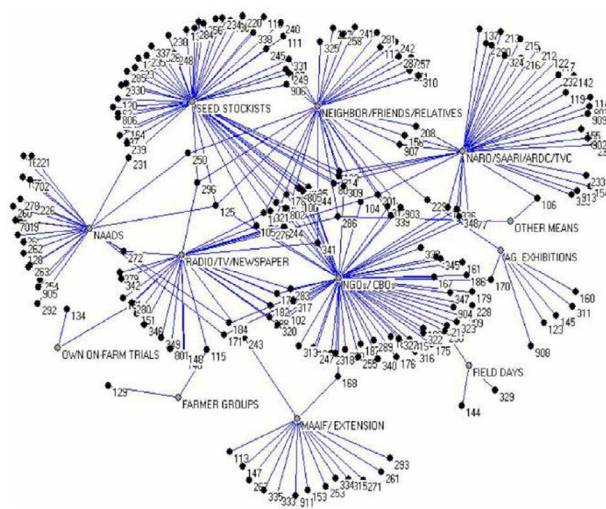
Fig. 5: Groundnut productivity information flow network (Thuo *et al.,* 2013)

Software Packages Available for SNA

A number of software packages are available for SNA. In general, network analysis software can be classified into two types: packages based on graphical user interfaces (GUIs) and those meant for scripting or programming languages. GUIs are easier to learn and execute while scripting packages are powerful. The most widely used GUI packages are UCINET, Pajek, Gephi, MuxViz, NetMiner, GUESS and ORA. NetMiner (Python) and igraph (package for R and Python) are a couple of scripting-based packages. Both free and commercial versions of these different software are available.

Though open source packages are difficult to learn, they have much wider functionality and more features than the commercial ones. There are good training, tutorials and support groups available for them. The software mentioned above could be used for visualizing networks through network maps and quantitatively measure network parameters.

Way Forward

Social network analysis is an emerging field of science which our social scientists can vigorously pursue for designing future studies. The field is rich with theoretical contribution from various disciplines blended with the potential possibilities of visualisation of networks and quantification of various parameters grounded on the graph theory. Though researchers like Spielman (2010) underscored the usefulness of this research technique in agriculture in developing countries, particularly for innovation system studies, network-based studies are still in their infancy in the Indian context. Though the same set of theories and applications are highly useful and widely used in case of biological sciences (mapping of genes and interaction effects), we also emphasised the application of SNA only in social sciences. Application of SNA is surely going to be a game changer for the fields of agricultural extension and economics, and will make great research impacts in the coming days.

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SCIENTIFIC PUBLISHING IN EXTENSION: ARE WE DOING ENOUGH AND ARE WE DOING WELL?

Enhancing the quality of extension research is a pre-requisite for improving the quality of academic publishing in extension. Much needs to be done on strengthening drafting skills and improving the quality of peer review too, argues SVN Rao, K Natchimuthu and S Ramkumar.

Researchers aim at understanding problems and often providing solutions to address these. Some develop technologies which make human life better and easier by saving time and other resources. Through continuous research they try to address existing and expected problems and come up with technologies/practices which may replace, modify or refine the existing ones. Publications serve as one of the important windows of the research output.

Publications primarily help researchers working in similar areas to gather information on recent developments in their field of study. It also helps the authors to get feedback on their work and get motivated to purse their research in new directions as suggested. The authors also get credit for their published work through its use as an indicator of performance in career advancement and grant of research funds. For the donors (public and private) who fund research, publications serve as a measure of accountability. Apart from all these, the publications help the wider community of knowledge users to know about the new knowledge generated through research.

Extension Research

Research in extension is required to address the following issues:

* Problem identification and prioritization of research areas as input to research stations – (Participatory research methods with the involvement of the concerned stakeholders including the scientists of various disciplines).
* Understand the role of extension and advisory services in the emerging and dynamically changing context/ scenario of development (globalisation, privatization, food security, food safety, climate change etc.)
* Testing of technologies – both ex ante and ex post; Identifying essential conditions for exploiting different technologies; Assessing the non- technological factors influencing the flow of technologies.
* Analyzing different farming systems; Assessment and prioritization of the knowledge and support needs for different crop -livestock production systems.
* Development and validation of innovative extension models.
* Development of appropriate training modules for capacity building and policy engagement.
* Generating information on when, where and how to produce and market; and identification of innovative methods to communicate to the concerned stakeholders including the farming community through appropriate dissemination methods / strategies.

- Evaluation of the existing extension models and expert systems under different crop - livestock production systems; Impact assessments of programmes (both public and private).
- Identification of best practices in different crops/livestock/fisheries sectors.
- Focus on curriculum development and course content to address the future challenges of extension.

Though the research in extension has wider scope, it mainly focuses on adoption and diffusion of innovations and often revolves around research – extension - farmer linkages. Extension research has many such self imposed limitations.

Though the extension science globally has moved beyond technology transfer to facilitation, learning, organising and building networks, extension research in India is still stuck in studying technology transfer (Prasad, 2013). 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 (Sivakumar, 2013). In most cases, extension research looks at farmers or extension personnel as subjects and crop/farming system as settings of the study. The concept of 'research' in extension needs to be broadened, recognising that beyond the public research and extension organisations, a range of actors have important and vital roles in the generation and dissemination of agricultural innovation (Prasad, 2014).

Though extension scientists in the NARS can potentially engage in useful research that can influence the technology development process, they are mostly engaged in organizing training programmes, conducting events, dealing with visitors to the institute and handling documentation responsibilities (Gowda et al, 2014). Lack of clarity on the role of extension scientists (extension work Vs extension research) has also contributed to this situation. Though participation in extension related activities provide lot of scope for conducting research and publishing them, academic publishing is a low priority in extension.

