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Improving Management of Natural Resources for Sustainable Rainfed Agriculture

Proceedings of the Training Workshop on On-farm Participatory Research Methodology

26–31 July 2001, Khon Kaen, Bangkok, Thailand

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About ICRISAT

The semi-arid tropics (SAT) encompasses parts of 48 developing countries including most of India, parts of southeast Asia, a swathe across sub-Saharan Africa, much of southern and eastern Africa, and parts of Latin America. Many of these countries are among the poorest in the world. Approximately one-sixth of the world's population lives in the SAT, which is typified by unpredictable weather, limited and erratic rainfall, and nutrient-poor soils.

ICRISAT's mandate crops are sorghum, pearl millet, finger millet, chickpea, pigeonpea, and groundnut; these six crops are vital to life for the ever-increasing populations of the SAT. ICRISAT's mission is to conduct research which can lead to enhanced sustainable production of these crops and to improved management of the limited natural resources of the SAT. ICRISAT communicates information on technologies as they are developed through workshops, networks, training, library services, and publishing.

ICRISAT was established in 1972. It is one of 16 nonprofit, research and training centers funded through the Consultative Group on International Agricultural Research (CGIAR). The CGIAR is an informal association of approximately 50 public and private sector donors; it is co-sponsored by the Food and Agriculture Organization of the United Nations (FAO), the United Nations Development Programme (UNDP), the United Nations Environment Programme (UNEP), and the World Bank.

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Editors

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Many individuals contributed to the success of the workshop. We sincerely thank Dr Narongsak Senanarong, Deputy Director General, DOA and M/s Preecha Cheuwchoom, Chanvid Lusanandana, and Somchai Tongpoonpol, and their staff in Region III, DOA for all the logistical support for the Workshop. We are thankful to the Asian Development Bank (ADB) for providing financial support through RETA 5812 "Improving Management of Natural Resources for Sustainable Rainfed Agriculture" for conducting this workshop. The Organizing Committee sincerely thanks Dr William D Dar of ICRISAT for delivering the inaugural address and also for extending his full support. Our thanks to Dr Aran Patanothai of KKU for his help in identifying the faculty from KKU; and to Dr Amado R Maglinao of IWMI for supporting the participation of MSEC project scientist from Indonesia and also for acting as faculty for this training workshop. We thank all the faculty members who helped in conducting the workshop successfully. M/s K N V Satyanarayana and Y Prabhakara Rao undertook the various secretarial tasks graciously and their help is acknowledged. We are thankful to Ms Sheila Vijayakumar for invaluable assistance for editing the manuscripts and to Mr K N V Satyanarayana for formatting and page-setting the manuscript.

Workshop Committee

S P Wani (Chair)	T J Rego
P Pathak	A Ramakrishna

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Executive Summary

A training workshop on “On-farm participatory research methodology” was organized from 26 to 31 July 2001 in Khon Kaen, Bangkok, Thailand. The workshop was organized by ICRISAT under the project “Improving management of natural resources for sustainable rainfed agriculture”, funded by the Asian Development Bank (ADB). Twelve participants from India, Indonesia, Thailand, and Vietnam participated from ICRISAT, International Water Management Institute (IWMI), and other organizations in India and Thailand.

In the Inaugural Session, Dr William Dar, Director General, ICRISAT welcomed all the participants to the training workshop. He congratulated Drs Narongsak Senanarong, Aran Patanothai, and S P Wani for organizing the workshop and mentioned that this activity was a joint commitment of various institutes to increase the crop productivity of rainfed areas in Asia. He also commended the project scientists for managing successfully five on-farm benchmark watersheds in three countries. He urged the participants to facilitate on-farm participatory research in their own locations.

Dr Narongsak Senanarong enumerated details about the representative site in Thailand located in the Churn watershed. Farmers are involved in the project from inception. The project efforts have resulted in several farmers adopting fruit tree cultivation instead of the traditional annual cropping. These and other improved practices will reduce soil erosion. Thus, integrated watershed management (IWM) in partnership with farmers will reduce land degradation in Northeast Thailand.

Dr S P Wani highlighted the workshop objectives:

- Increase participants’ understanding of teams and the characteristics of effective on-farm participatory research.
- Determine, based on literature and previous experiences, the conditions for reasonable success of participatory on-farm research.
- Develop skills that will empower the participants to effectively plan, conduct, and monitor participatory on-farm research.

The Inaugural Session was followed by eight “learning” or lecture sessions. The faculty covered various topics on on-farm participatory research. For effective on-farm research, partnerships should be successful. To make partnerships successful, both foundation and sustaining elements such as strong leadership, interdependency, communication linkages, and trust and commitment are essential. In collaborative efforts, team effort is critical and should be sustained. Ten essential elements are needed for successful team work: common goals; leadership; interaction and involvement of all members; maintenance of individual self-esteem; open communication; power within the group to make decisions; attention to process and content; mutual trust; respect for differences; and constructive conflict resolution.

In on-farm research, the farmer is considered an integral part of the farming system. Farmers must play an active role in identifying production constraints, designing technical improvements, and testing and evaluating these improvements. A representative farmer and representative site must be selected for the trial. A representative farmer should be one of a target population of farmers who have similar circumstances and could use similar recommendations. Likewise, a representative site should have environmental conditions similar to other fields in the area.

The farmer’s choice of cropping system depends on land, water, capital, and infrastructure. Nutrient balance studies were conducted on sorghum- and groundnut-based systems in India. Low biological nitrogen fixation of legumes in farmers’ fields is one of the causes for poor buildup of soil nitrogen. Inoculation with effective *Rhizobium* strains is recommended.

Adoption of technologies or any other research outputs is a measure of the impact of the research project which developed the technology. The continued maintenance and improvement of the adopted practice is the ultimate measure of success of any research initiative. Farmers do not follow simple trial and error methods but are rational in farm management. Various approaches such as the participatory research-extension approach, farmer back to farm approach, and consortium approach have been advocated to accelerate technology transfer and sustain its adoption.

Integrated watershed management refers to the use and conservation of natural resources effectively to meet the basic needs of land users. For successful and sustainable IWM, a participatory integrated, multi-disciplinary, and multi-sectoral approach is essential. The principles, objectives, and benefits of IWM were discussed. The key elements in participatory process were enumerated. It was emphasized that farmers must be given opportunities to express their views in identification of problems and must share their ideas with researchers, extensionists, and managers.

Community participation is an essential element for watershed management. This was emphasized in the progress of Nallavelli watershed village and the watersheds of the Drought Prone Area Programme (DPAP) in Andhra Pradesh, India.

The session on data needs and collection was not a lecture session but was an interactive discussion. The opinions of participants were collated. Data is required for proper planning and evaluation of research trials. But it depends on the objective of the study. Data is also required for future planning of research and to monitor or evaluate its impact. The precautions of collecting data, and various data required for watershed management were highlighted.

Participants visited the Tad Fa benchmark watershed near Khon Kaen and had good interaction with the farmers. As mentioned earlier, farmers have adopted fruit tree cultivation instead of annual cropping. They felt the need for bigger rain water storage facilities and were willing to bear the cost of construction. Women were not involved in watershed activities. Participants suggested that formation of self-help groups and women participation in watershed activities should be encouraged.

The Concluding Session of the training workshop included the presentation of a report by each participant on his/her on-farm watershed. An elaborate process of evaluation of watersheds as well as the training workshop was conducted. The difference in overall ranking of the watershed was marginal. However, WS4 (Adarsha watershed in Kothapally, Andhra Pradesh) was ranked highest. Site selection and data analysis were the most discriminating criteria. A majority (67%) of the participants expressed that the training workshop has fully met their expectations. The faculty and the training methodology were rated “very good” or “excellent”.

Inaugural Address: Improving Natural Resource Management for Sustainable Rainfed Agriculture in Asia

William D Dar[1]

Dr Narongsak, Deputy Director General, Department of Agriculture; officials from Khon Kaen University (KKU), and Department of Land Development; Dr Amado of the International Water Management Institute (IWMI); participants from Thailand, India, Vietnam, and Indonesia; and my colleagues from ICRISAT, Good morning!

On behalf of ICRISAT, I am pleased to welcome all of you to this Training Workshop on Participatory On-Farm Research Methodology. We are conducting this course in partnership with the Department of Agriculture of Thailand, KKU, and our sister institute IWMI. This activity showcases our joint commitment of increasing the productivity of rainfed areas in Asia. I therefore congratulate Drs Narongsak, Aran Patanothai, and Wani for putting this course together.

All of you who are working in the dryland areas of Asia are well aware of the natural resource dilemma we are facing in Asia today. This is due to high demographic pressures and our dependency on land as a means of livelihood. With increasing population, more marginal lands are being cultivated. In countries like Thailand and Vietnam, forestlands are also increasingly cultivated. About 700 million ha are rainfed with erratic rainfall. Additionally, irrigation is rarely assured in Asia.

Thus, the major problems we face in Asia today are food insecurity and environmental degradation, along with burgeoning population. In this region, 70% of the population depends on agriculture for a living, putting heavy pressure on the land. Poverty incidence is 28%. The population growth rate remains high, compounded by scarce capital. As a result, poverty manifested through hunger, malnutrition, and poor health haunts both the people and the governments of Asia.

The major constraint to sustaining the productivity of Asian drylands is land degradation. I have visited the benchmark watersheds in India, Vietnam, and Thailand. Clear evidence of severe land degradation can be seen in these places. Torrential seasonal rainfall creates a high risk for the cultivated lands. In Thanh Ha watershed in Vietnam and Tad Fa watershed in Thailand, forestlands on steep hills have been cultivated, resulting in severe soil erosion.

To sustain the productivity of drylands in Asia and minimize land degradation, the Asian Development Bank (ADB) is supporting ICRISAT efforts in Improving Management of Natural Resources for Sustainable Rainfed Agriculture. This is being implemented in partnership with the national agricultural research systems (NARS) of India, Thailand, and Vietnam. In this project, led by Dr Wani, five on-farm benchmark watersheds of 30 to 10,000 ha are operational. All the on-farm watersheds are technically supported by a consortium of institutions to address the complex problems of sustaining productivity. Our project is unique because on-station research is linked to on-farm benchmark sites.

Now let me touch on a subject of personal importance to me. You have all heard of the Green Revolution. The benefits of the Green Revolution did not reach the millions of poor living in the "gray" rainfed dry areas. Development investors earlier realized that quick gains could be achieved through investments in favorable areas. However, recent findings by the International Food Policy Research Institute (IFPRI) reveal that investments in rural infrastructure, agricultural technology, and human capital in many rainfed areas have been as productive as in irrigated areas. They also have an

1. International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru 502 324, Andhra Pradesh, India.

enormous impact on poverty. The study concludes that increased investments in rainfed areas is a "win-win" proposition.

Unlike returns to agriculture in the irrigated areas, returns in rainfed areas are seldom immediate and therefore require stronger partnerships. That this project has gained excellent momentum is a credit to all of you, the key partners in this project. Managing five on-farm benchmark watersheds in three countries and conducting on-farm participatory research is a daunting task, and you are to be commended for meeting this challenge.

To fill this tall order, we definitely need special skills. Recently, in Kenya, ICRISAT underwent a one-week course on Leading and Managing for Collaborative Advantage. Dr Wani, who participated in this course, will tell you how important and difficult it is to manage partnerships and teams. I am delighted that the ADB has agreed to support this course on participatory research because this on-farm approach has been proven the most effective way of sharing technologies among farmers and researchers.

On-farm trials are different from on-station trials. We need special skills and precautions to conduct on-farm trials effectively. We must take maximum precautions in conducting them because the problems are complex. There is a vast difference between on-farm trials conducted by researchers and participatory on-farm trials. All of you involved in these on-farm participatory trials are aware of the importance of human resources in the dryland areas. If we have to transform these areas from gray to green, we must minimize environmental degradation.

To achieve this goal, we must place people first. This course, which will empower you to conduct participatory on-farm trials effectively, will help consolidate the gains we have already made. The next phase is to expand on-farm research so that technologies to conserve natural resources and increase productivity are evaluated and further fine-tuned by farmers.

In this project, you will be addressing the problems of millions of resource-poor farmers in the dry tropics. This is our mission at ICRISAT and our core research agenda. I am confident that the team led by Dr Wani will take you through the course successfully and in the end, you will be able to facilitate on-farm participatory research in your own locations.

Before I close, I would like to thank our friend and partner, Dr Narongsak and his team who organized this course in Thailand. Dr Rego has ably handled the logistical arrangements, and he is proving a good resource person in this project in Thailand. Let me also commend the faculty of KKU who will share their expertise with you. I likewise thank Dr Aran Patanothai, an old friend of ICRISAT who continues to help us in this project. I wish you all the best and look forward to seeing the results of your experience here.

Thank you and good day!

Watershed Management for Minimizing Land Degradation in Northeast Thailand

Narongsak Senanarong[1]

The objectives of this research project funded by the Asian Development Bank (ADB) is to improve the management of natural resources, namely, soil and water, for increasing and sustaining the productivity of crops in rainfed agriculture.

The representative site in Thailand is located in the Churn watershed in Mekong river basin. The average annual rainfall in this benchmark site is about 1200 mm. The topography is rolling with undulated slopy lands having steep slopes of 89–93% including 4–6% rocky surface and moderate to mild slopes of 7–10%. The soil depth varies from 30 cm to 120 cm. This site was considered as prone to excessive soil erosion and the Department of Land Development (DLD) had already initiated control measures such as planting vetiver on contours and hillside ditch and encouraged the farmers to grow fruit trees instead of annual cropping.

In this project site our collaborators namely DLD, Khon Kaen University (KKU), and the Department of Agriculture (DOA) with the assistance of ICRISAT focused their work on:

- Socioeconomic surveys to identify the constraints to crop productivity.
- Strategic research to address the major constraints of crop production.
- On-farm participatory research to test and evaluate various options or technologies to improve the management of natural resources, namely soil and water, in order to increase the productivity of the farm land. In this on-farm research improved cropping systems and soil and water conservation techniques are being evaluated.

Traditionally most of the farmers grow maize as a commercial crop and upland rice for home consumption. Since last year a sizeable area is under vegetables. During 1997, the annual rainfall was 1,330 mm and the total runoff was 285 mm. The soil loss was 298 t ha^{-1} on steep slopes, 157 t ha^{-1} on moderate slopes, and 18–55 t ha^{-1} on mild slopes.

Our cropping system on-farm trials clearly convinced the farmers the value of legumes such as rice bean and groundnut to increase the productivity per unit area and also as a source of biological nitrogen (N) input which may result in reducing chemical fertilizer N to the maize crop. Our on-farm trials clearly indicate the benefits of growing rice bean as a relay crop by getting an additional yield of 690 kg ha^{-1} in addition to the normal maize yield of 4,375 kg ha^{-1}. This is obtained without land opening for the rice bean. Traditionally farmers try to grow a second crop after the first maize crop with land preparation and often the second crop fails due to drought and soil preparation further hastens soil loss.

