Chapter – III

Technology Assessment and Refinement

3.1 Technology – An introduction

Technology is any systematic knowledge and action applicable to any recurrent activity. Technology involves application of science and knowledge to practical use, which enable man to live more comfortably. The Merriam-Webster dictionary offers a definition of the term: "the practical application of knowledge especially in a particular area" and "a capability given by the practical application of knowledge".

Technology can be most broadly defined as the entities, both material and immaterial, created by the application of mental and physical effort in order to achieve some value. In agriculture, the term technology often confuses practitioners. This is because agricultural technology is a complex blend of materials, processes and knowledge. Swanson (1997) has classified agricultural technologies into two major categories:

1. Material technology, where knowledge is embodied into a technological product; and
2. Knowledge based technology, such as the technical knowledge, management skills and other processes that farmers need for better farm management and livelihood support.

KVK scientists need to have clarity over the technologies which they are assessing and refining in response to a specific problem in a specific microlocation. For example, a SMS may be assessing the efficacy of a particular management practice on a crop's yield or growth in the KVK district. Such management practices can be broadly classified as Knowledge based technology. Alternatively, all technological products tested and demonstrated under OFT and FLD fall under material technology. Ex: Seeds, pesticides, fertilizer, farm machinery, irrigation systems etc.

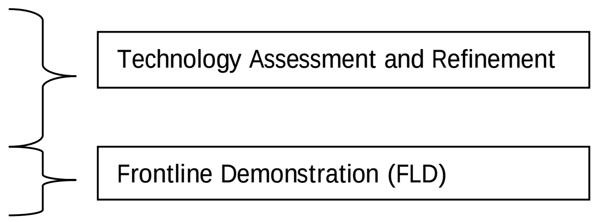
3.2 Technology Development

Technology Development (also called technology innovation) is a process consisting of all the decisions and activities which a scientist does from recognition of a need/ problem with planning, testing, conducting research, verification, testing and dissemination for adoption. During the same time, some problems on the technology might get back to the scientist for solution thus resulting in refinement of the same. Thus, technology development is a continuous process. KVKs act as a crucial player in testing, adaptation and integration of proven technologies. The KVK scientists have to equip themselves for 'technology application' - a process which includes the above mentioned processes; thus contributing their part in the overall process of technology development.

3.3 Understanding Technology Development Process

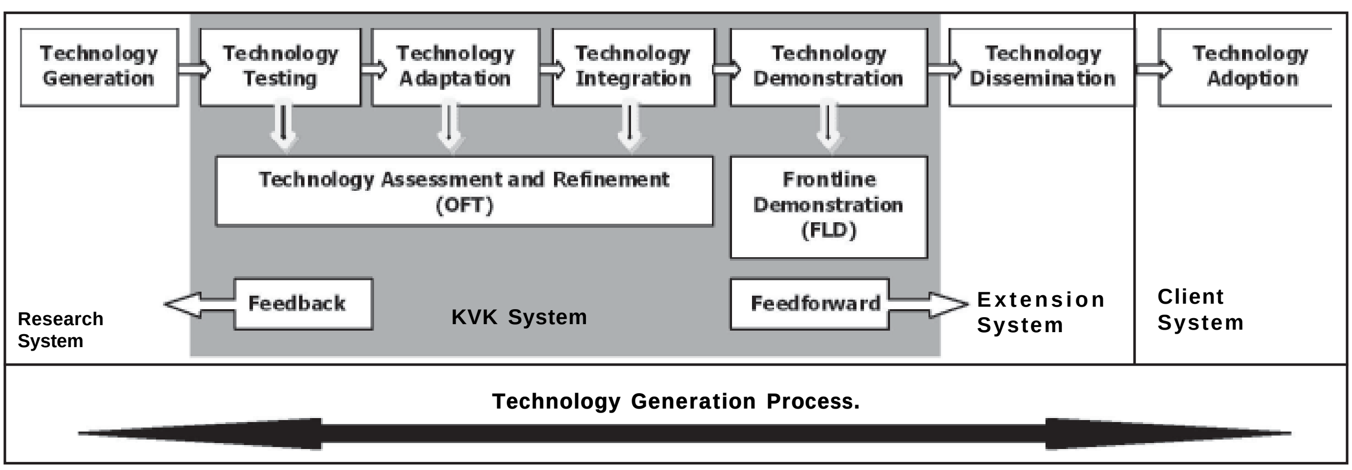
Understanding technology development process in agriculture and its components is vital for success of KVK scientists. Technology development basically constitutes seven processes. They are:

1. Technology generation
2. Technology testing
3. Technology adaptation
4. Technology integration
5. Technology demonstration
6. Technology dissemination
7. Technology adoption



Technology generation, the starting point of technology development process is mainly a function of research system. Testing, adaptation and integration processes constitute technology assessment and refinement which KVK system executes through OFTs. The feedback is passed over to research system. KVK system also involves in technology demonstration through FLDs. Feed-forward from successful OFTs and FLDs is communicated to the extension system for mass popularization in the district. Technology adoption; the final act, occurs among the members of client system i.e. farmers.

A conceptual model of technology development process in agriculture depicting the components and actors involved is explained below:



Conceptual Model of Technology Generation Process (Developed by Sajeev, M.V and V. Venkatasubramanian)

Research system generates new technologies. In Indian agriculture, research system comprises of ICAR institutes, SAUs, departments like DBT, DST, other Science and Technology Institutions and Commodity boards. NGOs, Corporate and farmer innovators also contribute to technology generation.

Extension system comprises of State departments of agriculture, animal husbandry and veterinary, fisheries, sericulture etc. SAUs, ICAR institutes, commodity boards, NGOs and Corporate sector also contribute to extension system.

Earlier, due to the primary focus on vocational training, KVKs were categorized under extension system itself. But today, with mandates being focused on assessment, refinement and demonstration of frontier technologies, the KVK system positions itself clearly between the research and extension systems thus acting both as a feedback and feedforward mechanism.