Many extension practitioners are involved in extension work but they rarely publish research articles, may be due to their lack of need/ interest for such publications or capacity to write articles from their work experience. Very rarely we find research articles from our colleagues working in 637 KVKs in the country. Same is the case with many NGOs involved in field extension work. In fact we are losing much of the excellent "work experience" gained especially by the field functionaries working in different production

systems by not sharing it through publications. It is a big loss to the extension profession. It is important to harness such useful experiences in different crop livestock production systems and make them accessible to others through publications, one of the important ways to share them.

Academic Publishing in Extension

Most of the current research in extension is from students' thesis work and their compulsion to publish their work either for acceptance of their thesis or for improving their chances for employment. Extension scientists/teachers in research centers, colleges and training centers have to either obtain resources from within or seek external funds to do their research. Requisite resources for research in extension are always in short supply mainly due to lack of clarity between extension research and extension work. Lack of capacity to formulate and submit multi-disciplinary research projects under competitive grants also adds to this challenge.

Academic publishing in extension has suffered mainly due to these limitations in quantity and quality of extension research. There are no two opinions about the necessity and urgency to improve the quality of our existing extension journals, which are in fact suffering from three failures.

1. Lack of willingness and capacity to take up quality research to produce quality output
2. Lack of capacity to prepare quality research papers (drafting skills/articulation/language) and
3. Lack of serious review of submitted papers by the Journal editorial committee/reviewers

The low rating/score given to extension journals by NAAS (National Academy of Agricultural Sciences) is a reflection of all these three failures.

Research: First of all quality of extension research needs improvement. This is a pre-requisite to have goodpublications in extension in quality journals. A lot was written in the earlier AESA blogs about the current status of extension research and how it could be improved. Usually three categories submit their research findings for publications in either printed or on line journals. These are students, faculty/ teachers of academic institutions, and extension practitioners. Although there are two options for the researchers to present their findings, the students and faculty usually choose the printed journal (s) with good rating rather than on line journals as the former is given more weightage for their assessments/ promotions/ career advancement.

Selection of appropriate journals is always a challenge for researchers. In the case of extension, the number of extension journals (having the word extension in the title) is few. Though there are a number of non-extension journals (social science and general agriculture related) which also publish extension articles, many researchers are not aware of these. To address this issue, AESA has done a marvelous work of compiling a list of journals which are relevant for extension researchers. This could be accessed at http://www.aesanetwork.org/where-can-we-publish-extension-research-a-note/

The few who know about the scope of these non-extension journals also refrain from submitting their papers in these journals as most of these are not considered/included by NAAS in their rating system. Low quality of extension research also affects its publishing in quality journals. Though many universities insist post-graduate and doctoral students to have at least two articles from his/her research work in journals of repute (before submitting thesis to the concerned university), this is not enforced strictly. Similarly, field practitioners who submit their theses rarely publish their articles from the thesis as their career prospects are not linked to the number and quality of publications.

A lot needs to be done to improve training on research methodology at the post-graduate and doctoral levels. New research methods (both quantitative and qualitative) are yet to find a place in extension curricula. The students and faculty also do not have access to latest books and journals due to budgetary restrictions in academic institutions. Low budgetary allocation to social science text books and journals is also a reflection of the poor image of extension discipline among administrators and others who take these decisions.

Writing skills: Writing a research paper is an art and requires skills which many researchers (students andfaculty) are lacking. These skills could be inculcated among the researchers through conducting appropriate training workshops. But this hasn't received any attention from the numerous professional societies in extension which we often find them at loggerheads. There are more than 10 professional societies for extension in India. There is no synergy among these bodies and in fact they compete for the articles to be published and also for getting grants for organizing workshops or seminars every year. Each of these societies publishes their own extension journals. However, none of these journals have rating above 4.0.

Article Review: Our systems for screening and review of research papers need real improvement.

The editorial committee which is responsible for publishing each journal as per the frequency and time lines set for it often fails to enforce quality. Many a time, it fails to bring out the journals in time due to several reasons that include, less number of articles received, poor quality of the articles received, lack of commitment on the part of the reviewers in sending their comments on the articles on time, inadequate funds to maintain the editorial office and lack of interest on the part of the editorial committee.

Recommendations

Funding for professional improvement and enhanced access to new knowledge: It is necessary for thefaculty to understand the dynamic changes happening in extension through trainings, reading journal articles and books. We need to make sure that sufficient funds are available within the different organizations to organize such trainings and subscribe to relevant journals and books.

Reorient professional societies to play new roles relevant for the future of the discipline. These includeenhancing skills related to:

3. Formulating good projects

4. Employing various research tools

5. Identifying new areas of research

6. Writing research articles – presentation skills

7. Accessing new research grants

Professional societies must jointly organize workshops for the benefit of the interested students, faculty and field practitioners on payment basis (no loss no profit basis). There are quite a good number of extension professionals available to deal with the identified topics. This of course, needs lot of ground work to plan and execute.

Review quality of existing journals and expand the number of journals (social science and agriculturalrelated) used for career advancement considerations. There is a lot of scope for improving the quality of the extension journals and the purpose shouldn't be to criticize but to provide constructive criticism to enable the editorial committees to improve the quality standards of their respective journals.

Promote list of latest books on extension and related disciplines and sharing of abstracts or links ofextension research papers published in different journals. AESA web-portal (www.aesanetwork.org) has made a good beginning on this.

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