Since last year a continuous effort has resulted in a large number of farmers taking up fruit tree cultivation instead of traditional annual cropping. In 2000, about 300 fruit tree saplings were planted in 2 ha land whereas in 2001 about 1,500 saplings of litchi, longan, and sweet tamarind are being planted on about 10 ha land and bananas are grown as intercrop in between fruit trees. Work is already in progress to check soil erosion in these orchards by planting vetiver around a basin near the saplings. We believe less land openings by plowing in these orchards will reduce soil erosion. The relay cropping of maize-rice bean will also reduce soil erosion. Our collaborators from DLD are measuring the runoff and soil losses in improved as well as in the traditional cropping systems.

1. Department of Agriculture, Chatuchak, Bangkok 10900, Thailand.

Even though we involve farmers right from the beginning it will take 4 to 5 years to see the impact of these systems on overall productivity and on the conservation of precious natural resources of soil and water in this fragile ecosystem. Many farmers are aware about the soil loss due to their present cultivation practices and the value of conservation of soil by shifting to alternate systems but the change is slow because of capital input requirement and waiting time in fruit tree cultivation.

We are convinced that through integrated watershed management approach in partnership with the farmers, we can minimize land degradation in northeast Thailand. This project implemented by ICRISAT is of great help to all of us. The challenge is to scale-up and this course on on-farm participatory methods will help all the partners to undertake this difficult task efficiently. On my own behalf and on behalf of the DOA, Thailand, I thank Dr William Dar, Director General, ICRISAT and Dr Wani, Project Coordinator for giving us the opportunity to organize this course in Thailand. I wish you all the best and we hope that you will enjoy our Thai hospitality.

Thank you all!

Successful Partnerships for Effective On-farm Research

S P Wani[1]

Successful partnerships are critical for undertaking on-farm research as several players are involved in such research trials. To make partnerships successful several elements are critical as discussed below (Fig. 1).

Foundation elements

Foundation elements are those actions that should be addressed in the initial stages of forming partnerships. If dealt with successfully, a climate of openness and trust begins to develop. Research has shown that the investment in building a strong foundation for a partnership is a significant determinant of future success.

Compelling vision

Partnerships need members and leaders who can develop compelling visions, a strong sense of purpose, and trust and commitment among the members and their home organizations. A shared vision and sense of purpose is what holds the alliance together. It defines the problems to be addressed and the strategies to be used. It also defines the scope of work, clarifies boundaries, and helps to keep the partnership from straying off the original intent.

Collaborative partnerships are powered by compelling visions and sense of purpose. For example, a recent study by the World Resources Institute found that the concept of sustainable agriculture serves as an inspiring and motivating vision which captures people's imagination and enhances their commitment. Compelling visions are often marked by achieving significant social or economic impacts as well as achieving technical advances or other objectives such as improving institutional capacity.

Strong and shared leadership

From the start leaders should portray their eagerness to develop a collaborative relationship and build a shared ownership of the problem and outcome. They should help the partnership develop the shared vision; see the potential for the partnership; address the different interests of the organizations; and facilitate the management of boundaries and resources.

Leadership should help the members understand and appreciate the motivation and interests, concerns, and social and cultural norms of the individual members and their home organizations. Leaders should model trust-building actions at the onset of the relationship. These actions are:

- involving others, and using their input or opinions,
- demonstrating a willingness to explore new ideas,
- being honest,
- showing a willingness to exchange ideas, and
- exhibiting sensitivity, i.e., cultural and emotional.

1. International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru 502 324, Andhra Pradesh, India.

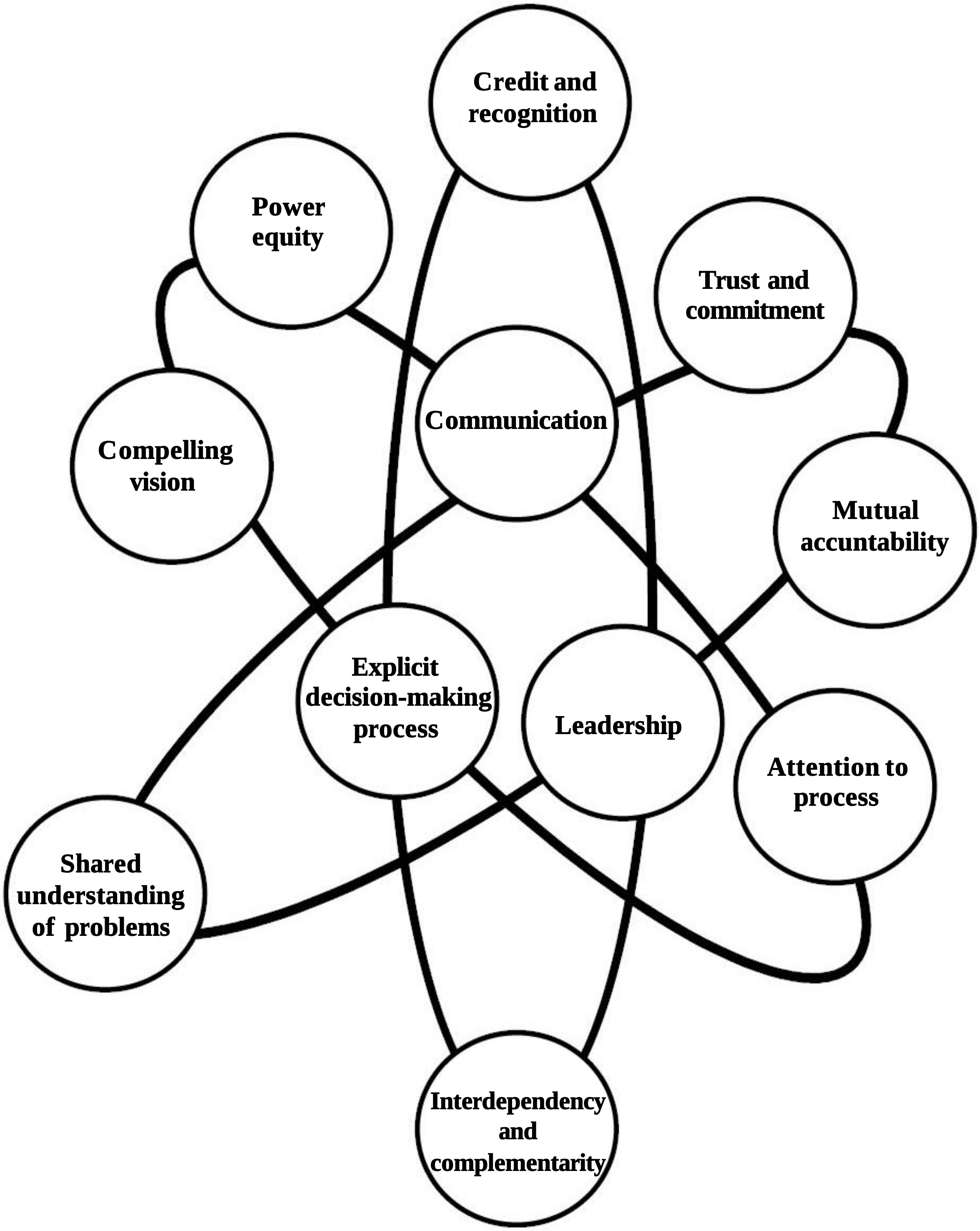

Figure 1. Elements of successful partnership

Successful partnerships are often developed with the help of skilled facilitation, either by the leader, another group member, or an outside professional. Leaders are responsible for ensuring that a facilitated process is used and that the facilitator, whether an internal or external person, is skilled in group process and understands the complexity of forming a collaborative relationship.

Shared problem definition and approach

Partners should be involved in the initial definition of the problem being addressed. Agreements must be reached on the specific problem to be solved, the analytical framework(s) to be used to solve the problem, and strategies for implementing the research agenda. To create a shared definition of the problem, each partner must make an effort to understand the problem from the other partners' point of view. Doing this in an international setting requires time and a commitment to learn how each partner's culture (both organizationally and personally) and professional discipline shape their cognitive approach and contribution to the problem definition and implementation approach.

Power equity

All parties in a partnership should feel they are respected by the other partners and that their contribution is valued. Each organization should feel it can influence the direction and focus of the partnership's vision and strategy. Often members can feel intimidated by other partners' positions and affiliations.

Some important behavioral factors to consider in creating power equity are:

- active and full participation,
- information sharing,
- negotiated priorities,
- clear assignment of roles and responsibilities, and
- equitable distribution of funds and other resources.

All these can signal to partners how much power and status is being accorded to them by other partners. When partners feel devalued or not properly (from their perspective) recognized or given credit for their contribution, the partnership process may break down or the results may fall short of the overall goal of the collaboration.

Interdependency and complementarity

Partners should see their interdependency early in the formation of the partnership. The interdependency is especially appropriate and necessary when the challenge being addressed is complex and requires a broad knowledge base, new technology, and diverse expertise. Each member should bring skills, knowledge, or resources to the partnership that complement those of other members. Members should see that together the partnership will create new value—something they could not do on their own. This is the essence of achieving collaborative advantage. Members must be viewed as legitimate contributors. Partnerships burdened with members who do not bring something new to the table are likely to have significant problems with inertia, unfulfilled commitments, and cumbersome decision-making. While bringing resources and expertise to partnerships is essential, it is also imperative that an organization feels the partnership will advance their own strategic priorities.

Mutual accountability

Given the interdependency of partnerships, success depends on each contributing member fulfilling their responsibilities and commitments in a timely fashion. Developing shared ownership and personal stake in the outcome are strong motivational elements for holding partners accountable. Often, however, the only leverage partners have is the appeal of the vision and the accompanying "good will" that has developed. Partnerships with agreed upon norms and sanctions and enough power and authority vested in the group to exercise these sanctions have a greater ability to hold members accountable than those appealing to good will.

Besides exercising actual sanctions and rewards, there are other actions which can inspire, motivate, and sustain partners' commitment regardless of their individual interests. These are:

- establishing milestones,
- developing short- and long-term indicators,
- setting quality standards for research results,
- identifying benefits,
- producing clear time frames,
- monitoring results,
- celebrating small wins, and
- according appropriate recognition and credit to all involved.

Accountability can be undermined by two situations: (1) members who do not carry out the planned research, leading others to feel that resources have been squandered; and (2) partners who are highly sought after and thus feel more independent than interdependent.

Sustaining elements

Sustaining elements are those actions which maintain the energy, commitment, and enthusiasm necessary for the partnership over time.

Attention to process

Attention to process means developing and reaching an agreement on guidelines that help the group deal with the following:

- communications between members,
- decision-making and approaches to solving problems,
- cross-cultural and non-verbal communication, resolving conflicts, and
- dealing with power differentials, and giving and receiving feedback.

When these guidelines are not followed, feedback should be given. Specifically, people should hear how their behavior is adversely or positively affecting the group's work. Giving feedback may be more sensitive when there are power imbalances, strong cultural differences, and inter-organizational political issues. When these conditions exist, it is essential to rely on previously agreed to guidelines for giving and receiving feedback.

Communication linkages

Members representing organizations in the partnership must continue to keep the 'home' organization informed about the partnership progress and aware of the benefits coming from the partnership. Partnerships involving members from different locations should place special emphasis on maintaining continuity between meetings by regular contact using phone, fax, or e-mail. Clarity about expectations of what is to be reported and how to communicate progress is essential to partnerships.

Explicit decision-making process

Successful partnerships have clear agreements on how the partners will make decisions. The decision-making process should allow for active participation and consensus building, and at the same time be efficient. Agreements should be explicit regarding how much reporting and documentation should be done, who should be involved in making decisions, and how quickly decisions should be made.

Trust and commitment

Creating complete commitment to the partnership's vision and goals takes time. Trust and commitment develop as a result of:

- People doing what they say they will do.
- Understanding and protecting the interests of all members, and listening with the intent to understand what others are saying.
- Being honest about what the partner organization can contribute to the effort **(not hiding limitations)**.
- Sharing successes with others and/or taking responsibilities for mistakes.
- Developing a shared set of values around both the expected output of the partnership and the processes for carrying out the work.

Credit and recognition

One of the major challenges in sustaining motivation and achieving quality results is to acknowledge and reward people for their successful efforts. Not all partners will have the same incentives or rewards. Agreements must be reached at the onset of the relationship about visibility, authorship, and intellectual property rights.

Ten Essentials of Teamwork

S P Wani[1]

Once teams are formed it is important that team efforts are sustained and team spirit is maintained. To make teams successful and perform better some ground rules or essentials should be adopted or followed. The following essentials are needed for successful team work (see Fig. 1).

Common goals

Members of a team need a reason for being and working together. There is common agreement among the team members about the team's goals and desired results. Although the goals may change over time, each member should clearly understand the goals at any point. When goals are less clear it is more likely that they will be misinterpreted by team members and the group will suffer internal tensions, arguments, and cross-purposes. Without clear goals, people become apathetic or use the group to achieve their own personal goals. In addition to clear, commonly agreed goals there should be an agreed upon strategy and work plan for achieving results.

Leadership

Leaders ensure that common goals are established and well understood by team members. Leaders are the people who are respected and sufficiently influential to get others to listen to them, to get support from reluctant members, and to build linkages with groups and people outside the team. Leaders work to remove obstacles that block getting the work done, get the team needed resources, resolve priority conflicts with other parts of the organization, and coach and train team members. Leaders help coordinate the work of the team, have good communication skills, and know how to get everyone involved to build commitment to achieve team results.

Interaction and involvement of all members

Roles and responsibilities of team members, including the team leader should be clear. The team takes time to sort out each team member's responsibility and decide for what he/she will be held accountable. The team can face problems when members are unclear about what they and others are to do. Everyone realizes that to achieve synergy and group spirit, all team members must contribute talents, skills, and abilities actively. When team members are full contributors, the team is more likely to have fun together and to enjoy their work with one another.

Maintenance of individual self-esteem

Members should not lose their self-esteem. Each person's contribution must be heard, valued, and acknowledged. Favoritism must be avoided, and members must be encouraged to be themselves. The challenge to the team and to the leader is to enhance, not lower, the self-esteem of each member.