Client system comprises of the ultimate end-user i.e. the farmer. Although KVK system does assessment, refinement and demonstration of new technologies as part of technology development process, some technologies get refined or rejected even in the last stage at farmer fields. Hence, client system even though being the final actor in technology development process, plays the ultimate decisive role.

3.4 Technology Management

Technology management can be defined as the integrated planning, design, optimization, operation and control of technological products, processes and services. A better definition for KVK scientists would be "the management of the use of any technology for farmer advantage." The KVK role under technology management is very huge where-in it selects latest technologies, tests them for suitability in different micro-locations of the district and demonstrates the proven ones to farmers and extension system.

3.5 Technology Fatigue

Linkages between the laboratory and farmer fields have weakened and extension services often have little to extend by way of specific information and advice on the basis of location, time and farming system. Good quality seeds at affordable prices are in short supply and spurious pesticides and biofertilizers are being sold in the absence of effective quality control systems. Farmers have no way of getting proactive advice on land use, based on meteorological and marketing factors. No wonder the prevailing gap between potential and actual yields, even with technologies currently available, is very wide (NCF, 2007). In case of KVKs, it was found utilizing old and obsolete technologies for OFTs, FLDs and training programmes thus resulting in poor feed-forward to the extension system. A knowledge deficit as mentioned above coupled with the usage of obsolete technologies and package of practices together leads to a situation called 'technology fatigue'. Indian agriculture, particularly agriculture by resource poor farmers in rural areas is now bearing the brunt of technology fatigue. The KVK role lies in providing timely supply of proven technologies specific to various micro-locations of the district thus alleviating the technology fatigue existing in the district.

3.6 Technology Gap

Technology Gap is the gap between the level of recommendation and the extent of adoption (against recommendations).

Technology gaps are a major source of concern for extension system. The success of traditional transfer of technology (TOT) models were mainly evaluated on the basis of the extent of narrowing down in technology gaps achieved by them. KVK system being primarily focused on assessment, refinement and demonstration of new technologies, its role lies in feeding proven technologies to the main extension system. Thus, the primary focus of KVK should not be mistaken as reduction of existing technology gaps. Rather, they are meant at alleviating "technology fatigue" by providing timely supply of proven technologies specific to various micro-locations of the district. Alleviation of technology fatigue is accomplished through processes of technology and methodology backstopping.

3.7 Technology backstopping

Backstopping refers to any precaution taken against an emergency condition. Accordingly, technology backstopping can be defined as any technology precaution taken to combat technology fatigue. In simple terms, technology backstopping is the process of making available ready to use technologies for farm families through assessment, refinement and demonstration processes in order to combat the existing/forecasted technology fatigue.

3.8 Methodology backstopping

This is a process almost similar to technology backstopping but differs with respect to the kind of technology solution offered. Instead of material technology, methodology backstopping aims at assessment, refinement and demonstration of knowledge based technologies often referred to as methodologies/package of practices. It provides detailed procedures to carry out the technology application functions by the extension personnel in the field. It includes methodologies for conducting OFT, which includes TAR, demonstrations, training, conducting surveys, impact assessment and evaluation etc.

3.9 Typology of technology passage through KVK system

KVK system has successfully established itself between the research and extension systems. Technology development process as explained earlier, invariably has assessment, refinement and demonstration components. Hence, there is a passage of technologies through various stages in a KVK system. This passage doesn't follow a uniform pattern. For example, a technology may go through assessment stage and demonstration stage but not through refinement stage. Based on the stages passed, five different typologies of technology passage can be identified for KVK system. A proper understanding of these typologies will help KVK personnel in deciding whether a particular technology will go for OFT and FLDs or both. The typologies identified by us are:

1. Source - Demonstration

In this type the technology from any source/provider directly goes to demonstration by KVK. This happens when the KVK is completely sure that the technology is fully suited for the district and can go directly for FLD. Here, the technology doesn't pass through assessment and refinement stages.

2. Source - Assessment

In this type the technology from any source/provider goes for assessment by KVK. This happens when the KVK is not sure that the technology is fully suited for different microlocations of the district. Here the technology fails at assessment stage itself and hence doesn't move to refinement or demonstration stages.

3. Source - Assessment - Refinement

This type is a variation of type 2. Here, the KVK is not sure that the technology is fully suited for different microlocations of the district. The technology goes for and succeeds in assessment but needs refinement and hence moves to refinement stage. Here, the technology fails in refinement stage and hence doesn't move to demonstration stage.

4. Source - Assessment - Demonstration

This type follows type 3. This happens when the KVK becomes sure that the technology is fully suited for different microlocations of the district. The technology fully succeeds in assessment and hence moves to demonstration stage. Here, the technology doesn't require refinement and hence move to demonstration stage.

5. Source - Assessment - Refinement - Demonstration

This type also follows type 3. This happens when the KVK becomes sure that the technology is fully suited for different microlocations of the district. The technology succeeds in assessment and refinement and moves to demonstration stage. Here, the technology is successfully refined by KVK and taken to demonstration stage i.e. FLD.

FLDs are supposed to be taken up on proven technologies only. Hence, it makes obvious that once demonstrated it will go to the extension system and client system. Rarely FLDs may fail thus preventing the technology passage. But KVKs are not supposed to demonstrate such technologies which are not fully proven. The failure of FLD can be due to some extraneous factors rather than technological factors.

