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An analysis of suggestions of extension strategies for diffusing contemporary water management innovations (CWMI) in similar Agro-ecological conditions

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Abstract
Ananthapur District is one of the most backward districts in India due to agro-ecological crisis more particularly ground water crisis. It is essentially an arid, drought-prone and entirely agrarian economy. In response to these crises farmer respondents have ardently adopted all the innovations related to water management in drylands, i.e., water harvesting, water budgeting, water sharing and water saving through using micro-irrigation systems, and adopting soil moisture conservation agronomic practices. Case study has also provided evidence that farmers get ample benefits in forming water sharing groups for assured crop yields. In such dryland regions, in order to diffuse these water management innovations among farmers in similar dryland agro-ecosystems, the questions that may arise include: 'What suggestions may have emerged as extension strategies for diffusing these water management innovations among dryland farmers in other similar areas?' To answer this question, opinions were sought from experts and their consensus was achieved through Delphi technique. The major finding were: Suggestions given for diffusing CWMI in similar agro-ecological conditions included convergence of actions from all stakeholders, government and non-government agencies and policy advocacy strategies for promoting water harvesting and sharing among dryland farmers.

Keywords: Delphi technique, CWMI (Contemporary water management innovations) and agro-ecological conditions

Introduction
Water is of fundamental importance to human development, the environment and the economy. Access to water and water security is paramount to improving food security, incomes and livelihoods of rural communities (Bazilian, M *et al.,* 2011) [4]. Reliable access to water remains a major constraint for millions of poor farmers, mostly those in rainfed areas, but also those involved in irrigated agriculture (Rockstrom, J. *et al.*, 2017) [5]. Climate change and the resulting changing rainfall patterns pose a threat to many more farmers, who risk losing water security and slipping back into the poverty trap (Shivakoti, B. R., 2007) [6] The need, therefore, to strengthen the communities' capacity to adopt and diffuse CWMI cannot be overemphasized. CWMI includes the management of water used in crop production (both rainfed and irrigated), livestock production and inland fisheries (Sharma, B. R. *et al.,* 2006) [7]. Improved agricultural water management in these production areas is the answer to both global food security and poverty reduction. Current food production must be doubled in order to meet the food needs of the world by 2050 the extension strategies should be suggested to policy makers (Dobermann, A. *et al*. 2013) [8]. The central question for farmers in Ananthapur district is how to manage moisture stress and save crops when rains are not timely and delayed (Rukmani, R., & Manjula, M. 2009) [9]. If this question is answered then all other problems are manageable. For the past few years farmers has been looking at this central question in several ways and developing, promoting and popularizing various drought mitigation measures (Action Fraterna Ecology Centre, 2017). To answer to the above question suggestion were given to adopt extension strategies to manage the agro-ecological crisis through drought mediated technology. Farmers has been intensely involved in promoting cropping systems that can address drought mitigation. The choice of crops, how they are inter-cropped and what goes into managing their cultivation have been key areas that farmers has been focusing on (Lin, B. B. 2011). Farmers believes that much of the problems of drought can be minimized and mitigated through the right cropping system. The other extension strategies were suggested for diffusion of CWMI were a participatory Approach, Research and Development, Demonstration with people on a visible scale and Policy Advocacy for diffusion (Scoones, I., & Cousins, B. 1993) [11].

Research Methodology

The Delphi procedure consists of a series of steps undertaken to elicit and refine the perspectives of a group of people who are either experts in the area of focus or representative of the target group (Rothwell and Kazanus, 1997) [3]. The first step is to select the panel or participants. The second step is developing structured questionnaire based on the problems to be investigated, or unstructured, in which an open-ended invitation to comment on the issues of interest is distributed individually to the participants. The information generated is processed and used by the investigating team to develop a subsequent more focused questionnaire, which is distributed together with the results of the previous round to participants in the third step of the procedure. This process of synthesizing data and refining the questionnaire continues until there is a convergence of perspectives among participants (Lang, 1998) [2].

Measuring degree of consensus

The questionnaire for the first round of Delphi was developed by the experts, scientist and extension functionaries after reviewing the existing literature, job description of the experts, scientist and extension functionaries and discussing with the Research Advisory Committee members.

Questionnaires for second round were developed from the responses of first round of Delphi using constant comparative method. Subsequently, the questionnaire for round III (developed using the responses from the round II) was administered in the same manner as in previous two rounds. The data were collected from the experts through questionnaire and electronic mail method.

Furthermore, consensus was said to be high when quartile deviation was less than or equal to 0.5 and IQR less than or equal to 1, medium when quartile deviation was in between 0.5 and 1 and IQR greater than 1 but less than 2 and low consensus if quartile deviation is more than 1 and IQR more than 2. The important levels were: high in which the median value is 4 and above, while medium in which the median value is 3 and low when medium value is less than 3.