1. International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru 502 324, Andhra Pradesh, India.

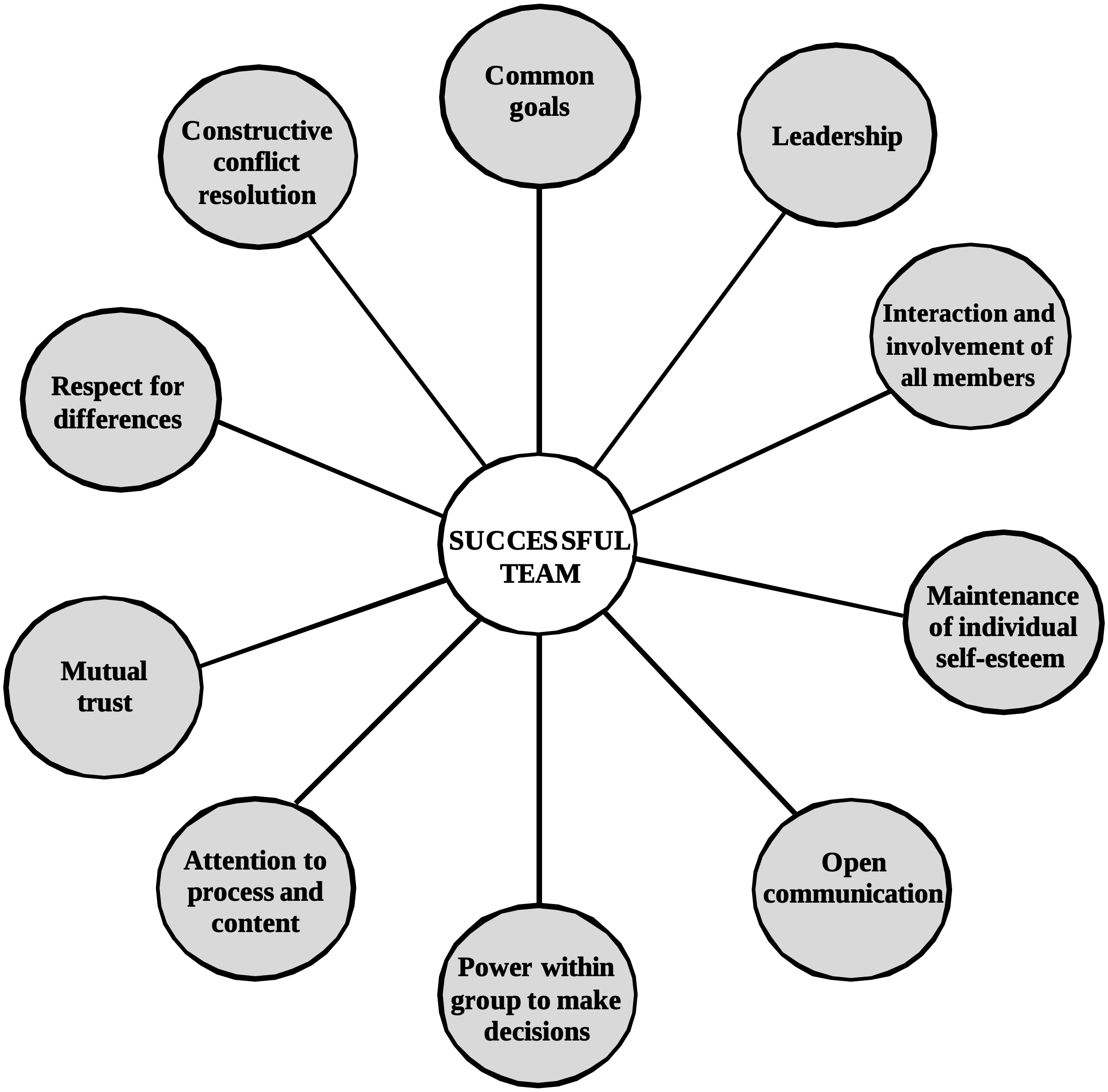

Figure 1. Essentials of a team

Open communication

Team members should feel they can be outspoken and that the channels of communication are open to everyone, especially to the leader. The team should have ample time to communicate; share information; discuss issues; and use all communication channels to pass on information, make suggestions, and bring up new ideas.

Power within the group to make decisions

The work of the team should center around those aspects that it has the power to influence as much as possible. Teams should be clear about the amount of freedom and authority they have to make decisions. Sometimes a team can make decisions that are either ignored or vetoed in the organization.

If more decisions are made at the level where they are carried out, people would have more success in working in teams.

Attention to process and content

For people to function well together as a group, attention must be paid both to the process of working together and the content of the group's task. For example, establishing guidelines for working together or operational protocols ensures that the team can function smoothly in the pursuit of their results. Usually, the task to be done gets a lot of attention, while the process of how the team members work together is expected to fall into place without much discussion.

Mutual trust

Trust is the cumulative results of how the team leader and members treat one another. Trust is exemplified by predictability, reliability, and consistency. When something happens to break that trust (a commitment not met, a confidentiality betrayed, dishonesty), it can be difficult to rebuild. Members and the team leader may need to discuss how their behaviors and attitudes affect trust and try to work to build and maintain trust.

Respect for differences

Team members need to feel they can disagree and be different from others without fear of being punished. The leader sets the tone by his/her behavior, yet each member has to take responsibility for acknowledging and respecting the needs of others. Respect for differences includes appreciating the different cultural and functional perspectives team members bring to the work they do.

Constructive conflict resolution

Conflict is natural. When it surfaces, it must be addressed in a healthy way. Team members should be open and direct in their expression of conflict. Again, the leader plays an important role in getting group members to express conflict and come to general agreement. Unresolved conflict leads to less-than-adequate performance, resentments, and lack of motivation. Therefore effective teams take time to address and resolve conflicts.

Planning On-farm Trials and Selection of Sites and Farmers

P Pathak[1]

The main objective of any on-farm research is to generate viable technologies that fit into the existing farming systems and help to overcome production constraints. Results from on-farm research should provide more options to farmers. The farmers would be able to use resources more effectively to solve problems, relieve constraints, and exploit new opportunities at the local level without further degrading the environment (Steiner 1987). Another objective is to provide feedback to on-station research so that the research is more focused and problem-oriented.

For watershed projects, on-farm research should result in farm recommendations or extension messages that are readily adopted and continually used by farmers. In a watershed project, successful recommendations cannot be developed on a research site without the involvement of the community. Farmers must play an active role in: (1) identifying the problems or production constraints, (2) designing technical improvement, and (3) testing and evaluating these improvements. This participation constitutes a substantial difference between on-farm experimentation and conventional multi-locational testing of research station-developed technologies. In on-farm research, the farmer is considered an integral part of the farming system. Therefore, evaluation of the trials also includes the farmer's skills and reactions, besides the biological, technical, or economic performance of an improved practice. Farming systems can be substantially improved only if the farmers can express their constraints and are involved from the beginning.

Planning on-farm research

On-farm research is an iterative process or a sequence of activities. There is constant feedback, which allows the original problem identification or design to evolve and adapt to current requirements. Often on-farm research has five stages (Steiner 1987), which are briefly described below:

Selection of the target area and the target group(s)

For our ongoing watershed projects this selection was already made when the project area was determined. However, as conditions often vary substantially within the watershed area (Fig. 1), it may be necessary to define smaller areas with similar physical, biological, or socioeconomic characteristics within the watershed boundary.

Description or diagnostic stage

The purpose of the diagnostic stage is to:

- Gain an understanding of the farm environment and the farming systems;
- Assess those conditions that influence farmers' decisions;
- Identify major physical, chemical, biological, and socioeconomic constraints in the farming systems that limit agricultural production;
- Identify the research priorities.

1. International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru 502 324, Andhra Pradesh, India.

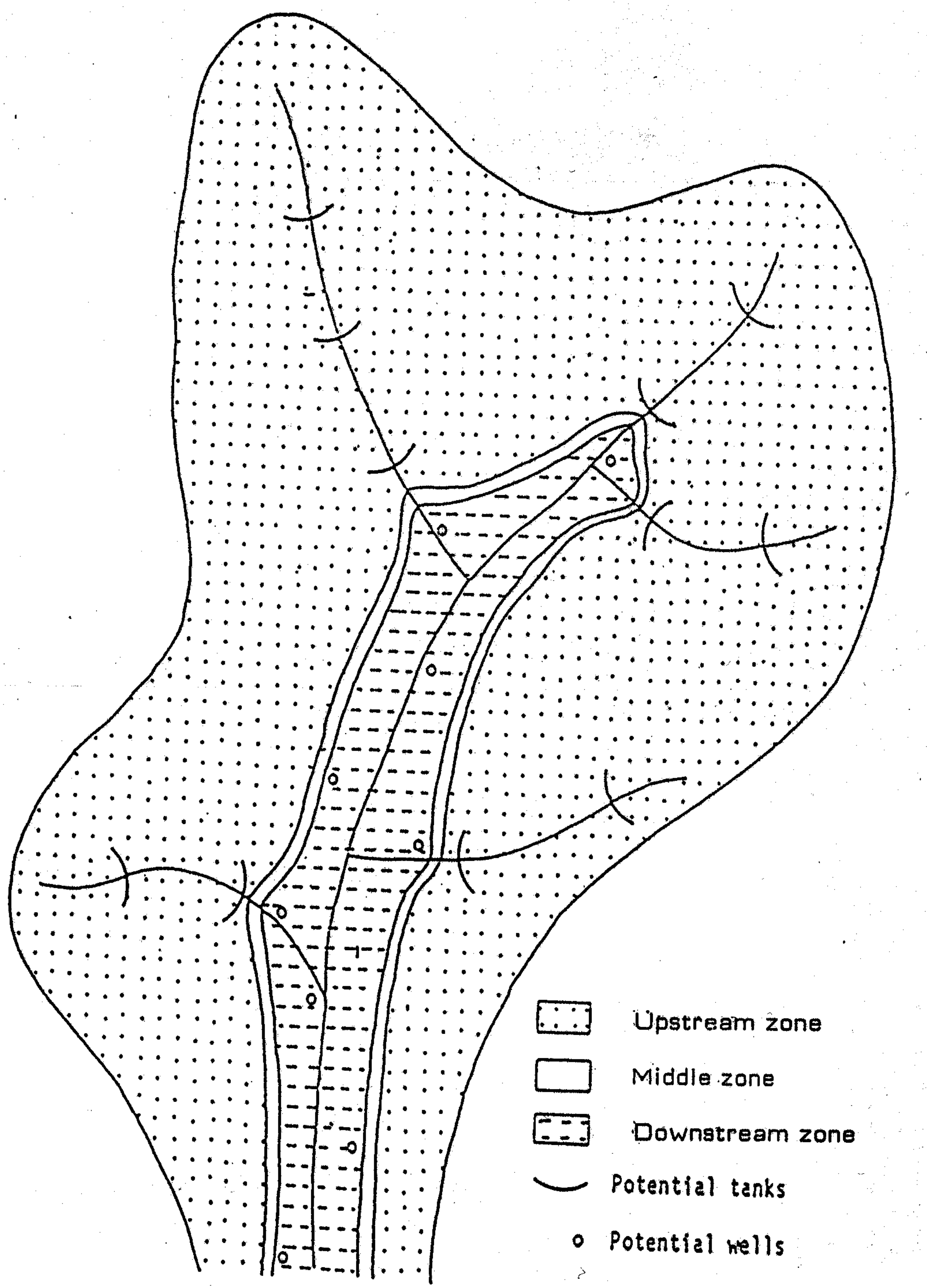

Figure 1. Schematic drawing of a watershed showing the upper, middle, and downstream parts of the watershed

The following activities need to be undertaken:

- Collection and analysis of baseline data;
- Exploratory survey;
- Description of the farmers' environment and the farming systems;
- Identification of problems and opportunities.

Design stage

Possible solutions (improved practices) to production constraints that can fully exploit available opportunities are identified. These solutions are then analyzed to ensure that the solutions suit the existing farming systems and do not create new constraints.

Testing stage

The testing stage is usually called on-farm experimentation. To evaluate on-farm trials some criteria are applied:

- Technical feasibility to ensure that farmers can adopt the suggested pattern.
- Socioeconomic feasibility to see that suggested innovations are compatible with the socio-cultural system and economically viable.

Often new problems and constraints are identified during the testing stage, necessitating a change in the original experimental design or further work at a research station.

Extension stage

Once positive results are obtained from the on-farm experiments, these should be disseminated within the recommendation domain by the non-governmental organizations (NGOs) and extension service, usually first on a limited scale in a pre-extension scheme.

Site and farmer selection

The criteria for choice of site depends upon the objectives and subject matter of the experiment. If the experiment is to test alternative land and water management practices for soybean, then the farmer chosen must grow soybean and the site chosen must have a representative soil, slope, and other features. The key is to choose a representative farmer and representative trial site (Stroud 1998).

Once a field site is identified, the farmer should be interviewed again about the field's history, specific practices used, and any yield differences occurring within the field. The problem under investigation should be discussed and the farmer's attitude towards the proposed solutions ascertained.

On-farm trials are more meaningful if conducted with representative farmers on representative sites. The criteria for site selection must be developed based on background and survey data. The sites may be stratified; e.g., high fertility and low fertility fields should be chosen. Another criterion is logistics. Constraints of time and finances may force the positioning of trial sites as clusters or located along roads.

A representative farmer should be one of a target population of farmers who have similar circumstances and could use similar recommendations. Specific criteria as given below should be developed:

- Are the farmer's income level and resources representative?
- Are the farmer's management practices representative and suitable for the type of trial in mind?
- Does the farmer work full time?
- Is he/she a resident of the farm?
- Is the farmer interested in participating in the trials?

It is most important that the selected farmer should be cooperative and willing to partake in the on-farm experiment. Non-representative farmers can give misleading results and make the extrapolation of results difficult.

A representative field or trial site has soils, slope, terrain, and cropping history similar to other farms or plots belonging to farmers in the same target group. In the watershed project, while selecting sites special care should be taken to see whether sites belong to upstream, middle, or downstream areas of the watershed (Fig. 1). These zones generally have very different farming conditions and problems.

When choosing a trial site the following specific aspects should be considered:

- Uniformity: Features such as soil texture and color, slope, stoniness, previous year's crop, weed growth, erosion marks, drainage gradients and presence of trees, stumps, or termite mounds should be noted. Other features such as soil depth, general fertility level, flooding during rainy season, and other important problems should be noted after discussing with farmers.
- Hazards: Areas to avoid are those likely to be damaged by wildlife and livestock, such as near major pathways, pasture lands, and houses or trees.
- Accessibility: An accessible field should be chosen, especially during the rainy season. This is extremely important for the experiments where considerable data are expected to be collected during the rainy season.
- Size of available trial area: A field should be able to accommodate the trial.

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Principles and Concepts of Cropping Systems

T J Rego[1]

What is a cropping system?

Cropping system is an important component of farming systems and represents cropping patterns practiced on a farm. Cropping pattern refers to the proportion of area under various crops (at a point of time in a unit area) or different crop sequences followed in a year. Cropping system is one of the land use systems in the farm. Other land use systems are horticulture, agri-horticulture, floriculture, vegetable production, silviculture, pasture, silvi-pasture, farm-forestry, agroforestry, etc. Farming system includes all other farm enterprises such as fishery, animal husbandry, poultry, piggery, silkworm rearing, and mushroom culture in addition to the various land use systems.

Types of cropping systems

Cropping systems are classified based on the number, combination, and spatial arrangements of crops grown at a given time or in succession during the year.

- Monocropping: A single crop is grown on a piece of land and the same crop is grown every year.
- Multiple cropping: Two or more crops are grown on the same piece of land in one calendar year.
  - Intercropping: Two or more crops are grown at a given time in spatial arrangement.
  - Mixed cropping: Two or more crops are randomly grown at a given time without any distinct arrangements.
  - Sequential cropping: Two or more crops are grown in succession one after another.
  - Relay cropping: A type of sequential cropping in which there is an overlap of a few days between the harvesting of the preceding crop and seeding of the succeeding crop.