3.10 Technology Assessment and Refinement

Technology Assessment and Refinement (TAR) refers to a set of procedures whose purpose is to develop recommendations for a particular agro-climatic situation/ location through assessment and refinement of recently released technology through participatory approach. It refers to the process or a set of activities before taking up new scientific information for its dissemination in a new production system. *OFTs conducted by KVKs are based on this concept and thus distinguish it from agronomic and research trials*. As detailed earlier, the process of TAR has three components. They are technology testing, technology adaptation and technology integration. TAR should be:

- Site specific
- Holistic
- Farmer participatory
- Technical solution to existing problems
- Inter-disciplinary
- Interactive

This process involves Scientist-Farmer linkage in terms of:

- Sufficient understanding of the farming situations
- Adequate perception of farmers' circumstances and their needs
- The variability of conditions on the research status as compared to farmers' fields
- Problem orientation instead of disciplinary approach

Technology assessment in agriculture by KVKs is the study and evaluation of new technologies under different micro locations. It is based on the conviction that new discoveries by the researchers are relevant for the farming systems at large, and that technological progress can never be free of implications. Also, technology assessment recognizes the fact that scientists at research stations normally are not trained field level workers themselves and accordingly ought to be very careful while passing positive judgments on the field level implications of their own, or their organization's new findings or technologies. Considering the above factors, the ICAR has envisaged On Farm Trials (OFTs) through its vast network of 562 KVKs covering almost the entire geographical area of the country.

3.11 On Farm Trials (OFT): Concept

An On-Farm Trial aims at testing a new technology or an idea in farmer's fields, under farmers' conditions and management, by using farmer's own practice as control. It should help to develop innovations consistent with farmer's circumstances, compatible with the actual farming system and corresponding to farmer's goals and preferences.

On-farm-trial is not identical to a demonstration plot, which aims at showing farmers a technology of which researchers and extension agents are sure that it works in the area. *It should be noted that OFTs are strictly to be conducted in collaborating farmer fields and not in KVK land.*

3.12 Stakeholders of On-farm Trials

There are various stakeholders in an on-farm trial. Understanding them and their roles can help KVKs to develop better OFTs. The stakeholders are:

1. The farmers who are the clients for the out-coming results,
2. The SMS who should help the farmers to overcome their problems and improve their economical situation. On farm trials can give them valuable information in this respect,
3. The Scientist who needs to apply promising on-station results under farmers' conditions before releasing the technology to the extension service,
4. The extension system and government itself, who is interested in seeing an efficient and participatory technology development model evolving, since most top-down approaches have failed miserably.

3.13 Typology of On Farm Trials

We can distinguish three types of OFTs in India according to the stakeholder who is going to take the lead role:

- **Type 1, Research driven**

  Research system designed and managed (with the assistance of extension)

- **Type 2, Extension driven**

  Extension System or KVK system designed and managed by farmers

- **Type 3, Farmer driven**

  Farmers designed and managed, with the assistance of Extension system/KVK system.

3.13.1 Research Driven

Rationale

Research has shown promising results in on station trials. Now the concerned researcher wants to evaluate the new technology in multi location as the on station trial does not represent the wide range of conditions (e.g. soil fertility, weed flora, altitude, rainfall, farmers' conditions).

Objective

Assess the performance of the new technology under various conditions and test the acceptability by farmers.

Particular characteristics

The trial is usually planned in advance and included in the annual work-plan of either research or extension. Objective and layout of the trial is thoroughly discussed by the researcher with the Institute/Division head and the respective extension agency. Here,

a. Extension agency involved helps to locate suitable fields.
b. Usually plots are of small size.
c. Researchers design and manage the trials with the help of extension agencies.
d. If necessary, researchers furnish inputs and may exceptionally hire labour.
e. Trials are used for the purpose of field day.

Outputs

Information on the performance of new technology under various conditions; information on the acceptability by farmers and interesting positive results are published in various journals.

3.13.2 Extension Driven

Extension driven OFTs should not be confused as to only extension system managed. The OFTs by KVKs also fall under this type since the whole purpose of OFTs by KVKs is to give feed-forward to the extension system.

Rationale

Type 1 trials have confirmed that the new technology will work in farmers' conditions; therefore SMS plan to implement the trial on a wider scale with active involvement of the farmers. Researchers are interested in getting the information on both biophysical and farmers' assessment of the technology. KVK and SMS have developed their own ideas on how to improve aspects of the new technology. They want to try it out in real farm situation.

Objectives

a. Assess the biophysical performance of a new technology in a wide range of micro-locations within the district.
b. Obtain the farmers viewpoint about the technology.
c. Assess cost/benefit ratio.

Particular Characteristics

a. Interest of farmer having the trial on his land must be ascertained. Objective must be very well understood by farmers,
b. SMS discuss their ideas with PC and researchers.
c. SMS determines on the design and provides instruction.
d. Plots are often larger than in type 1.
e. Farmers' assessment of the result is essential.
f. Scope for refinement after assessment .
g. Feed back of the results to research system and
h. Feedforward of successful technologies to extension system.

Outputs

a. Farmers' reaction on technology, on management requirement and economical sustainability of the technology.
b. Feedback for the design of new future trials and
c. Compilation of a large number of similar trials giving fairly reliable data on performance over a broad range of farm types and circumstances.

3.13.3 Farmer Driven

Toughest of all types, yet the most sought after one. It involves Participatory Technology Development thus contributing to sustainability of results. The KVKs are also expected to bring their OFTs to this level from being an extension driven one at present.

Rationale

a. Farmers are aware of a given technology, they like what they see and would like to experiment it by themselves.

b. Farmers are aware of a problem and would try some methods to solve them and

c. Researchers want to know to which extent and how a technology is adapted by farmers.

Objectives

a. To study how farmers adapt and adopt technologies,

b. To investigate what factors affect the performance of technology.

c. Provide on station researchers with feed back on problems at farm level and provide new research issues and

d. Participatory technology development.

Particular Characteristics

a. Farmers identify problems and choose from menu of technologies.

b. Farmers decide to choose the technologies and modify them to fit their particular farming system. Control plots are not really necessary unless the farmer decides to have one.

c. High level of participation and self mobilization.

d. Feed back of the results to research and other interested entities.

e. Feedforward to other farmers.