In this study, the Delphi technique was used to arrive at consents of various experts working in water science and technology on the Suggestions of Extension Strategies for Diffusing Contemporary Water Management Innovations (CWMI) in Similar Agro-Ecological Conditions.

Result and Discussion

The suggestions are presented here in five categories: technological innovations of conservation agronomy, extension and communication strategies, agricultural education and administrative measures and policy advocacy measures.

Suggestions for Innovations Development Strategies

In the dryland agro-ecosystem what are the suggestions in the form of research in agronomy, soil science and water technology for promotion of better water management innovations among the farmers in similar dryland agro-ecosystems were taken and listed out based on the opinion of the agronomists and water technologists.

Table 1: Innovation development strategies through research by the water specialists n=23

No	Innovation development strategies	Median value	Q1	Q3	IQR	QD	Remarks
1	Convergence approach is needed to conduct mega project of longitudinal research studies needed for assessing rain water harvesting and rain water use efficiency on villages and watersheds	5	4	5	1	.5	HH
2	Social scientists and management experts need to evolve new research based data on designing, running social institutions for social learning on rain water use.	4	3	4	1	.5	HH
3	Agronomic research is needed on low cost soil moisture conservation innovations, spacing, mulching, mixed cropping, inter-cropping and contingency crop planning.	5	4	5	1	.5	HH
4	Developing IFS (Integrated Farming Systems) model including crops, animals, and trees for efficient utilization of all on-farm resources and generating agro-ecological solutions to farming systems.	4	4	4	0	0	HH
5	Agro-ecological research is needed to generate useful information on basic research on all aspects of selected eco-systems. This basic scientific information is needed to teach farmers.	4	4	5	1	.5	HH

HH-high consensus with high importance,

As can be seen in the table above, the most important suggestions for innovation development strategies included: (i) need for convergence approach in conducting a mega project of longitudinal research studies for assessing rain water harvesting and rain water use efficiency on villages and watersheds. (ii) Need for research based data on designing, running social institutions for social learning on rain water use by social scientists and management experts, (iii) Need for agronomic research on low cost soil moisture conservation innovations, spacing, mulching, mixed cropping, inter-cropping and contingency crop planning, etc., for dryland agriculture, (iv) Developing IFS (Integrated Farming Systems) model including crops, animals, trees for efficient utilization of all on-farm resources and generating agro-ecological solutions to farming systems.. In all these research programmes for innovation development for achieving sustainable agricultural research in dryland areas was the need for agro-ecological research to generate useful information on basic research on all aspects of selected eco-systems. Such agro-ecological basic scientific information would be useful to teach dryland farmers.

Suggestions on Extension and communication strategies

Extension and communication strategies suggested by the panel of experts were listed out to diffuse water management innovations in similar agro-ecosystems.

Table 2: Extension and communication strategies as suggested by the experts =23

No	Extension and communication strategies	Median value	Q1	Q3	IQR	QD	Remarks
1	Conducting series of training course for all stakeholders to re-orient for dryland agro-ecosystems.	4	4	5	1	.5	HH
2	Developing package of practices on water management innovations and developing training manuals and training kits. Extension literature on agro-ecological principles.	4	4	5	1	.5	HH
3	Developing extension literature on agro-ecological rationale behind contemporary water management	5	4.5	5	.5	.25	HH

	innovations.						
4	Promoting adaptation strategies for farmers to cope with increasing climate variability and climate change.	4	4	5	1	.5	HH
5	Conducting a series of travel workshops in the drought-hit villages and creating awareness and action plans for motivating and mobilizing farmers for community level rain water harvesting and sharing	4	4	5	1	.5	HH
6	Empowering people for social inclusion and equitable distribution of benefits from community managed common property resources like rain water, surface water and ground water.	4	4	5	1	.5	HH

HH-high consensus with high importance

As can be seen from the table above, the suggestions for developing extension and communication strategies were: (i) Conducting series of training course for all stakeholders to re-orient for dryland agro-ecosystems, (ii) Developing package of practices on water management innovations and developing training manuals and training kits. Extension literature on agro-ecological principles, (iii) Developing extension literature on agro-ecological rationale behind contemporary water management innovations, (iv) Conducting a series of travel workshops in the drought-hit villages and creating awareness and action plans for motivating and mobilizing farmers for community level rain water harvesting and sharing, and finally, (v) Empowering people for social inclusion and equitable distribution of benefits from community managed common property resources like rain water, surface water and ground water.

Suggestions on Agricultural Education

Contents and methodology of teaching for graduates and post graduates need to be changed for preparing agricultural graduates for dealing with all the critical issues involved in dryland agriculture. These suggestions are given in Table 3.