Advantages of multiple cropping

- Avoids risk of total crop failure due to erratic rainfall or pests and diseases and ensures food security.
- Increases the annual net yield per unit area.
- Optimum utilization of natural resources such as land, water, sunlight, and nutrients.

Factors influencing choice of cropping system

Farm resources

The choice of cropping system depends on land, labor, water, capital, and infrastructure. In drylands, water availability is the most important constraint for crop production. The amount of rainfall as well as soil type and water-holding capacity influence the type of cropping system based on the length of the crop-growing season (Table 1).

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Table 1. Potential cropping systems in relation to rainfall and soil type.

Rainfall (mm)	Soil type	Water availability period (weeks)	Potential cropping systems
350–600	Red soils and shallow black soils	20	Single rainy season crop
350–600	Sandy soils	20	Single rainy or postrainy season crop
350–600	Deep black soils	20	Single postrainy season crop
600–750	Red soils, black soils, sandy soils	20–30	Intercropping
750–900	Sandy soils, deep black soils, red soils	>30	Sequential cropping or double cropping
>900	Sandy soils, deep black soils, red soils	>30	Sequential cropping or double cropping (assured)

Farm enterprises

Enterprise at the farm level leads to a cropping system having specific crops; e.g., fodder crops in dairy and cereal grain crops in poultry.

Farm technology

Improved technologies alter the cropping systems. In deep black soils with annual rainfall of >750 mm, dry seeding helps in obtaining both rainy and postrainy season crops instead of only one postrainy season crop.

Crop interaction

Intercropping

- The interaction between the component crops may be competitive, non-competitive, or complementary.
- Competition for growth factors such as sunlight, water, and nutrients must be avoided.
- A combination of tall and short crop (millet/groundnut) or short- and long-duration crop (groundnut/medium-duration pigeonpea) reduces competition for sunlight.
- Water is used more efficiently by crops that extract water from different soil depths due to different rooting depths (sorghum/pigeonpea) or produce more canopy (cotton/mung bean), thus reducing evaporation from soil surface.
- A combination of cereal and legume crops reduces input of nitrogen (N).

Sequential cropping

- The interaction is non-competitive.
- Some preceding crops have an allelopathic effect on the succeeding crop.
- Soil fertility is reduced by the preceding crop, particularly if it is a non-legume crop.

- Residual effect of farmyard manure (FYM) or phosphorus (P) fertilizer can be seen on the succeeding crop.

Crop management

Intercropping

- Prepare seedbed as per the base crop.
- Use less competitive varieties.
- Adjust time of sowing; e.g., staggered planting in aggressive and non-aggressive crop combinations.
- Adequate nutrient application is essential as per the requirement of component crops.
- Weed control: Weed infestation is less compared to monocrops; but chemical control is difficult.
- Pest and disease control: Incidence of pests and diseases is less due to crop diversity.

Sequential cropping

- Crop management is easier than in intercropping because the crops are treated separately.
- Use short-duration and photoperiod-insensitive varieties.
- Harvest the first crop at physiological maturity to avoid terminal drought of second crop.
- Overcome the allelopathic effect of the preceding crop on the succeeding crop.
- Add additional amounts of N if the preceding crop is sorghum or millet because their roots have wide C:N ratio.
- Reduce fertilizer input by 10–15 kg N ha^{-1} if the preceding crop was a grain legume.
- If FYM or P fertilizers are applied to the preceding crop, reduce the input of N and P to the succeeding crop.

On-farm Nutrient Balance Study of Sorghum- and Groundnut-based Systems in Semi-Arid Tropical India

T J Rego[1]

Nutrient balance studies have shown that the depletion of soil nutrients is one of the most important problems for sustainable agriculture in sub-Saharan Africa. Information on nutrient depletion in India is surprisingly scarce. Jha and Sarin (1984) anticipated more pronounced nutrient depletion in dryland agriculture where input of purchased fertilizer and farmyard manure (FYM) is traditionally low. Nutrient balances can be calculated on various scales, e.g., national or regional level, farms of particular farming system or fields of particular cropping system. Much of the published data in India is on the national and regional level and deals only with mineral fertilizer inputs and estimates of crop nutrient uptake.

In India, despite a steady increase in fertilizer consumption, nutrients removed from fields still exceed inputs (Tandon and Narayan 1990). There are considerable differences between the nutrient balances in different agroecological regions. A review of literature indicated that there were four approaches adopted by different researchers to estimate nutrient balances.

In some parts of semi-arid tropical India (e.g., Mahabubnagar district of Andhra Pradesh) farmers traditionally grow a rotation of sorghum and castor in the rainy season (110 to 135 days) on low water-holding capacity Alfisols. Sorghum and castor are frequently grown as intercrops with pigeonpea. Anantapur district in southern part of Andhra Pradesh is a major groundnut-growing area, where the rainfall pattern is similar to that in Mahabubnagar. In this environment groundnut is a dryland crop, which tolerates this unfavorable rainfall pattern. Hence, farmers follow only groundnut monoculture. Also, groundnut is a valuable oilseed cash crop.

To obtain reliable data on nutrient mining in dryland farming systems of the Indian semi-arid tropics (SAT) we conducted nutrient balance studies on farmers' fields. After a survey of dryland cropping systems on Alfisols in the Indian SAT, we decided on two cropping systems (sorghum-based system in Mahabubnagar district and groundnut-based system in Anantapur district) that were of primary importance. Our nutrient balance study was limited to these systems and to three major nutrients, nitrogen (N), phosphorus (P), and potassium (K).

Methodology

The basic cropping systems on Alfisols in the Indian SAT were determined and delineated through the use of crop statistics and geographic information system (GIS). Sorghum- and groundnut-based systems were selected because they have been the most important dryland cropping systems in this area. Based on the initial survey, the villages Nusikottala and Krishnamreddypally in Anantapur district and Bhootpur mandal in Mahabubnagar district were selected as locations for the nutrient balance study in groundnut- and sorghum-based cropping systems respectively.

The farmer sample was stratified according to farm size (small < 2 ha, medium 2–10 ha, and large >10 ha) and farmers from each group were selected for the nutrient balance study. Fields of 45 farmers were selected according to this crop distribution in the first season. The nutrient balance of the same field was determined in the second season regardless of the crop. In addition to these criteria, access

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to irrigated land was considered important for nutrient management of dryland crops. The same proportion of farmers with access to irrigated land was maintained in the sample group. The selection of farmers and fields was much similar in the groundnut-based system.

We attempted to establish a nutrient balance for N, P, and K for the two cropping systems in the seasons 1995/96 and 1996/97. Of the five identified inputs [mineral fertilizers, organic manure, atmospheric deposition, biological nitrogen fixation (BNF), sedimentation], and five outputs (harvesting product, residue removal, leaching, gaseous losses, water erosion), it was possible to determine the nutrient application with mineral fertilizers and organic manure and BNF (in case of N), and the nutrient removal with harvested products and residue removal. The BNF by groundnut in farmers' fields of Anantapur was estimated by three different methods; N-difference, $\delta\,^{15}N$, and ^{15}N isotope dilution. Pearl millet, non-nodulating groundnut, and weeds were used as reference crops. Crop nutrient removal was generally determined after laboratory analysis of samples cut from quadrants. The N and P content of plants was determined with a Technicon autoanalyzer and K content with an atomic absorption spectrophotometer after digestion of plant samples in concentrated sulfuric acid with 0.5% selenium at 360°C. Grain and vegetative parts were analyzed separately. The amount of fertilizer and organic manure applied was determined through farmer interviews. An initial soil sampling through full profile depth was only sampled in selected fields. In the second year, all fields were sampled to the depth of the murram layer (semi-weathered stratum). The soil samples were analyzed for mineral N content (Keeney and Nelson 1982), available P content (Olsen and Sommers 1982), exchangeable K (Thomas 1982), and native *Rhizobium* population.

Results

We estimated overall nutrient balances in some cropping systems. In a sorghum-castor rotation, the N input was 87 kg ha^{-1} as against an output of 77 kg N ha^{-1}, and this indicated a net annual gain of 10 kg ha^{-1}. As N losses were not estimated in this study, and they may have been quite significant, the net gain of 10 kg N ha^{-1} may not indicate the correct N balance. For P and K which are less susceptible to loss, the estimates clearly reveal the positive P and negative K balances in the cropping system. With an improved sorghum/pigeonpea-castor system, the nutrient balances were estimated at +24 kg N ha^{-1}, +26 kg P ha^{-1}, and –16 kg K ha^{-1}. The positive balance for N does not include an estimate for BNF of pigeonpea, which if included may increase the positive N balance. Nutrient balances for the mirror images of the two systems, i.e., castor-sorghum (+45 kg N ha^{-1}, +35 kg P ha^{-1}, +1 kg K ha^{-1}) and castor-sorghum/pigeonpea (+58 kg N ha^{-1}, +44 kg P ha^{-1}, +32 kg K ha^{-1}) were positive, which seems different from their object systems due to seasonal variability. Over a long period, we observed similar nutrient balances in a long-term cropping systems experiment at ICRISAT in Patancheru, India. Continuous cropping system of sole groundnut was on average positive for P (+37 kg ha^{-1}) and negative for K (–20 kg ha^{-1}). For N when we did not include an estimate of BNF then the balance was negative (–111 kg ha^{-1}). If we assume 50% of groundnut N uptake is from BNF then also the balance is negative (–30 kg ha^{-1}). However, our estimates of BNF [% N derived from atmosphere (Ndfa)] by groundnut in farmers' fields ranged from 42 to 65 with an average of 53%. Significant correlation was observed between % Ndfa of groundnut and nodulation and exchangeable K of soil. In order to have a positive N balance the BNF value should be >68%. The soil analysis data from these farmers' fields indicate low buildup of soil N in spite of groundnut monocropping for more than 40 years. Low BNF in the farmers' fields may be one of the causes for poor buildup of soil N.

Conclusions

This study provides factual information on nutrient balances specifically for different cropping systems on farmers' fields, which can be generalized to the region. Low BNF in groundnut monocropping over a longer period suggests the need for inoculation with effective *Rhizobium* strains or better agronomic management such as K application to the crop, etc. Measuring N losses precisely, with different cropping systems in farmers' fields by applying ^{15}N isotope would help in understanding N dynamics in this environment. Phosphorus inputs met the crop requirements in most of the cropping systems that were studied. Potassium application needs to be recommended along with N inputs in dryland cropping systems either through FYM or fertilizer inputs to reduce nutrient mining. There is a need to assess if the BNF by groundnut in farmers' fields of Anantapur could be improved by K application. Positive nutrient balances in maize- and cotton-based cropping systems shall be attributed to farmers' preference for fertilizer application to commercial crops. As a continuation of this work, we are studying nutrient balance in improved as well as in traditional cropping systems of a large number of farmers' fields in the Lalatora and Kothapally watersheds in India.

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Evaluating Technology Adoption and Assessing Impact of Research Projects

Amado R Maglinao[1]

Research and development (R&D) should be viewed as a continuum with various actors playing at different stages and at different levels or degrees of participation. The national agricultural research and extension systems (NARES) usually play a more active role in the applied and participatory research while the international agricultural research centers (IARCs), advanced research institutes (ARIs), universities, and colleges commonly conduct the basic and strategic types of research (Fig. 1). This R&D continuum should further be interfaced with extension to enhance technology integration, diffusion, and ultimately, adoption.

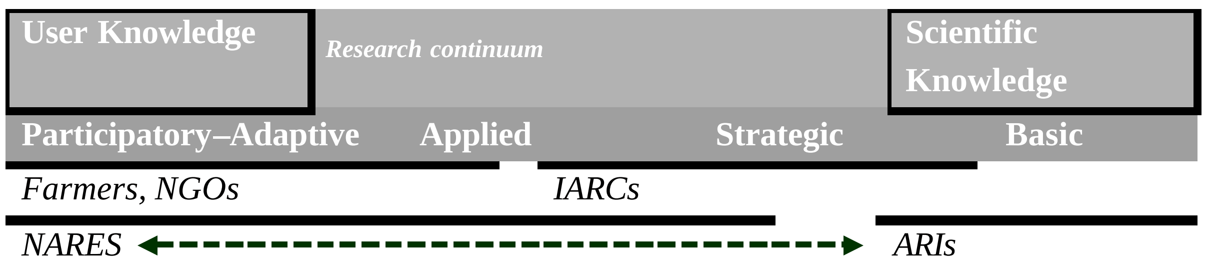

Figure 1. The primary stakeholder domains across the research continuum of an SWNM (soil, water, and nutrient management) consortium (Source: Craswell and Maglinao 2001).

Adoption of technologies or any other research outputs is a measure of the impact of the research project which developed the technology. In our case, we can ask the question: Will there be any difference in the level or rate of adoption of the technologies we are testing once we promote or extend them to the farmers through the conduct of participatory on-farm research?

This paper highlights the advantages and disadvantages of participatory on-farm research, and discusses technology adoption and impact. It briefly describes how the monitoring and evaluation system could serve as a tool to evaluate technology adoption and assess impact of research projects.

On-farm participatory research

Involving farmers in the design and implementation of research on their farms can provide a number of benefits in terms of the functional effectiveness of the research process (Farrington 1998). Other aspects being equal, Conroy et al. (1999) highlighted the advantages of greater farmer participation in research. These are:

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- Applied and adaptive research will be better oriented to farmers' problems.
- Farmers' knowledge and experience can be incorporated into the search for solutions, and highly inappropriate technologies can be "weeded out" early.
- The performance of promising technologies developed on-station can be tested under "real-life" agro-ecological and management conditions.
- Researchers will be provided with rapid feedback on the technologies tested, and promising technologies can be identified, modified, and disseminated more quickly, reducing the length of research cycles and saving time and money.
- Farmers' capacity and expertise for conducting collaborative research is enhanced and becomes a valuable resource for future research programs.

While participatory research has these unique advantages and should be promoted, we must, however, remain aware of its inherent limitations. Rhoades (1998) warns that we should not expect too much from participatory on-farm research. There are some limitations as given below:

- Participatory research is a partial and subjective method, as sampling of ideas and a few persons are always imperfect. Socio-cultural conditions may change rapidly (rendering results volatile) and analyses can be strongly biased. Analyzing results requires a good scientific mind and a large dose of common sense.
- Using results through common scientific techniques is frequently very difficult or even impossible. For the biophysical aspects of trials, some important difficulties are:
  - There are few repetitions, if any.
  - Processes are very difficult to monitor and are often monitored only once a year.
  - It is difficult to install and maintain equipment.
  - Management of trials are difficult to control or even to monitor.
  - Farmers often do not see the value of a "control treatment", and change treatments intuitively.

Adoption of technologies

Adoption of technologies or other outputs and the continued maintenance and improvement of such practices are the ultimate measure of success of any research initiative. However, adoption of any technology is not a simple process. Coming up to a decision to adopt or reject a given technology follows different stages and communication plays an important role in this innovation-decision process (Fig. 2). In general, farmers do not follow simple trial and error methods but are very rational in the way they manage their farms.

Studies invariably point to the complex nature of the adoption process and the many interrelated factors affecting its sustainability. These factors could be summarized as technical (physical and biological), economic, social, and even political. These factors interact with each other in a complex way and vary from technology to technology and from situation to situation.