Outputs

a. SMS document the farmers' decisions, preference and the management strategies.

b. Information is collected on the uptake of the new technology by fellow farmers.

c. Feedback to researchers on technology performance and on further research needs.

Points to consider

a. It is not wise to force collection of the biophysical data (yield, climate, and soil fertility) in type 3 because of too many confusing factors.

b. Constant monitoring, recording of farmers' comments is necessary.

c. Encourage farmer to take some notes himself (inputs, yield etc.)

d. Self-diffusion of the technology needs to be monitored (e.g. seed distributed to neighbours, area expansion etc) and

e. Socio-economic data should be collected.

3.14 Principles of conducting OFTs

KVKs have to spend considerable time and efforts in planning and implementing OFTs. The basic principles of conducting OFTs are never to be ignored in this process. The principles are:

1. *Define a clear question you would like to have an answer for*

Narrow your trial down to its simplest form; define a clear simple question to which the OFT should give an answer.

2. *Keep it simple*

Limit your trial to a comparison of two (or maximum three) treatments.

3. *Go step by step*

Farmers usually do not adopt entire new systems of production; they go step-by-step adapting components of the technology. Therefore the OFT should not include too many new steps/practices at once.

4. *Seek help*

When the problem is clear and the idea on how to go about the trial has evolved, the SMS should contact a competent researcher to discuss the plan of the OFT. He can also take help from other SMS and PC of the KVK.

5. *Replicate and randomize*

Plan on enough field space (in farmers' field) to do more than one strip of each treatment being tested. Mix treatments within blocks.

6. *Stay uniform*

Treat all the plots exactly the same except for the differing treatments. If possible, locate your experiment in a field of uniform soil type (slope, fertility etc.).

7. *Harvest individual plots*

Record data from each individual plot separately. Do not club all treatment types together or you'll lose the value of replication.

8. *Remain objective*

The results may not turn out as you expected or planned. Be prepared to accept and learn from negative results. Negative results show that the technology under testing is not suitable in the present form for the specific microlocation of the district. Such results are hence equally valuable for the benefit of farming systems at large.

9. Manage your time wisely

Expect to devote extra time to your OFT during busy seasons. Make sure you can carry out your trial even though you are busy, or get extra help from other SMS.

3.15 Points to be considered in conducting On Farm Trials by KVKs

- OFTs are being replicated under different farming situations in various microlocations of the district with suitable numbers of treatments.
- Results are being obtained on different parameters both quantitative and qualitative jointly by SMS and farmers.
- Suitable options based on qualitative and quantitative results under the farmers' perspective with their own perceptions would be suggested from the available alternatives.
- Sustainability under farmers' socio-economic, agro-ecological and infrastructural situations are the major criteria for the final recommendations regarding suitability of technology tested.
- The results and the variations from the research station recommendations are to be communicated back to the research system after further refinement in technology on the specific parameters.
- Technologies which failed in assessment stage itself or after refinement too have to be communicated back to research system as not suitable for the district. This will prevent duplication of assessment efforts and prevent loss to farmer community in the district.

3.16 Broad steps in conducting OFTs

The process of On Farm Trial broadly has five steps. They are:

1. Diagnosis
2. Planning
3. Conducting
4. Assessment and
5. Extrapolation/Diffusion.

3.16.1 Diagnosis

The diagnosis involves collection and analysis of information by concerned SMS to design an OFT. In this step, a study of farmers' circumstances and practices are made in order to :

- ➢ Understand the farming systems prevailing in the district and system interactions.
- ➢ Identify existing/possible productivity problems.
- ➢ Begin to develop hypothesis on possible solutions.

Farmers' circumstances include :

a. Agro-climatic circumstances

- ➢ Climate and weather conditions.

- Soil and topography.
- Pests, weeds, diseases etc.

b. Socio-economic factors

- Institution (Credit).
- Markets (Inputs and Products).
- Income and Land holding.
- Farmers' own resources (Family labour) etc.

KVKs identify the farming systems/ system interactions through the following sources/methods:

- Secondary data/ sources.
- PRA methods to be exercised by SMS in collaboration with local people.
- Interview with local officials/ opinion leaders.
- Informal farm surveys.
- Farmers' interview using structured/ semi-structured schedules and
- Field observations.

3.16.2 Planning

The planning step in an on-farm trial includes listing of problems, ranking problems in terms of severity, importance and frequency and identifies causes of problems and list possible solutions to well defined problems and screen possible solutions for feasibility. There are various types of on-farm trials like small-plot researcher managed trials for defining problems; level trials or determinative trials for finding profitable practices and input levels; and trials for verification of previous results.

While identifying the solutions from on-farm trial, one should note that the technology will have Profitability and Compatibility with the existing farming systems, reduces risk, and ease of testing for farmers. The assessment of trials is made based on agronomic sense of trial results, statistical significance, economic analysis, and ability to solve the problem-cause and solution developed during diagnosis. The results of trial are extrapolated for defined groups of farmers in specific micro-locations of the district.

Planning involves :

1. Listing problems
2. Ranking Problems
3. Identifying causes of problems and
4. Listing possible solutions

Problems should be ranked so that higher priority problems can be clearly distinguished from lower priority problems. KVK scientists should aim to focus on those problems which, if solved, would lead to a significant benefit to farmers.

Prioritization/ ranking is done with scores based on the following criteria

1. Problems that cause a large productivity loss
2. Problems that occur frequently
3. Problems that affects majority farmers
4. Problems affecting major cultivated crops

Identifying the causes of problems

If the causes of a problem are not understood properly, SMS may waste time and resources on inappropriate solutions. Understanding the root causes of a particular problem would help to get proper solutions which could make timely detection and correction of defects.

Listing possible solutions

KVK scientists have to list possible solutions to well defined problems, whose causes are fairly well understood. At this stage, SMS lists any possible solution that seems to them. The least feasible ones are later screened out.