Table 3: Agricultural education strategies as suggested by the water specialists n=23

Sl. No	Agricultural education Strategies	Median value	Q1	Q3	IQR	QD	Remark
1	Special course on agro-ecology concepts and principles need to be taught at graduate level to appraise students the principles of cyclical complementarities in agro-ecosystems	4	3	4	1	.5	HH
2	Conducting study tours of farmers to the farms of innovative farmers showing profitable production under deficit irrigation. This will encourage conviction among dryland farmers.	4	3	4	1	.5	HH
3	Re-orienting scientists and students of agriculture to new approach of ecological farming through refresher courses for innovation development in sustainable agriculture.	4	4	5	1	.5	HH
4	Encouraging inter-disciplinary research by agronomists, agricultural engineers, water technologists and physiologists to evolve sound and sustainable technologies based on agro-ecological principles.	5	4	5	1	.5	HH

HH-high consensus with high importance.

As can be seen from the table above, the suggestions for engaging scientists and students in the discourse on agro-ecology for sustainable agriculture were listed as: (i) Special course on agro-ecology concepts and principles need to be taught at graduate level to appraise students the principles of cyclical complementarities in agro-ecosystems, (iii) Conducting study tours of farmers to the farms of innovative farmers showing profitable production under deficit irrigation. This will encourage conviction among dryland farmers, (iii) Re-orienting scientists and students of agriculture to new approach of ecological farming through refresher courses for innovation development in sustainable agriculture, and finally, (iv) Encouraging inter-disciplinary research by agronomists, agricultural engineers, water technologists and physiologists to evolve sound and sustainable technologies based on agro-ecological principles.

Suggestions on Administrative measures and Strategies

The items were listed as suggested by the administrative measure and innovative program needs to be developed to address the dryland agro-ecosystem in a novel way for restoring the confidence of farming communities in dryland agro-ecosystem areas.

Table 4: Administrative and Policy measures as suggested by the water specialist n=23

Sl. No	Administrative and Policy measures	Median value	Q1	Q3	IQR	QD	REMARK
1	Policy framework need to be develop for arid and semi-arid zones for judicious ground water management.	5	5	5	0	0	HH
2	Administrative guidelines need to be evolved for rain water harvesting aquifer recharge and ground water use for all drought-hit districts and strictly adhered to.	4	3	4	1	.5	HH
3	Innovative projects and schemes need to be devised with rewards, subsidies, incentives and penalties and additional budget for rain water harvesting, aquifer recharging and judicious use of ground water through micro-irrigation system.	4	3	4	1	.5	HH
4	KVKs in drought-hit districts and in arid and semi-arid areas need to be developed as model training unit for training farmers and extension functionaries and all aspects of eater harvesting, saving and sharing through sprinklers and drip irrigation systems.	4	4	4	0	0	HH
5	Group extension methodologies need to be developed at block level through convergence of all line departments for mobilizing dryland farmers for efficient rain water, and ground water management.	5	4.5	5	.5	.25	HH

HH-high consensus with high importance.

As can be seen from the table above, the suggestions for administrative and policy measures for diffusing water management innovations among farmers in similar agro-ecosystems are listed as below: (i) Policy framework need to be develop for arid and semi-arid zones for judicious ground water management, (ii) Administrative guidelines need to be evolved for rain water harvesting aquifer recharge and ground water use for all drought-hit districts, (iii) Innovative projects

and schemes need to be devised with rewards, subsidies, incentives and penalties and additional budget for rain water harvesting, aquifer recharging and judicious use of ground water through micro-irrigation system, (iv) KVKs in drought-hit districts and in arid and semi-arid areas need to be developed as model training unit for training farmers and extension functionaries and all aspects of eater harvesting, saving and sharing through sprinklers and drip irrigation systems, and (v) Group extension methodologies need to be developed at block level through convergence of all line departments for mobilizing dryland farmers for efficient rain water, and ground water management.

Conclusion

At the outset, the most significant suggestions included: going through all the issues considered, the most important suggestions for extension strategies can be listed as below:

1. Social scientists and management experts need to evolve new research based data on designing, running social institutions for social learning on rain water use.
2. Conducting a series of travel workshops in the drought-hit villages and creating awareness and action plans for motivating and mobilizing farmers for community level rain water harvesting and sharing.
3. Conducting study tours of farmers to the farms of innovative farmers showing profitable production under deficit irrigation, for encouraging conviction among dryland farmers
4. Group extension methodologies need to be developed at block level through convergence of all line departments for mobilizing dryland farmers for efficient rain water, and ground water management.
5. KVKs in drought-hit districts and in arid and semi-arid areas need to be developed as model training unit for training farmers and extension functionaries and all aspects of eater harvesting, saving and sharing through sprinklers and drip irrigation systems.

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