Accelerating technology transfer and sustaining its adoption pose a major challenge to research and extension. Various approaches such as the participatory research-extension approach, farmer back to farmer approach, and the consortium approach have been advocated. Maglinao (1996) suggested a conceptual model for an integrated approach to facilitate technology transfer and adoption. The framework emphasizes the complementation among the researcher, the extension worker, and the

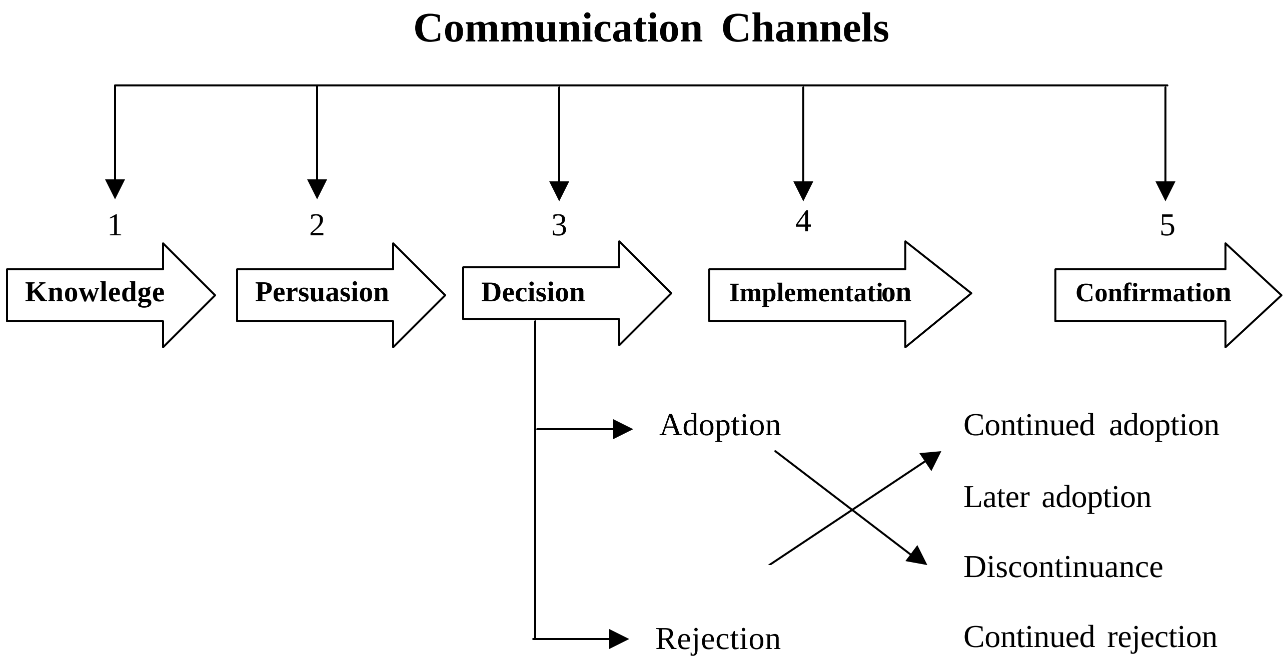

Figure 2. Stages in the innovation-decision process

farmer to answer the challenge. Information and communication play a central role in the model. The availability of the necessary support services is essential.

Impact of agricultural research and development

Economic rationalism dictates that every enterprise justifies its existence in an explicit, preferably, quantitative way. Impact assessment and evaluation is therefore subject to close attention in the international agricultural research community, especially among the donors. Impact means the "significance, importance, value or power of an event, idea, action, etc., to produce change(s)". It could mean differently to various observers and the different objectives the assessment would like to address. Impact assessment is an important and integral part of research management.

Kinds of impact

Horton (1990) distinguished two types of impact corresponding to two broad types of technology that may be generated by an agricultural program, i.e., production impact and institutional impact. Production impact is related to production technology which relates to the physical, social, and economic effects of new cultivation and postharvest methods on crop and livestock production, distribution and use, and on social welfare in general (including the effects on employment, nutrition, income distribution, and environment).

Institutional impact refers to the effects of new R&D technology on the capacity of research and extension organizations and programs to generate and disseminate new production technology. It includes organizational models, like the integrated commodity program, and institutional strategies for program planning and evaluation, training, networking, on-farm trials, and interdisciplinary team research involving social and biological scientists and promoting supportive policy environment for agricultural research and development.

Environmental impact is another concern that has attracted the attention of not only researchers and research institutions, but also of policy makers and donors. While production impact could be measured at the field level, the broader impact on the environment needs evaluation on a larger scale. For instance, the off-site effect of soil erosion could be in-stream problems of water quality and quantity, sedimentation effects on reservoirs, degradation of potable water, increased dredging or siltation, accelerated runoff leading to localized flooding, and reduced hydrological cycling and recharge of groundwater (Enters 1998).

Monitoring and evaluation

Monitoring and evaluation is a common and general tool used to assess a research project, technology adoption and impact. As such, it should be an integral component of research projects, but it is usually not given serious attention. For more effectiveness, monitoring and evaluation should be carefully designed to determine whether goals and objectives of projects over time are being achieved. This can easily be done if the project objectives are Specific, Manageable/Measurable, Achievable, Resourced, and Time-bound, or commonly referred to as SMART.

Monitoring and evaluation of programs/projects

Project monitoring and evaluation are related but have distinct functions. Monitoring provides information for project management and is continuously done. On the other hand, evaluation assesses the overall project effects and their impacts and is done periodically. It should be emphasized that one should know not only the objectives of the project but also the reasons for monitoring and evaluation.

In project management, there is an increasing trend to use the logical framework as a tool or guide for monitoring and evaluation. The logical framework provides a structure for specifying the components of an activity and the logical linkages between a set of means and a set of ends. It is used to visualize the project in terms of: (1) a set of cause-and-effect relationships through which resources provided are transformed so they contribute to achieving the objective of the intervention; and (2) assumptions about important external factors which affect these relationships. It places the project in its larger framework of objectives, within the program and within the national research system. It serves as a useful tool for defining activities, inputs, timetables, assumptions for success, outputs, and indicators for monitoring and evaluating performance. In a way, it enables one to describe a project in terms of three sequential relationships: (1) inputs to outputs; (2) outputs to effects; and (3) effects to impact.

For soil and water conservation programs, Sombatpanit et al. (1996) identified a number of points that must be considered in monitoring and evaluation for success and failure. These are:

- Baseline data are always needed to assess changes and trends.
- Programs should be assessed at all stages, and project areas should be compared with non-project areas with similar problems and treatments.
- Assessments must be specific and not based on blanket recommendations.
- Great care should be taken in selecting assessment criteria. Objectives and perceptions of success or failure may vary among the different groups involved.
- Particular interest groups may conduct their own assessments based on their own objectives and targets, identifying and analyzing short-, medium-, and long-term benefits.
- Absence of success of a project in physical terms does not mean that it had no value. Experience gained and lessons learned are also benefits of a project; it is also useful to know what does not work.
- Quantitative indicators, e.g., area treated, number of trees planted, improvement in ground cover

(proxy indicators), are not sufficient by themselves for assessment. Qualitative indicators such as the increase in positive attitude of farmers towards the need to conserve soil and water resources are more important to sustainable success.

- Long-term programs are required to ensure long-term benefits. Adequate assessment of the adoption and the benefits of soil and water conservation practices for the farmers is possible only in long-term programs.

Evaluating technology adoption

In evaluating technology adoption, one can study the factors affecting adoption or non-adoption of a technology. One can also compare and analyze the rate and extent of adoption. Just as monitoring and evaluation in general, studying technology adoption could be done through qualitative and/or quantitative assessment. The most commonly used tools are surveys and interviews. Analysis could be done by simple methods using means/averages or by sophisticated statistical methods and models.

The more common analytical tools used in adoption studies are models that examine the relationship between a wide range of explanatory variables and the adoption of technology (new or indigenous). These technologies may be varied such as new varieties of crops, new cropping patterns, and fertilizer or input use of new management practices.

Assessing impact

Impact assessment can and should take a variety of forms (Buenavista et al. 2000):

- Direct measurement of impacts (e.g., water quality changes, reforestation rates).
- Comparisons of before/after or with/without project conditions and changes.
- Testimony from key individuals and groups, including those outside the study site and not associated with the project.
- If possible, projections of likely future changes given progress towards impact as of the present.

In assessing the impact of the International Board for Soil Research and Management (IBSRAM), Bangkok, Thailand as an institution, Maglinao (1998) used a framework that shows the linkages between the programs and activities of the institution and their actual or potential effects or impacts on institutions (institutional impact), particularly the NARES and on farmers (production impact). The analysis was primarily based on project reports and a few interviews. While the author recognized the limitations of the study, it provided some initial steps in coming up with a methodology for impact assessment. It is planned to use the same framework in assessing the impact of the Management of Soil Erosion Consortium (MSEC) project (Fig. 3). A closer look at the framework will show that it

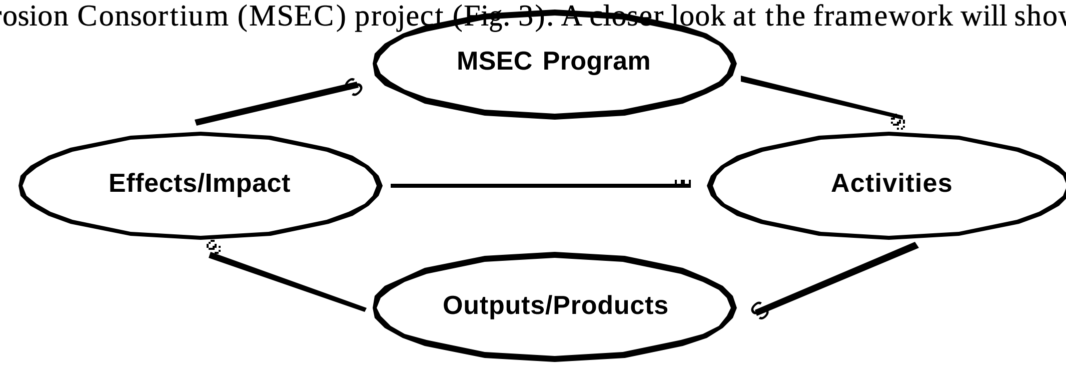

Figure 3. Conceptual framework for the analysis of MSEC impact

could be very well related to the project logical framework discussed earlier.

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Concept of Integrated Watershed Management and Key Elements of its Processes for Sustainable Management

P Pathak[1]

Soil and water are vital natural resources for human survival. The growing population in developing countries and increasing demand are placing tremendous pressure on these resources. As a result natural resources such as land, water, and forests are fast depleting in many countries posing a serious threat to sustainability of agriculture, livelihood opportunities, and vulnerable communities. Sustainable management of these resources with minimal adverse impact on environment is essential for the development and sustenance of livelihoods of resource-poor farmers. Watershed is an ideal unit requiring a multidisciplinary approach to resource management for ensuring continuous benefit on sustainable basis. Integrated watershed management is a prerequisite not only for land, water, and biomass management of degraded areas but also for improving the livelihood of farmers as well as for conservation of areas so that biodiversity is protected for future generations.

Integrated watershed management

Integrated watershed management may mean different things to different people but "sustainable integrated watershed management" deals with the use and conservation of natural resources to meet the basic needs of land users. The new approach to watershed management is 'people-friendly' and 'process-based' rather than physical target-oriented (as was the case in most of the past watershed programs).

A watershed is made up of the natural resources in a basin, especially water, soil, and vegetative factors. The comprehensive development and management of a basin so as to make productive use of all its natural resources and also protect them is termed "integrated watershed management". It is important that integrated watershed management must consider the social, economic, and institutional factors operating within and outside the watershed area. Since integrated watershed management involves decision-making, a multidisciplinary and multi-institutional approach is essential for efficient utilization and protection of natural resources.

Successful watershed

For successful watershed management, a participatory, integrated, multidisciplinary, and multi-sectoral approach is essential. Gender issues, the needs of disadvantaged groups, and distributional equity should be considered and the ownership of the people ensured. Good communication skills at all levels are crucial to achieve the aims of participatory integrated watershed management.

Major objectives of integrated watershed management

Integrated watershed management aims to improve the livelihood of the community/farmers by increasing their earning capacity through offering improved facilities required for optimum production. Some of the major objectives of integrated watershed management are to:

- Conserve soil, rainwater, and vegetation effectively, harvest the surplus water to augment water sources, and improve groundwater recharge.

1. International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru 502 324, Andhra Pradesh, India.

- Promote sustainable farming and stabilize crop yields by adopting suitable soil, water, and nutrient management (SWNM) practices and cropping systems.
- Improve vegetation through afforestation, horticulture, and pasture land development based on land capability class.
- Enhance the income of individuals by adopting alternative enterprises.
- Restore ecological balance.

Principles of watershed management

Sound watershed management means controlling floods and reducing land degradation as well as improving livelihood of farmers. The main principles of watershed management are given below (Katyal et al. 1995, Singh 2000):

- Utilizing the land according to its capability.
- Maintaining adequate vegetative cover particularly during the rainy season.
- Conserving maximum possible rainwater at the place where it falls.
- Draining out excess water with a safe velocity to avoid soil erosion and diverting it to storage tanks for future use.
- Preventing gully formation and checking at suitable intervals to control soil erosion and recharge groundwater.
- Maximizing productivity per unit area, per unit time, and per unit of water.
- Increasing cropping intensity and land equivalent ratio through intercropping and sequential cropping.
- Safe utilization of marginal lands through alternative land use systems.
- Ensuring sustainability of the ecosystem benefiting the man-animal-plant-land-water complex in the watershed.
- Maximizing the combined income from the interrelated and dynamic crop-livestock-tree-labor complex over the years.
- Stabilizing total income and cutting down risks during aberrant weather situations.
- Improving infrastructural facilities with regard to storage, transportation, and marketing.

Key elements in participatory processes

Key elements in participatory processes for integrated watershed management are the critical elements which need to be integrated into watershed management programs but have often been overlooked in the past. The key elements are:

- Participatory, multidisciplinary, and multi-sectoral approach.
- Envisioning of both farmers and professionals for integrated watershed management.
- Farmers' empowerment and ownership of watershed management processes and programs.
- Assured and quick benefit generation by watershed management programs.
- Mainstreaming gender concerns specially those of women and other disadvantaged groups.

It should be clear that unless the watershed or natural resource management activities result in quick (preferably within a crop season or a year) net direct benefits to the participating farmers, their participation can not be expected. Without direct benefits and farmer participation, there will not be any on-farm level watershed management or conservation and better utilization of natural resources. On common property resources also, if they are to be managed better by the people, they must produce quick benefits to them. Thus, gender-sensitive processes and activities assuring quick economic benefits (along with environmental and social benefits to all) are needed.

In all the above elements of the participatory process, dialogue is important to achieve true participatory watershed management. Farmers should get the chance to express their views and opinions to identify problems and to share their ideas with researchers, extensionists, and managers. Local (or farmers') organization and institutional strengthening should be the important development objectives. The result of such approach will be the boosting of confidence of the farmers and the spreading of innovative ideas from farmer to farmer (Sharma and Krosschell 1997).