Solutions are based on :

1. Probability that the technology will function
2. Profitability of the technology
3. Compatibility with the existing farming situation/ systems
4. Contribution to reducing risks and
5. Ease of testing for farmers

3.16.3 Conducting

OFTs are conducted in the fields of representative farmers and to evaluate the selected small numbers of experimental variables in participation with the local people/ farmers.
While conducting OFTs, SMS can

1. Explore production problems
2. Test possible solutions
3. Verify recommendations and
4. Demonstrate them with farmers

3.16.4 Assessment

The results of OFTs are analyzed carefully. The analysis require assessment of :

1. Farmers' reactions and opinions
2. Agronomic interpretation/ feasibility
3. Statistical significance
4. Economic analysis/ profitability and
5. Ability to solve the problems - cause and solution developed during diagnosis.

The following technological attributes are considered while assessing the results in OFTs compared to the existing local ones.

1. Profitability
2. Risks
3. Relative costs
4. Simplicity
5. Sustainability
6. Farmers safety and
7. Farming system compatibility

The results are assessed based on the above technological attributes. After assessment, a technology may be recommended for FLD directly if found fully suitable for the microlocation of the district. In many cases, the technology after assessment may be found totally unsuitable for the district. Or the SMS will find that by little refinement the technology can be made suitable for the microlocation. In such cases, the technology after assessment will go again for refinement in farmer field in the next season. After successful refinement the technology can be taken up for frontline demonstrations. If a technology fails in refinement stage, then it is not to be recommended for the extension system or for FLDs by KVK itself. But the results have to be communicated to research system without fail.

3.16.5 Extrapolation/Dissemination

When SMSs are convinced and satisfied with the results/outcome out of OFTs, they formulate recommendations for demonstrations (FLD) on a larger area in the farmers' fields so as to popularize the technology amongst farming communities and to give feed-forward to extension system. The KVKs ensure that :

1. Extension agents participate in the trial and demonstration process (to transfer recommendations to farmers with skills and confidence) and
2. Farmers involvement in the demonstration process (to participate effectively in the diffusion of new technologies).

3.17 Practicalities of OFTs: Step by step guidelines

Crops, animals and their environments are highly complex systems with a multitude of variables that change from location to location in any district of India. Due to this complexity, practices optimized for a research station might not be so successful when transferred to farmer field. Though the new location anywhere in KVK district may appear similar to that of research station, there may be an undefined key limitation or combination of minor but different limitations that constrain potential production. In many cases, carrying out a small-scale OFT, actually at the new location, will lead to an optimal local farming practice more rapidly than trying additional sub-treatments at the research station.

This section is concerned with the practicalities of OFTs. Here, we clarify the following issues which every SMS should be thorough with:

1. When an OFT is needed?
2. The benefits and traps of OFTs,
3. The most appropriate types of OFTs,
4. General concepts underlying OFTs,
5. Basic designs of OFTs,
6. Methods of data collection and sample data and
7. Interpreting OFT data to improve existing farming systems.

There should be stimulation of ideas and every SMS can incorporate his/her own ones. The OFTs will need to be adapted significantly to match the requirements of the location.

3.17.1 When are OFTs needed?

OFTs are needed when one or more of the following situations exist in the district.

1. When practices recommended by the research stations and extension system are not being followed in the district;
2. When practices recommended by the research stations and extension system are being followed, but yields/results remain low in the district;
3. When a district has locations that has special attributes which do not fit the general pattern. Eg: the location may be hilly, steep-sided valleys, rocky surfaces, perhaps with more moisture or more salinity; and
4. When particular microlocations are less productive than neighbouring ones in same/ neighbouring districts despite best efforts by farmers.

3.17.2 Elements of a good OFT

A good OFT is supposed to have the following elements:

1. A question based on a clearly identified problem and hopefully a solution;
2. A hypothesis, which is your expected outcome of the OFT;
3. Treatments, that is, variations to the normal procedure;

4. A control, which is what the farmer normally does. This control must always be included to compare or check against any treatment;
5. A design, that is, where treatments are positioned in the field and in relation to each other- the design is very important and may be the difference between obtaining an answer or not;
6. A method, that is, the steps taken to get the answer to the question; and
7. Measurement and recording of effects by counting, linear or volume assessment, or weighing - these give the trial objectivity and show how big the effects are.
8. Recording the weather data during the study is also very important.

Weather changes every season and may affect how well the treatment works. For example, the effect of added fertilizer will be very different depending on the timing and amount of rainfall. Having weather information helps to put the trial into the context of other years.

An OFT that is not carried out properly is often worthless. It may seem to give an answer though the answer may in fact be quite wrong. If forward planning or changed farming practice is based on that wrong answer, the farmer could lose income on future crops.

Every KVK SMS should keep in mind that "*No OFT is preferable to a bad OFT*".

3.17.3 Some benefits of OFTs

There are various benefits of conducting OFTs. These are for both the KVK, SMS, farmers and any other stakeholders.

1. The OFT may show how to increase economic returns by a changed practice that increases yield. The change could be quite minor and cost little;
2. The OFT may show how to reduce costs by reducing the use of fertilizer, machinery, labour or water without loss in yield;
3. In the long-term there may be indirect benefits of any changed technology that improves sustainability. An example might be of lime application which raises pH in the topsoil this season, thereby releasing previously bound nutrients, improving nitrogen fixation, flocculating clays and increasing earthworm populations over time leading to better incorporation of surface organic matter, improved aeration, better drainage, and finally, higher yield;
4. Unexpected positive things may be discovered about the farm because the farmer has been thinking about it differently and observing it more closely and critically;
5. There is close interaction between the SMS and the farming community as they work together. The farmer learns trial methods and concepts from the SMS and the SMS learns more about the local cropping systems and about limitations other than the technological ones;
6. Fellow farmers will be interested in the trial, will be doubtless and also give their opinions, may even join in and will be the first to adopt and then adapt the refined technology if it works.