Benefits of integrated watershed management

Some of the benefits of integrated watershed management are:

- Improving water availability, controlling floods, and reducing land degradation.
- Maximizing productivity per unit area, per unit time, and per unit of water.
- Proper utilization of marginal or wastelands through alternate land use systems.
- Stabilizing income even under unfavorable weather conditions.
- Improving livelihood of farmers by maximizing the combined income from the interrelated crop-livestock-tree-labor complex over years.
- Ensuring ecological balance.

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A Case Study of Nallavelli Watershed Village in Andhra Pradesh, India

K P R Vittal[1]

The Indian Council of Agricultural Research (ICAR) has launched a project on 'Technology Assessment and Refinement through Institute Village Linkage' which offers a pivotal linkage between the farmers' needs, resources, and local environment and an institute. The farmer is the active partner both in decision making and implementation of the research and technology transfer programs. The overall aim is to combine the generated information to suit profitably to individual farming situations. The Central Research Institute for Dryland Agriculture (CRIDA) is one of the institutes identified for implementing the project. Under a conditional criterion to identify a village that was least impacted by urbanization, with maximum number of land owning farmers, agriculture as main occupation and diverse farming enterprise, predominance of rainfed farming, and community comprising several religions, castes, varied socioeconomic status, etc., a core group of scientists selected the village Nallavelli in Yacharam Mandal, Ibrahimpatnam Block, Ranga Reddy district, Andhra Pradesh, India.

Location and village information

Nallavelli village is situated in the northern Telangana agro-ecoregion 7 under the influence of hot, semi-arid region with a mean annual rainfall of 760 mm (±37%) at 17° N latitude and 78°44' E longitude. The village statistics are presented in Table 1. The village is typically varied in topography with a great deal of undulations affording a challenging program on watershed management (Fig. 1). Encompassing an area of 3200 ha approximately, the terrain contains 31 micro-watersheds of varying sizes ranging from 13.8 to 344.3 ha. We have further divided this watershed into sub-watershed, mini-watershed, and micro-watersheds wherein the catchment of the first order stream have been delineated. An assessment of hydrogeomorphology of the area indicates the presence of dykes and fractures/lineament in >12% of the area, residual hills in 23%, and more than half of the rest under weathered pediplain formed by Archean Granite and Gneiss. Groundwater prospects are moderate to good in half of the area and >25% area has negligible exploitable groundwater resource.

Transect

First hand information was gathered from the farmers by the scientists while criss-crossing the fields by the Agro-eco Setting Transect method. Four distinct types of agro-ecosystems were observed during the transect walk. As we approach the village, a typical rainfed ecosystem is observed where castor and sorghum + pigeonpea are the major cropping systems on Alfisols, Entisols, and Inceptisols. Topography is undulating, interspersed with a couple of hillocks. Soil and conservation measures are rarely followed. Soils are highly eroded. Adjacent to the dryland ecosystem lies the irrigated ecosystem. A tank in the southwest direction of the village is the main source of irrigation. Within the command area of the tank, there are borewells which are an important source of irrigation. Rice and vegetables are the main irrigated crops. Some irrigated lands suffer from salinity and alkalinity. On the east of the village lies the dryland tract. Castor, sorghum, pigeonpea, and cowpea are the important crops. Some pockets of irrigated areas also coexist. These pockets, irrigated by bore wells, are devoted primarily to rice and vegetables. Following this dryland area is an undulating stony terrain punctuated by hardy grasses and also bushes, which are exclusively for grazing. Hillocks with steep slopes are badly eroded as is seen from the exposed granite outcrops with few hardy trees growing.

1. Central Research Institute for Dryland Agriculture (CRIDA), Santoshnagar, Hyderabad 500 059, Andhra Pradesh, India.

Table 1. Statistics of Nallavelli village in Andhra Pradesh, India.

Description	Area (ha)	Description	Area (ha)
Land category		**Land capability class**	
Total revenue area	3187	II e	467
Total geographical area	2422	III es	138
Cultivated area (net sown area)	836	IV es	526
Forest area	212	Settlement	26
Uncultivable waste	20		
Non-agricultural use	64	**Population[1]**	
Permanent pastures	64	Total persons	2900
Current fallows	1220	Total families	500
Other fallows	6	Tribal families	50
		Sheep-rearing families	60
Crops		Non-agricultural occupation	
Rice (rainy season)	85	(carpentry, pottery, etc.)	20
Rice (postrainy season)	60	Milch animals	260
Castor	240	Sheep	1150
Sorghum + pigeonpea	200	Land holdings	821
Pearl millet	15		
Vegetables	40		
Orchards	2		
Others (horsegram, cowpea)	50		

1. Approximate values.

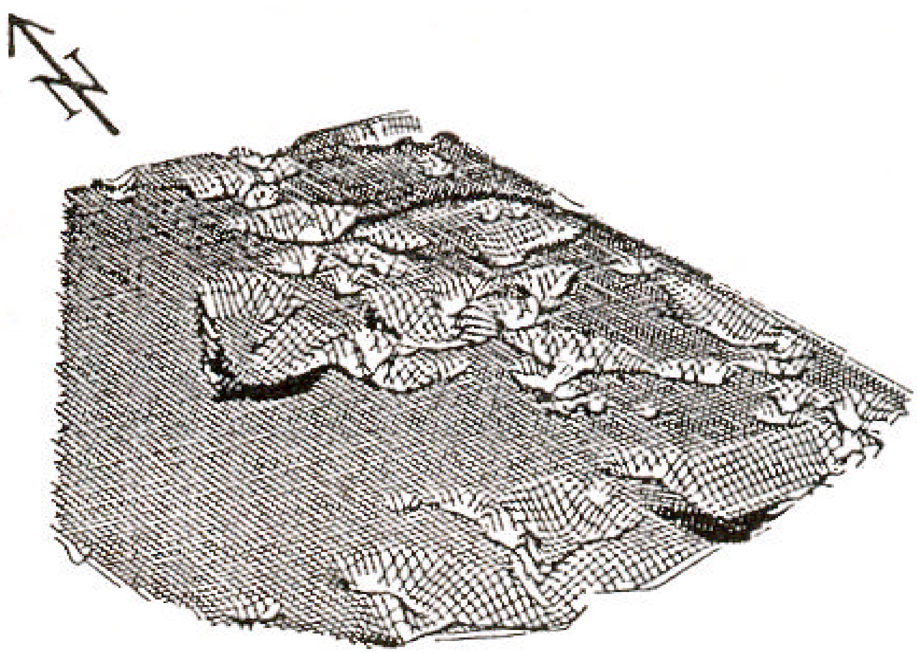


Figure 1. Digital elevation model of Nallavelli watershed, Andhra Pradesh, India

Livelihood analysis

An examination of livelihood analysis reveals that the contribution of agriculture to total income increased with the farm size. Dryland farmers derive one third of their total income from sheep rearing. Livestock (milch animals) significantly contribute to the overall income of the small and marginal cultivators. Farmers having irrigation facilities and larger holdings receive major share of their income from agriculture (> 70%). The proportionate expenditure on social functions is also high for rich farmers. With increase in farmers' incomes the proportionate expenditure on food decreased and that on clothing and education increased.

Matrix ranking

The matrix ranking for various crops have shown that the farmers are not always profit driven as they also consider input requirement and availability of resources for choosing crops and varieties. Rice and pigeonpea are grown for both food and profit. Sorghum is raised for fodder. Castor cultivation is preferred because of more monetary value and less labor requirement. Farmers know that mixed cropping is a strategy of risk minimization. Farmers replace rice with vegetables when water is scarce.

Trend analysis

Farmers reported a declining trend in rainfall. The tank, stream, and wells in the village also are drying more frequently in recent times than earlier. The tank in the village received runoff only twice in the last 10–15 years. However, the factual position on declining trends in rainfall and water availability could not be confirmed by the real time series data. Although rice, castor, sorghum, and pigeonpea are the traditional cropping systems, farmers of late have started devoting more area to sunflower, groundnut, and *ber* as a consequence of low water availability. A few enterprising farmers are growing mango and teak. Farmers are aware of the increasing menace of soil erosion over time. They complained of rise in pest incidence during recent years and declining work of labor. The productivity levels of all the crops are reported to be falling over time.

Seasonal analysis

Seasonal analysis of rainfall, cropping patterns, labor shortage, fodder availability, and milk production was done by the farmers. Rainy season crops such as sorghum, pigeonpea, and tomato are sown during June–July, castor and cowpea in July, and horse gram during first fortnight of September. Rice is predominant in rainy season and postrainy season under assured irrigation. Tomato and sweet potato are planted in postrainy season. Okra is taken up during January–March by a few farmers. Incidence of red hairy caterpillar in castor occurs largely in August. Considering the seasonality of incidence of various pests on different crops, September and November are the key months from the plant protection point of view for rainfed crops. Brown plant hopper attacks rice crop during August and January.

Rainfall is generally confined to the period between June and November. Peak rainfall is reported in September followed by August and October. Scarcity of labor is in September, March, April, and July which coincides with peak agricultural operations such as preparatory cultivation, sowing, and harvesting of different crops. Scarcity of green fodder is more severe during April–June.

The land use and hydrology map was drawn by the farmers. The village has three natural streams flowing from west to east. Irrigation water tank is in the southwest. The tank is fed by the overland flow from catchment area located mostly on the western side. The stream originating from the tank flows through the village beyond its western border. It feeds two small canals which run parallel to the stream. Much of the wet land area under rice lie on either side of the stream and small canals. Most of the dug wells and tube wells are also located in this lowland area (Fig. 2).

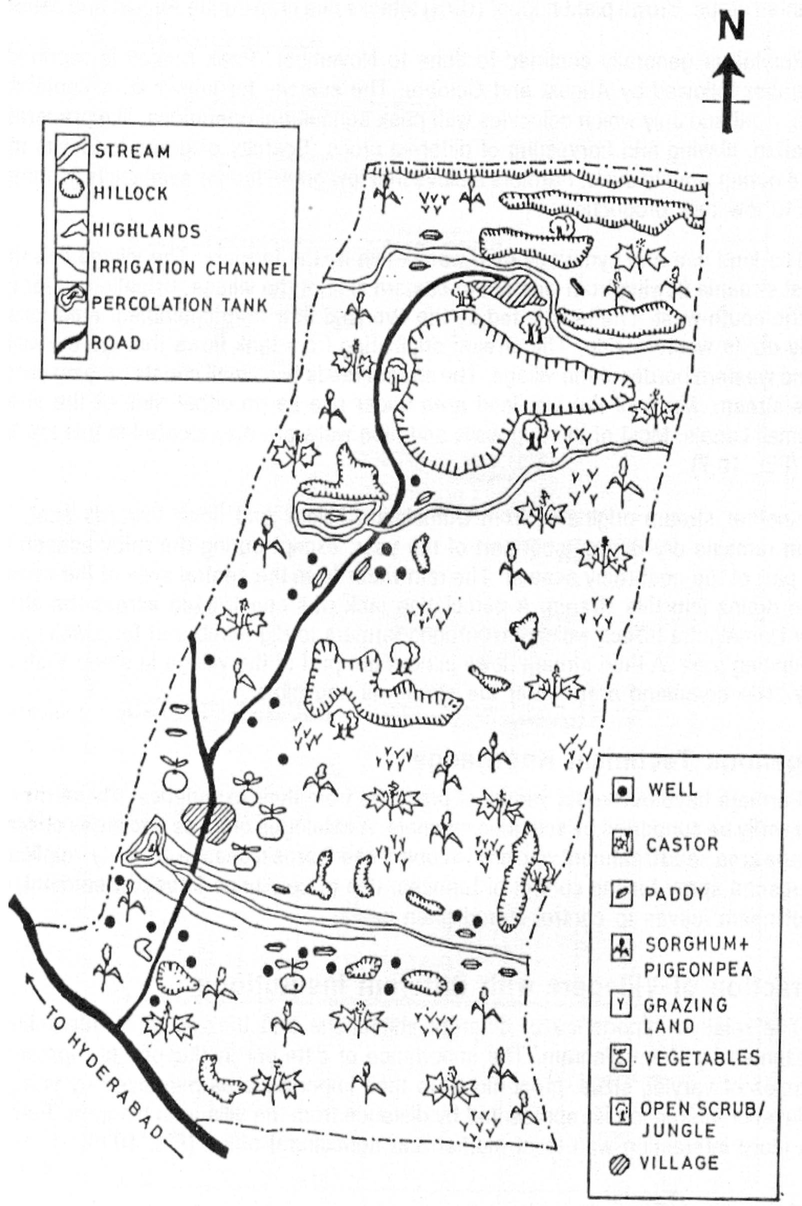


Figure 2. Hydrology and land use map prepared by the farmers

Indigenous technical knowledge

Farmers have evolved various practices from their experience:

- Seed treatment with ash to control seedborne diseases in paddy.
- Application of kerosene spray for the control of termites.
- Use of cow urine in seed treatment.
- Use of neem leaves to control stored grain pests.

Participatory planning

Through suitable participatory rural appraisal (PRA) techniques five different categories of farming situations with varying areas of rainfed and irrigated land were identified. Accordingly, their needs and resources also varied. Different technology modules encompassing the areas of arable farming, horticulture, alternate land use systems, and off-farm activities were formulated in consultation with the farmers.

The modules included introduction of crops and varieties, crop and pest management practices, livestock management practices and activities for income augmentation as per the farmers' needs, their problems, resources, and willingness to act upon. Based on these modules, an action plan was prepared for 460 farmers to be implemented during the next two years. As soil conservation and water harvesting are of prime concern to the farmers and the farming situations in the village, it was felt essential to deal these situations separately for cultivated land, non-agricultural land, and waterways and drainage lines, and thus achieve sustainability of production.

The following are the important prioritized problems identified by the farmers in the village:

- Resource conservation, development, and management
- High fluorine content in drinking water leading to fluorosis
- Frequent and prolonged power cuts
- Low yields of crops, particularly castor, rice, pigeonpea, and vegetables
- Uncontrolled grazing and soil erosion in drylands
- Low milk yield of buffaloes
- Lack of veterinary health facilities
- Non-availability of quality and timely inputs such as pesticides, fertilizers, and seeds
- Lack of transportation facilities and market access
- Lack of credit and marketing facilities
- Lack of gainful employment opportunities
- Lack of proper storage facilities for farm produce

Emphasis of this initiative would be low investment requiring crop management practices. Once the interest to improve rainfed crops, is generated, introduction of new crops wherever possible, will be discussed. It is also observed that unawareness about the improved techniques of rainfed agriculture and limited assurance of returns on investment, coupled with poor entrepreneurial ability, are the basic reasons for farmers' apathy to improve the productivity of rainfed crops. Problem-cause diagrams, prepared by farmers, formed the basis for development of technological modules, specific to different farming situations. Poor quality seed, incidence of pests and diseases, and inadequate weed and nutrient management are the important causes for the observed low yields of rice, sorghum, castor, and pigeonpea. An action plan was prepared along with costs and points of intervention by various agencies.