3.17.4 Some problems in conduct of OFTs

Associated with the benefits explained above, there may be the possibility of various problems in conduct of OFT by KVKs. The most important ones among them are given here.

1. The trial land will be out of normal use during the OFT, so normal production from farm may not be achieved. Including the trial as part of the farm's normal cropping pattern and keeping the trial small and manageable can minimize this cost and make farmers' accept OFTs to be conducted on their farm;
2. The yield from the trial could be appreciably lower than normal yield, even perhaps a total loss. SMS should foresee whether the farmer in question can afford that risk or not;
3. Extra inputs will be a cost, items like fertilizers, labour, machinery and perhaps most importantly, time and
4. There may be a personal and social cost of possible failure on the farmer i.e. the family and friends. Expectations of the OFT should be moderate, not exaggerated. It is always better for KVK SMS to undersell expectations.

3.17.5 Designing of OFTs

The most important points to be taken care while designing an OFT are outlined below.

1. Do not plan too big an OFT, discuss demands on the farms' resources and time as well as your own, aim to complete the study in full. Be realistic;
2. Have a well-defined problem that can be clearly understood by farmers and answered by your approach;
3. If a factor other than the main one appears to be strongly influencing the answer, then formulate with the farmer a subsidiary question by adding sub-treatments, however;
4. Do not add so many sub-treatments that the farmer is lost in the complexity of your OFT;
5. Do not use fancy statistics to confuse yourself and collaborating farmers. Do not be misled by averages. Examine the detail in the data to assess the trends and the significance of any 'external factors'.

3.17.6 Selecting collaborating farmers

Thorough discussions have to be made with the collaborating farmers before start of OFT. The purpose of OFT has to be made clear to the farmer without any scope for doubt. Try to select farmers who have risk bearing ability. Also, the collaborating farmer should have good rapport with other farmers. This will help free interaction of the neighbouring farmers with him thus spreading the message. Also try to avoid 'people biases' wherein the SMS tends to select an influential farmer with lot of land and resources under him. It is easy to conduct OFT under such influential farmers. But, many a times this prevents other interested farmers from interacting with the elite farmer and SMS. This also creates an image of 'inaccessibility' upon the KVK among the villagers.

3.17.7 Selecting OFT plot from farmer field

Many farmer fields have good and less good parts and there are often gradients between the two. Explain to the farmer that if bits of the different parts can be included as sub-trials without jeopardizing the main trial carried out on the dominant land type, the trial will probably provide much more information. However, exclude the areas that are very unrepresentative of the whole field, or unimportant. Also make sure that the OFT plot is easily accessible for all farmers of the village and for the KVK also. This will facilitate easy organizing of farmers' day, field visits etc.

3.17.8 Understanding the OFT plot

The SMS should start discussions about the farm itself by trying to define with farmers the extent of the available growing season. This can be an introduction to thinking about the interplay of the environment and any varieties used. Explain to the farmer that knowing the growing season is important for using any cropping area to its full, achieving sustainable potential, particularly in a rainfed environment.

The critical factors are: how long is the microlocation environment warm enough, moist enough and sunny enough to start and support the growth of the crop; and to what extent can different varieties and management approaches alter the length of the season.

If available, long-term weather records for the district should be collected. This will be useful for calculating the average starting and finishing dates for the area and to illustrate the discussion.

Discuss with collaborating farmers about what they see as the main limitations to the growing season. Its length is likely to be limited by a cold season such as winter and by the start and end of the rainfall period.

Pre-OFT discussions by SMS with collaborating farmers

It can also be affected by sudden catastrophic weather events. There are other catastrophic risks like insects and some diseases that are more likely to occur at specific times in the year and may limit the crop season. If such events occur every year in the district microlocation, they should be avoided by having the crops at stages that are not damaged during these events. In some perennially warm, damp areas, both starting and finishing dates may be largely under the farmers' control, but in all areas farmers can have a degree of control over season length either through farm management or choice of crop.

3.17.9 Understanding the growing season

The SMS has to make an exclusive effort to understand the growing season. While doing so, the following questions have to be considered which are vital for the success of OFTs. (These questions are in general and will vary depending on crops and technologies tested).

1. Could local crops yield better if sown earlier or later? Why?
2. Are crops maturing fully or are they drying off before their grain is completely filled?
3. Are local temperatures too high or too low at any stage for any of the crops? When?
4. Is there sufficient water available at the right times for the crops? When is it limiting?
5. Is it possible to modify soil structure to enable crops to use the full potential growing season?
6. Is it possible to grow one crop species after another, perhaps using shorter duration varieties, to make more productive use of the potential growing season?

These questions are intended to lead to the conclusion that two main factors determining the potential growing season are the environment and how well the plant material chosen matches the environment. A third all-important factor combining the first two together is the farmer's management of the crop. The OFT activities must be accurately timed around the changes occurring in the environment and in the crop.

3.17.10 Understanding normal operation timings

The normal operation timings of farmers vary even within the district. Hence the SMS has to make sure the following aspects.

1. Is the selected land ready for planting at the start of the season?
2. Is the land too dry or too wet to allow the crop to be planted at the optimal time? Can a change in tillage or planting methods overcome the problem?
3. Are previous crop residues causing delays? Can they be better managed in advance, removed or incorporated or used for mulch?
4. Was the previous crop harvested in time to allow planting of the current crop at the optimum date or should a shorter duration variety have been used?
5. Was the previous crop harvested early to take advantage of the best market price? Would the current crop yield be more if planted early?

3.17.11 Understanding farming efficiency of collaborating farmer

The efficiency with which the farmer previously managed his crop growth activities is also an indicator to the success of present OFT. Some questions for which answers have to be found include:

1. Are fertilizers and irrigation, where available, being applied at the most beneficial time for the crop and are they used efficiently in his/her field?
2. Are pests, diseases and weeds being controlled at the right time and effectively? Could the outcome of present trial be achieved by using less effort or fewer chemicals in smaller amounts?
3. Is machinery available when needed?