Enhanced Community Participation in Watersheds: An Experience of the Drought Prone Area Programme

T K Sreedevi[1]

Community participation is an essential element for watershed management. Many programs of development and management of natural resources have suffered due to inadequate participation of local people. For the success of any strategy of natural resource management involvement of local people is important because uncontrolled use of natural resources by individuals has many adverse effects. As integral components of the watershed community, people and animals should be given utmost importance. They depend on the watersheds for their needs and in turn influence the progress or deterioration. Thus participation of the people is essential for the success of the watershed programs. The detailed analysis of some of the successful watersheds in India revealed that community participation played a significant role in making the watersheds successful.

In the past, watershed management was synonymous to soil and water conservation. Today, it is more synonymous with people's livelihoods and is used as a vehicle for overall development of rural people through poverty alleviation and sustainable development for the welfare of the people. With the new focus on poverty alleviation and food security through appropriate natural resources management, the prime focus of watershed management is on people rather than on natural resources. The degree of farmers' or people's participation in watershed management varies with the situation:

- Contractual: Contract farmers to provide land and/or services.
- Consultative: Farmers consult scientists about their problems and solutions but decision is made by the researchers.
- Collaborative: Farmers and scientists collaborate as partners in the research process.
- Collegiate: Farmers conduct the research and researchers provide technical advisory support.

Participatory watershed management aims at achieving the involvement of farmers and communities in planning and management of natural resources in a watershed. Farmers and other land users are the main stakeholders in watershed management; therefore they have to take charge of the processes for development of watershed resources. Farmer-led approach is needed to achieve the empowerment and self-reliance for achieving the aim of participatory watershed management.

Basic principles for effective community participation

Some basic principles which facilitate effective community participation are:

- Compelling vision
- Strong and shared leadership
- Shared problem definition and approach
- Power equity
- Interdependency and complementarity
- Mutual accountability

1. Drought Prone Area Programme (DPAP), Ranga Reddy District, Abids, Hyderabad 500 001, Andhra Pradesh, India. Present address: Andhra Pradesh Rural Livelihood Project (APRLP), Rajendranagar, Hyderabad 500 030, Andhra Pradesh, India.

- Attention to process
- Communication linkages
- Explicit decision making process
- Trust and commitment
- Credit and recognition

There are many approaches that can result in people's participation in even very complex efforts like integrated watershed management. The participation process also includes a combination of these approaches, with indigenous and traditional approaches for effective long-term participation which is critical in case of integrated watershed management.

Promoting community participation

Earlier projects had sufficient expertise in implementing soil and water conservation measures and were largely based on technical perspective, involving only land and water management activities. The activities in those projects did not involve people who are actually the important players within the watershed and whose activities have a significant impact. To make the watershed program successful, the primary goal should be the participation of the local community. Project implementation can only be successful if the people participate and contribute adequately to the development program. In an effort to achieve community participation for managing natural resources in the watersheds, ICRISAT is working to build stronger partnerships with state and local agencies, community leaders, and people. These efforts are based on a strong commitment to involve those affected by or responsible for environmental regulation in finding the most effective workable solutions possible. Successful partnerships are critical for understanding participatory watershed management, as several players with varying interests are involved.

The objectives of any watershed program should be to minimize the degradation of the natural resource base, enhance crop productivities, and enhance the income of the farmers on a sustainable basis. These objectives can be achieved with efficient management of rainwater and adoption of improved agricultural practices, and by providing impetus to livelihood options through farmer participation. Enhanced community participation is key to the success of a watershed program; participation of large number of farmers is needed for the system to be sustainable.

DPAP watersheds

The Drought Prone Area Programme (DPAP) is being implemented in 17 of the 22 districts of Andhra Pradesh, India. As per the new watershed guidelines, >3000 watersheds covering an area of 120 million ha have been instituted. A major program for development of all the degraded lands in Andhra Pradesh over 10 years was launched during 1997 as the 10-year perspective plan. The action plan for development included wetlands, degraded lands, and degraded reserve forests.

The DPAP has mainly used funds allocated from central government sources. Private land, forestland, community land, and other community property resources are considered for watershed treatment. The main activities taken up under the watershed development program include entry point activities, soil and moisture conservation, water harvesting structures, horticulture activities, social and agroforestry activities, pasture development, self-employment, and revolving fund for the thrift groups.

To promote community participation in the DPAP watersheds, various steps such as formation of watershed association have been taken. All the members of the village are members of the watershed association. The association is registered under registration of societies act. It is a sovereign body that decides every activity of the watershed. The watershed committee was also formed. It is the executive body of the watershed association and is headed by the chairman, who is unanimously elected in the village. A secretary who maintains records and also other members representing various sections of the society to assist the watershed committee were selected. Self-help groups of the village are executing the works to be undertaken in the village. All the transactions are made transparent by a social audit. Estimated expenditure is displayed in the central location of the village. The funds received and expenditure incurred are discussed in the watershed association meetings. Landless laborers and women's participation is also critical for watershed development. The watershed program provides space for livelihood options by making credit available through revolving funds. The flow of funds is from the project director to watershed project account; the payment is done to self-help groups through cheques. Monitoring and evaluation of peoples' participation is carried out. Learning visits and training programs are organized for farmers. The primary stakeholders are empowered in income-generating activities like nuclear poyhedrosis virus (NPV) production and vermicomposting. The villagers are given access to information through pamphlets, knowledge fairs, cultural programs, and poster presentations.

There are several difficulties in implementing the watershed program. Attendance of stakeholders in the meetings is poor and an inequity in sharing the benefits is observed. To surmount the difficulties, improved delivery systems and services are made easily accessible to farmers. Extensive and intensive interactions with the farmers are encouraged. A watershed is successful only when the community becomes a part of the program right from planning to its implementation and in assessing the impact.

Participation means the act of partaking by farmers in all the stages of watershed programs right from planning, designing various structures, execution, monitoring, and evaluation of their performance. Such participation requires that the target group of farmers voluntarily spend their time and energy for the program, adopt the recommended measures and practices, and repair and maintain structures in good condition on a sustained basis.

The traditional systems of use of natural resources in the village communities have evolved over a period of centuries. However, the traditional systems that once met the test of sustainability have not been able to respond adequately to modern rates of growth in demand as required by current population pressures and rapidly declining quality of land and water resources. To achieve sustainable use of natural resources there is a need to increase farmers' participation in efficient management of natural resources.

Involving stakeholders for better water management

Involving the users in the management of their common resources is the best way for ensuring effective local management. Recognizing this, the state has made a pioneering move to create water-users' association (WUA) under the Andhra Pradesh Farmers Management of Irrigation Systems Act, 1997. Through these WUAs, the stakeholders are involved in the maintenance and management of irrigation systems. The WUAs have been created at the primary level; distributory committees and project-level committees are also functioning to facilitate efficient water utilization by farmers. The primary task of the WUAs is to manage (operate and maintain) water resources. This not only involves raising funds for maintenance but also supervising works, deciding on water allocation and improving services. The WUAs would also be bringing together strong forces in encouraging water conservation through committed participation in watershed development programs, establishing water markets for varied uses such as floriculture and greenhouses, and promoting agricultural extension. The WUAs could also play a critical role in spreading awareness among the farmers.

The DPAP tackled continuous challenges in designing interventions and organizing communities so that the benefits are distributed more evenly to landless people, shepherds, and women. These are the least influential members of the community and their needs and interests require special attention. Their involvement is essential otherwise watershed projects can actually have a drastic impact by restricting their access to resources that contribute to their livelihoods. Some non-governmental organizations (NGOs) in Andhra Pradesh and Karnataka (e.g., MYRADA and OUTREACH) have developed innovative ways to build everyone's interests into the projects in advance and other projects would gain by learning from them.

ICRISAT-ADB watershed project

The DPAP is involved in the ICRISAT project, funded by the Asian Development Bank (ADB), at Adarsha Watershed, Kothapally, Andhra Pradesh. Community participation was encouraged in watershed management by empowering the farmers and also by building strong working relationships with state and local governments and NGOs, and encouraging voluntary initiatives for improving sustainable use of resources.

Data Needs, Data Collection, and Data Analysis for On-farm Trials

Facilitator: S P Wani[1]

In this session the approach adopted was different; i.e., the faculty acted only as facilitator and the participants contributed actively in the discussions. With appropriate facilitation most of the answers emerged during the discussions from the participants. The participants were then asked to write about the discussions and submit reports the next day. The following points have been collated from the brief reports submitted by the participants.

Why should data be collected?

Data required to be collected varies depending upon the objective of the study/experimentation. For example, for planning on-farm research or water conservation measures to be adopted different types of data are needed. Data is required:

- For appropriate planning of research trials to achieve maximum impact.
- To compare and evaluate the treatments in an experiment.
- For future planning of research.
- To monitor/evaluate impact of the research.

The purpose of data collection determines the type of data and also the extent of data collection. The data needs of researchers, extension staff, and farmers vary distinctly as also the purpose for which they collect/use the data. Based on the purpose, data collection needs to be determined.

Precautions for collecting data

- A representative sample should be used for data collection.
- The sample size should be adequate to draw valid conclusions. For household surveys, 20–25% households should be surveyed.
- Data may be elaborate or simple depending on the objectives of the study.
- Cross-verification of data must be ensured.
- Data should be pertinent to the objectives of the study.
- Data collection method should be simple (i.e., understandable to farmers so that farmers' participation is ensured).
- Priority of data collection through proper research planning should be done before the research is conducted/implemented. Thus, the scope for missing data should be negligible.
- Reasons for data collection, advantages of data collection, and/or use of data should be discussed with farmers to let them know the usefulness of the data collection activities.
- The farmers' views or perceptions of data/observations should be considered and included in data listing.
- Often, the farmer's perspective of agriculture may be different, more important, and useful than workers/scientists/non-governmental organizations (NGOs) working in the watersheds.

1. International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru 502 324, Andhra Pradesh, India.

Data sources

The source of data are of two types:

1. Primary: Collected by researchers
2. Secondary: Published records

Data required

- Climate data: Rainfall, distribution, potential evapotranspiration (PET), radiation, minimum and maximum temperature, wind velocity, length of growing period (LGP).
- Soil data:
  - Chemical: Organic carbon, major/minor nutrients.
  - Physical: Texture, mechanical composition, bulk density, pH, information about constraints, layers, and strata.
  - Biological: Earthworms, biological activity, microbial biomass.
- Crop data: Cropping intensity, crops, growth and growth attributes, phenology of the crops/trees, yield and yield attributes, pattern, cultivars, seasons, annual/perennial, economic inputs.
- Major plant nutrient uptake data.
- Input and output data.
- Socioeconomic data: Income sources, labor sources, input, output/income, infrastructure, administration, environment, indigenous knowledge, education, loans, etc.
- Land holding: Size, area, fragmentation.
- Livestock: Species, age, diseases, economic yield, hospitals.
- Health: Hospitals, diseases, water quality, government support.
- NGOs: Location, interest, association, etc.
- Mechanization: Tractor, plowing/harvesting equipment, sprayers, etc.
- Data from published records: Provision/region/district land database on organization, area, production, rainfall to identify status of location in relation to region.
- Runoff and soil loss measurements.
- Groundwater level.
- Flood situation.
- Impact data.

Data analysis

Researchers who analyze and interpret data should be aware of the farmers' agenda. Interpretation of on-farm research data should be available for the farmers/extension staff on time; otherwise, researchers will lose the interest and participation of farmers. For example, farmers who require fertilizer recommendation will not wait until they receive the recommendation from scientists if it is time for fertilizer inputs. It is the responsibility of the organization to analyze the collected data/ samples and communicate the report(s) to the farmers in time so that if any improvement/corrective measures are required farmers can adopt the same without wasting any cropping season. This will facilitate the transfer or adoption of technology in the shortest time possible.

A comparison of perception of data is given below:

Scientist	Farmers
Objective evaluation	Identify bottlenecks and make corrections accordingly
Proper planning	Improve productivity
Further testing and refinement of technology	Adoption of technology in shortest time

Conclusions

Data needs for on-farm participatory trials (OFPTs) vary with the set goal of the trials. Necessary data must be collected by having a representative sample size and using appropriate methods such as detailed household surveys or participatory rapid appraisal (PRA) methods. While collecting data good quality must be ensured and appropriate verification tools must be used. Analysis of data and communication of results to the participating farmers is critical. Success of OFPTs depends on proper data collection, analysis, and interpretation. Thus, data collection and analysis is a critical component of OFPTs.

Field Visit to Tad Fa Benchmark Watershed: Observations

On 28 July 2001 all participants and resource persons along with the officials of the Department of Agriculture (DOA) and Director of Office of Agricultural Research and Development (OARD) Region III left Khon Kaen, Thailand in the morning and reached Tad Fa village after two and half hours. Drs Suchinta and Veerya who are specialists on on-farm participatory research from Khon Kaen University also joined the group.

After reaching the village, Dr S P Wani welcomed the group and gave a brief talk about the Asian Development Bank (ADB) project activities in Thailand. Mr Somchai of DOA-OARD, assisted by Dr T J Rego, then presented an outline of the ongoing work at Tad Fa.

After the introduction the group traveled to the monitoring site. Here the group members saw the automatic runoff and sediment sample collection system. The two systems were dedicated to two micro-watersheds respectively. Perennial crops were predominant in one micro-watershed while the other micro-watershed had mostly annual crops. The participants walked through these micro-watersheds and had good interaction with farmers. A detailed interaction ensued with one farmer who had grown banana in between fruit trees after seeing in some other farmer's field in a neighboring village. This farmer is also conducting an "experiment" to see the effects on banana by growing other fruit trees with and without banana. He is convinced about the value of fruit tree cultivation in these slopy lands. He is also practicing mulching the plantation with weeds and other farm wastes as advised by DOA staff of the ADB project.

The group then visited the "automatic weather station" and saw various equipment and their functioning.

After lunch the group had discussion with participating farmers for nearly one hour. Drs Suchinta and Veerya facilitated this discussion. After the introduction the following topics were covered:

- Fruit tree cultivation
  - Farmers reasoned that growing fruit trees is beneficial in the old age as it requires less labor and conserves soil when compared to annual cropping. Also the government encourages the activity.
  - Farmers would like to start planting fruit trees at lower end of hills so that trees can be easily watered during dry periods.
- Soil erosion
  - All the farmers perceived soil erosion as a major problem in this area.
  - They realize that it may lead to yield decline in the future.
  - They are willing to try contour cultivation on mild slopes of hills wherever possible.
- Water collection
  - Farmers felt the need for bigger rainwater storage facilities.
  - They were willing to bear the cost of construction.
  - They are ready to donate land for digging tanks.
- Farmers' perceptions of ADB project
  - Most farmers are aware about the project objective and activities in the field.

– They wish that the project continues and they can benefit through soil and water conservation measures.

– They would like to have a drying facility for banana processing as the prices fall tremendously during the harvesting season.

– Most farmers appreciated the efforts of Mr Somchai and Mr Somsak in advising them to change the cropping pattern from annual cropping to fruit tree cultivation.