Finding out which, and to what extent, these environmental, crop variety and management factors have an impact on the best use of the growing season is the first reason for above questions regarding farmer field.

The second reason for such questions is to test ideas to overcome the constraints to production that have been already identified. Debating the above mentioned questions will improve knowledge of the SMS and the farmers' awareness of local limitations. Hopefully, in discussions SMS will identify the key constraints to productivity on the farm and can debate ways through which the constraints might be overcome. These possible solutions could become the treatments in an OFT.

Design OFT by including possible solutions as treatments. It may take several meetings before the OFT is finalized to the satisfaction of all actors involved but it can be a highly profitable utilization of time for both SMS and the concerned farmers. Throughout, encourage the free-flow of ideas from farmers. Do not dominate these interactions with your scientific theoretical knowledge.

3.17.12 Selecting technologies for OFTs

The KVKs should take utmost care in selecting technologies for OFTs. If the OFT is planned as a simple varietal assessment then, it should be made sure that the variety is newly released. The SMS should take care that the variety is not more than 5 years old. The KVK should always try to assess and refine latest technologies so as to prevent and alleviate technology fatigue in the district. An old variety or technology will become part of an OFT only if the trial is meant for anything else than varietal trial. Eg: testing efficacy of a particular management practice to improve yield of a popular/ ruling variety. But, it should be noted that there is no point in wasting resources for an OFT to assess and refine the management practices of a 20 years old variety. If the trial is about comparing varieties, discuss with the farmer which new variety to include and why. Talk about their pest and disease resistance, lodging tolerance including propensity for tillering, fertilizer and water requirements, grain quality and yield, and likely crop duration from different planting dates.

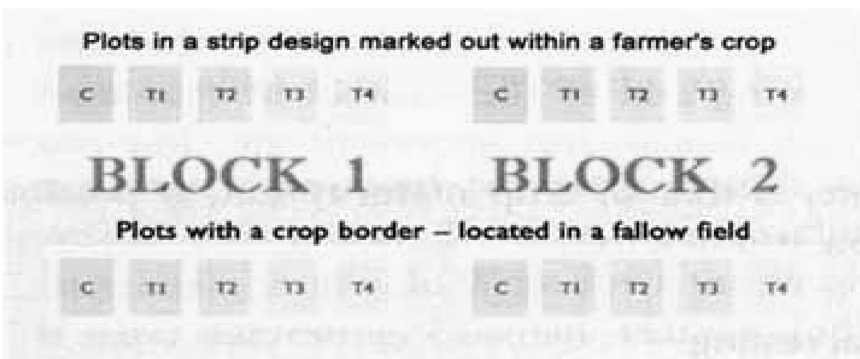
The same applies in testing of other material technologies. Highly successful pesticides, agricultural implements, hybrid seeds etc which are already cultivated by farmers of the district should be never taken up for OFTs. Some KVKs are even found to have attempted to assess and refine management practices of various local varieties. The KVKs should find a more remunerative technological option than assessing and refining local varieties. It should be also noted that the B:C ratio of any assessed technology should be far superior to that of farmer practice so as to advocate the same to them in future. A marginal increase in incomes is not worth advocating as far as replacing ruling technologies are concerned.

3.17.13 Designing OFT plots

If practicable, use a strip design for the OFT. This is the simplest possible form of design that farmers will readily understand. It is a rectangular strip a few meters wide, marked out within a normal farm crop. The treatments are applied in bands along the strip like the stripes across a scarf, and replicated as blocks at intervals.

This design is appropriate for simple trials like checking for fertilizer response of a crop whereas a research layout is better if there are many variables and sub-treatments.

Strip plot positions marked out in a farmer's crop and in a fallow field. Controls (C) and treatments (T_1-T_4) are repeated in two blocks. Harvest areas are the edged squares around the treatment letters.



(Figure courtesy: FAO, 2004)

Plot size

There is no hard and fast rule as to what the size of OFT plot should be. The answer is that it depends on the technology or methodology tested and hence becomes the discretion of the SMS concerned.

Plot size always depends on the technology under testing but larger is usually better in case of crops. Also, explain to farmers why observations and measurements should only be on plants towards the central part of treatment plots, avoiding the outer rows that are subject to 'edge effects'. Plants at the edges of experimental plots have more water, light, and nutrients available to them than the plants within the plots so they often yield better than the norm. These 'edge effects' are naturally offsetted if a clean cultivated border surrounds the plot. So the SMS should consider convincing the farmer in surrounding the OFT plot with a border of additional crop if it is not already located within a crop.

Examples of the two approaches are shown in the above diagram. Plot size, therefore, depends on balancing the need to eliminate edge effects against using bigger plots that may make the trial more costly and harder to maintain.

Control plot and treatment plots

There will always be a control plot (C in the diagram), which is the plot planted with the usual variety and with normal farm practice applied. Additionally, there can be at least one treatment plot, if a main variation to normal practice is also tested along-with. Agronomic trials usually have several treatments that represent degrees of variation to normal practice. It is better to avoid so many treatments in an OFT.