Participants' opinions/suggestions

- Women farmers or women are not involved in the watershed activities.
- Specific programs for women need to be devised to encourage their participation.
- The farmers are meeting regularly and a good beginning has been made for participatory management of watershed.
- Willingness of farmers to donate their lands and also contribute for constructing water harvesting structures is a laudable change in their attitude.
- The project team's continued interaction with the farmers was evident through discussions.
- Farmers are hard working and willing to try new methods/crops in their areas; e.g., contour cultivation, gully plugging, and vegetative bunds. Also, planting fruit trees is picking up in nearby areas.
- Three raingauges located in proximity need to be corrected.
- Self-help group formation can be encouraged through provision of revolving funds to the community.

All the participants enjoyed the field trip covering visit to Tad Fa watershed and also a visit to snake village on the way. M/s Viriya Limpinuntana and Suchint Simaraks provided valuable information about the region to the participants and also acted as facilitators and translators for this field visit. Participants returned back with satisfaction and with enriched knowledge about the rural setting in Northeast Thailand.

Field visit to Tad Fa watershed, Thailand

Summary of Group Discussion on Evaluation Criteria Using Case Studies – Group I

Synthesizer and Presenter: T K Sreedevi

Group Leader	Somnath Roy (Lalatora, India)

Group members

Kothapally, India	T K Sreedevi
Ringnodia, India	M C Chaurasia
DOA (Thailand)	Suppachai
VASI (Vietnam)	Thang
DOA (Thailand)	Somchai

Watershed sites

WS1 Lalatora, Madhya Pradesh (India)

WS2 Tad Fa, Khon Kaen (Thailand)

WS3 Ringnodia, Madhya Pradesh (India)

WS4 Kothapally, Andhra Pradesh (India)

At the beginning all the group members unanimously selected Mr Roy as group leader. Mr Roy acknowledged and conveyed his thanks.

Immediately after taking over the Chair, Mr Roy fixed certain ground rules after discussing with the group members. The group members accepted wholeheartedly the following rules:

1. Every member will present their case study and each individual will be provided 10 minutes. Immediately after presentation, 5 minutes will be allotted for objective critique to interact and seek clarifications.
2. A relaxation of additional 5 minutes will be allowed to ease language barrier.
3. The whole process will be viewed as PROCESS and not as CONTENT and accordingly the presentation will be restricted within the prescribed format/head only.
4. The prescribed format is:
    a. Identification of problems
    b. Objective setting/goal
    c. Selection of site and farmers
    d. Selection of treatment
    e. Strategy followed
    f. Data collection
    g. Learnings from experiment
    h. Future plan

Presentation of case studies

Each participant presented the details of their on-farm watershed. Through the above process the group saved time and also eased language barriers. Every participant's presentation passed through objective critique. Following the presentation all queries were answered and the participants critiqued on the listed criteria based on the learning during the course and each participant evaluated the case study independently. After completion of the entire presentation process, every group member was asked to rank the level of participation of farmers on a scale of 1, 2, 3 (3 for maximum ranking). All members submitted their ranking reports. Weighted average was calculated to arrive at the performance of each watershed in the context of participation. For presentation of results it was decided that the watersheds will be coded and site names will not be used as the exercise was for learning the process and not for assessing the objects. However, at the time of presentation, it was decided to use site names just as the other group did.

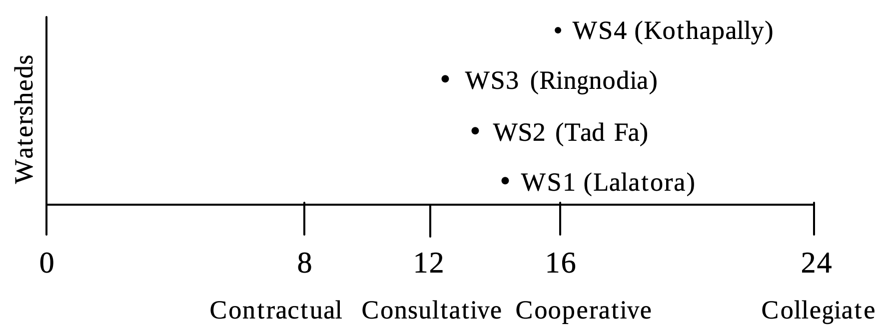
Synthesis of evaluation

After analyzing all the presentations it was observed that "Identification of problems", "Treatment", "Data collection", and "Objective" are more participatory whereas "Selection of farmers" require more participation and "Treatment", "Strategy" and "Future plan" are almost as suggested by scientists.

On the basis of more participatory approach WS4 got highest average. The score is as follows:

Watershed	Score
WS1 (Lalatora, India)	14.0
WS2 (Tad Fa, Thailand)	13.6
WS3 (Ringnodia, India)	12.4
WS4 (Kothapally, India)	16.0

Scores were depicted as follows to indicate the extent of participatory approach adopted for different watersheds.



WS4 Largely cooperative and moving towards collegiate.

WS3 Passed consultative stage and moving towards cooperative stage.

WS2 Passed consultative stage and moving towards cooperative stage.

WS1 More towards cooperative than other watersheds.

Summary of Group Discussion on Evaluation Criteria Using Case Studies – Group II

Synthesizer and Presenter: K P R Vittal

Group Leader	K P R Vittal (India)

Group members

Thailand	Somsak Idhipong and Pranee Srihaban
Vietnam	Hoang Minh Tam
Indonesia	Robert L Watung
India	A K Misra

Work sites

Thailand	Tad Fa
Vietnam	Thanh Ha
Indonesia	Kaliganang
India	Bhopal (on-station research)

(Note: India was not considered as the site was not on-farm.)

Selection criteria

1. Goal
2. Site selection
3. Problem identification
4. Selection of farmers
5. Strategies adopted
6. Data analysis
7. Future plans

Rating

1. Contractual
2. Consultative
3. Cooperative
4. Collegiate

Method

The rating was given to individual selection criteria by five members of the team. The ratings varied from 1 through 3. The total score was summed up. Based on the overall rating, Vietnam was ranked highest, followed by Indonesia and Thailand.

Criteria	Rating*				
Goal	T	>	V	>	I
Site selection	V	>	I	>	T
Problem identification	T	>	I	>	V
Section of farmers	T	>	V	>	I
Strategies adopted	I	>	T	>	V
Data analysis	V	>	I	>	T
Future plans	V	>	I	>	T
Overall rating	V	>	I	>	T

* T = Thailand; V = Vietnam; I = Indonesia

Site selection and data analysis were most discriminating criteria. The difference among watersheds was marginal.

Case study

Based on overall rating Vietnam was selected. The individual criteria are discussed.

1. Goal: Soil and water conservation (SWC) was given priority followed by crop management. Both the components were dealt independently and not on the same farmers' fields.
2. Site selection: The site study was thoroughly done by the participating institutes, Vietnam Agricultural Sciences Institute (VASI) and ICRISAT, and a site that needs intervention in terms of SWC and crop management was selected to suit available expertise.
3. Problem identification: Discussion was held with 50 farmers out of 160. Issues and strategies were identified.
4. Selection of farmers: Interested farmers were selected based on their knowledge, area in the watershed, labor availability, etc.
5. Strategies adopted: SWC - bunds, stones, etc.; integrated nutrient management - *Gliricidia* and reduction in fertilizer, improved varieties, etc.
6. Data analysis: Economics, changes in cropping pattern (legume-based); human resources development in the watershed was considered.
7. Future plans: Work will start with wider perspective and will be expanded in the watershed.

Evaluation Report of the Training Workshop

Course evaluation

A questionnaire consisting of 19 questions covering various aspects of on-farm participatory research methodology was prepared. A pre-course evaluation test was conducted to evaluate the knowledge and awareness of participants before the training workshop. Participants scored 4–11 marks with an average of 8 out of 19 marks. The post-course evaluation clearly indicates a substantial improvement in the knowledge and awareness of the participants about the participatory research methodology in watershed context (Table 1). The marks scored were in the range of 5–16 with an average of 11 out of 19 marks.

Table1. Performance of participants during the training workshop.

	Number of participants[1]	
Marks(%)	Pre-course evaluation	Post-course evaluation
≤25	2	1
26–50	5	3
51–75	3	5
>75	0	1

1. Total 10 participants evaluated.

Evaluation of the training workshop by the participants

The participants were requested to evaluate the various aspects of the training workshop through a questionnaire (Appendix 1). An analysis of the response from the participants is presented. In general the participants rated the training workshop as very useful, informative, and effective. They expressed that the knowledge gained will help them in conducting and monitoring participatory research in the watershed. Majority of the participants (67%) expressed that the training workshop has fully met their expectations while the remaining 33% rated it as partly met their expectations.

The participants found that the faculty selected for the training course was very good to excellent. Most of the faculty ensured full participation of the participants. The training methodology and the quality of the training material was judged as very good and excellent.

Evaluation of faculty

Remarks	Excellent	Very good	Good	Poor
Instructors’ knowledge	3 (30%)	6 (60%)	1 (10%)	-
Extent to which the instructor used challenge and creativity to enhance learning	3 (27%)	7 (63%)	1 (10%)	-
Instructors’ interest in helping the participant to learn	6 (55%)	4 (36%)	1 (9%)	-
Interaction with fellow participants	3 (27%)	7 (63%)	1 (10%)	-

Course quality

Remarks	Excellent	Very good	Good	Poor
Quality of training methods	5 (42%)	6 (50%)	1 (8%)	-
Quality of reading material	1 (10%)	6 (60%)	3 (30%)	-
Quality of presentation material	-	4 (33%)	8 (67%)	-
Sequencing of sessions	-	8 (73%)	3 (27%)	-
Choice of faculty	2 (17%)	5 (42%)	4 (33%)	1 (8%)
Training methodology	4 (34%)	7 (58%)	1 (8%)	-

Course contents

Contents	Excellent	Very good	Good	Poor
Lectures	5 (45%)	3 (28%)	3 (27%)	-

Extent to which the course met the expectations

Fully met	Partly met	Not met
6 (67%)	3 (33%)	-

Administrative arrangements

Remarks	Excellent	Very good	Good	Poor
Pre-course information	2 (25%)	4 (50%)	2 (25%)	-
Training facilities	3 (34%)	3 (33%)	3 (33%)	-
Stay arrangements	5 (63%)	3 (37%)	-	-
Training design	5 (56%)	4 (44%)	-	-

General comments/suggestions about the training workshop

- The approach used in this training workshop was new and very effective. The participation of all the participants was meticulously drawn into the discussions, session after session overcoming the cultural and linguistic barriers.
- The workshop was educative and also was a refreshing experience.
- This training workshop should have been organized during the first year of the Asian Development Bank (ADB) project. This would have greatly helped us in conducting participatory research in the watershed.
- It was a very good learning experience. Most of the participants felt that the practices or technologies learnt during this workshop will be taken to the farmers' fields for better application.
- Evaluation should be based not only on what the participant remembers but also should consider what he/she knows. Some participants felt that for the pre-course and post-course evaluations we should follow open book system rather than closed book system.
- During the training workshop more case studies should have been taken.

Appendix 1

Training Course Evaluation

Name of the Participant: Country:

(OPTIONAL)

Please take a few minutes to complete the course evaluation form which would help improve the future training inputs.

Please mark (4) in the appropriate box.

Course Value

Remarks	Most relevant	Very relevant	Relevant	Least relevant
Extent to which the knowledge and skills imparted during the course relate to your job requirements.				
Degree of confidence that the course can help improve your job performance				

Course Contents

Contents	Excellent	Very good	Good	Poor
Lectures: 1. 2. 3. 4. 5. 6. 7. 8.				

Evaluation of Faculty

Remarks	Excellent	Very good	Good	Poor
Instructors' knowledge Extent to which the instructor used challenge and creativity to enhance learning Instructors' interest in helping the participant to learn Interaction with fellow participants				

Course Quality

Remarks	Excellent	Very good	Good	Poor
Quality of training methods Quality of reading material Quality of presentation material Sequencing of sessions Choice of faculty Training methodology				

Extent to which the course met your expectations? Please give reasons.

Fully met	Partly met	Not met

Is the duration of the course sufficient to meet the course objectives? Please comment.

Administrative Arrangements

Remarks	Excellent	Very good	Good	Poor
Pre-course information Training facilities Stay arrangements Training design				

Comments and Suggestions

Group Photograph

Participants at the Training Workshop on On-farm Participatory Research Methodology in July 2001, Thailand

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About ADB

The Asian Development Bank (ADB) is a non-profit, multilateral development finance institution dedicated to reducing poverty in Asia and the Pacific. Established in 1966, it is now owned by 60 members with headquarters in Manila, Philippines and has 22 other offices in the borrowing countries around the world. ADB institution engages mostly in public sector lending for development purposes in its developing member countries. ADB's clients are its member governments, who are also its shareholders.

The adoption of poverty reduction as a strategy gives primacy to ADB's fight against poverty in Asia and the Pacific. It helps improve the quality of people's lives by providing loans and technical assistance for a broad range of development activities. In doing so, the institution emphasizes on promotion of pro-poor, sustainable economic growth, social development and good governance. ADB carries out activities to promote economic growth, develop human resources, promotion of gender and development thereby improve the status of women, and protect the environment, but these strategic development objectives now serve its poverty reduction agenda. Its other key development objectives, such as law and policy reform, regional cooperation, private-sector development, and social development, also contribute significantly to this main goal.

Asian Development Bank formulates operational strategies for individual countries, including economic and policy analyses, and undertakes country performance reviews, which provide a basis for policy dialogue with the governments of developing member countries. ADB develops country assistance plans, which include identification of individual technical assistance and loan projects and programs. It also establishes and maintains relationships with DMC governments for overall country economic reporting and for loan negotiations.

The operations strategic focus of ADB is on promoting growth to reduce poverty in poor inland provinces, improving economic efficiency, and improving environmental protection and natural resource management. Over the years, ADB has played a significant role in economic and social transformation in Asia and the Pacific, boosting economic growth, fostering social development, and helping improve the quality of life for millions of people.

About IWMI

The International Water Management Institute (IWMI) is a non-profit scientific research organization focusing on the sustainable use of water and land resources in agriculture and on the water needs of developing countries. With the mission of "*Improving water and land resources management for food, livelihoods, and nature*", IWMI's research is organized around five themes. These are: (1) integrated water resource management for agriculture, (2) sustainable smallholder land and water management, (3) sustainable groundwater management, (4) water resource institutions and policies, and (5) water, health, and environment.

IWMI works with partners in the South and North to develop tools and methods to help these countries eradicate poverty through more effective management of their water and land resources. It has research projects running in 21 countries in Asia and Africa. Work is coordinated through regional offices located in India, Pakistan, South Africa, Sri Lanka, and Thailand. The Institute has subregional offices in China, Nepal, Ghana, Kenya, Senegal, and Uzbeistan. The Institute is a member of the Future Harvest group of agricultural and environmental research centers that is supported by 58 member governments, private foundations, and international and regional organizations known as the Consultative Group on International Agricultural Research (CGIAR).

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