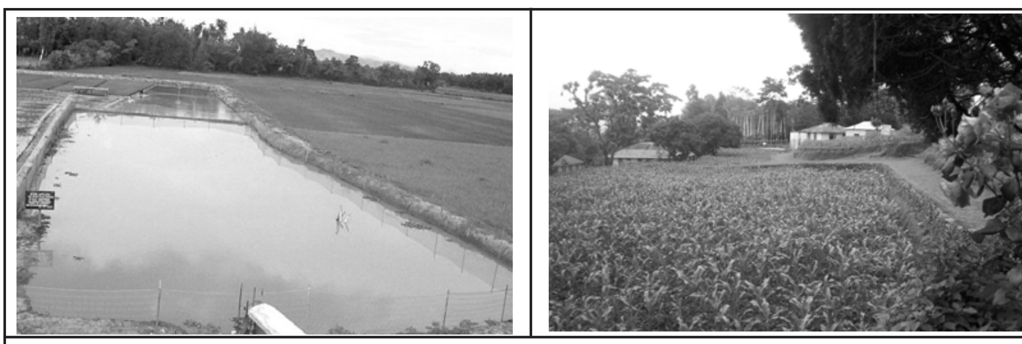
Plot layouts

In a strip design of the above-mentioned OFT the treatments could be applied end to end along the strip. Plots can be of any width within the strip as long as they are wide enough to permit the cutting of at least one harvest in their centre plus a wide enough border of plants around the harvest areas to avoid fertilizer interference from adjacent plots (wash on, root exploration, etc.). The harvest areas are shown as edged squares in the illustration.

If the OFT question is more complex involving two or more interacting factors, like ‘What is the best variety by sowing date for the particular microlocation of the district?’, requiring three varieties and three sowing dates, a conventional research design is generally required.

Plot locations

Locate the OFT plot in an uniform average area that typifies the farm or field. Avoid areas that are likely to be useless for cropping or are in some way abnormal. If the field has small outstandingly good or substandard parts, also exclude these extreme types from the main trial. You could consider



Plot locations

adding them as sub-trials. Explain to the farmer that responses on the extreme parts will not apply to the farm in general, but could provide useful secondary information about the farm.

The trial plots should preferably be within the normal crop. Mark the locations and dimensions of each plot clearly right from the outset and label the treatments. The demarcating sticks/poles should be clearly visible. White and yellow colours work well for sticks.

3.17.14 Cultivation in OFT plots

The trial plots should be cultivated at the same time and in the same way as the normal crop and as part of the normal crop preparation. There are two exceptions. If the trial is about cultivation methods obviously there will be differences. If the sowing date is a variable, plots for each sowing date must be cultivated and otherwise prepared separately, each at a similar period in advance of its sowing date. This complicates the study because of the need to get machinery to small plots past other plots and through the normal crop.

3.17.15 Observations in OFT plots

For example if the OFT is a simple varietal trial, the following normal observations are to be made.

Seedling emergence

Variable results in trials start with variable plant stands due to uneven cultivation and problems during sowing. These problems are unavoidable in some cases, but if they are noted or measured, their influence on the final data can be allowed for.

Ten days to three weeks after planting, when all seedlings are emerged, lay a meter-long measuring stick next to the row and count the number of seedlings along its length. Do this for one sample in every plot. Note down all the numbers with their plot identifier and determine how homogeneous the seedling density among plots is. Is one treatment poorer than others? If the seeds have been broadcast, put down four sticks of one meter to form a meter square and count seedlings inside the square. A larger or smaller area can be enclosed but its size should be known and the same area enclosed for each plot. If preferred, the meter square approach can also be used in crops that are precision sown in rows by machine.

Flowering

Flowering is a most critical time for the crop, both in terms of the crop's sensitivity to the environment and because flowering marks the beginning of the grain filling phase. For each plot make a record of the date of flowering and of the weather at that time. A useful, though less important and less precise date, is that of crop maturity but, if possible, note it down also.

Harvesting

The common question in trials is, "How will the treatment affect final yield?" So the final yield must be measured accurately and in an unbiased manner.

Here are some basic rules regarding harvesting which a SMS can follow and discuss with farmers too:

1. Don't leave plants in the field after they are ripe while waiting for the next treatment to be ready. Any unexpected event may occur and the ripe treatment will be lost to birds, mice, rain, wind or straying cattle;

2. Use the same method for harvesting all plots. Do not harvest some by machine and others by hand;
3. If a small combined harvester is available, first trim away plot edge rows or borders and then harvest the remainder, plot by plot, collecting the grain (and trash) of each plot separately. The area harvested should be identical for all plots and must be a known area. If it cannot be identical because of driver errors or other factors, then measure and write down the areas actually harvested;
4. If harvesting by hand, ignore edge rows. Do not select individual plants in plots. Use the measuring stick or meter square quadrat to indicate a meter of crop row or crop area to harvest from the central part in each plot. Avoid parts of centre rows that you know established poorly from earlier observations and notes. In general, do not include in the sample sections that have been positively or negatively affected by something other than the treatment;
5. Cut off the plants at ground level but do not include any soil;
6. Tie up and clearly mark the plot sample with its plot identification, block, treatment, and harvest date. Bag if possible so that parts are not lost;
7. Keep the samples together in a vermin proof area;
8. A main source of error in assessing biological and grain yield is that the amount of moisture in samples may differ between treatments. Dry the samples together in the hot sun, a hot greenhouse, a plastic house or in an oven.

Harvesting in OFT plots

Measuring the results

- Weigh the dried samples. Weigh in the bags if the bags are uniform weight and then subtract the bag weight from the total. Write the numbers down;
- If samples are hand harvested, thresh and weigh the grain. If they are machine harvested, just weigh. Write down the weight;
- If hand harvested, calculate Harvest Index (HI) by dividing the weight of the threshed grain by the weight of the whole sample. The result will commonly be between 0.25 and 0.55. If machine harvesting, divide the weight of the threshed grain by the sum of the trash and grain weights.

Recording the weather on the farm

If the KVK is collaborating with literate and resourceful farmers, and there is no weather station close by, think seriously about the possibility of recording temperature and rainfall on the farm. Temperature should be recorded regularly and calculate mean temperatures. All are needed to interpret why a crop yielded well or poorly and matured early or late, and to plan changes in management for future years.

Recording weather in farm

Preferably the farmer should be made to use a maximum and minimum thermometer hung in a flat-sided box painted white or in the shade. Explain how it is used, especially the need to reset it after reading. It is best to read and reset it at least once a week, preferably on the same day each week, and all the year round. The amount of rainfall and its seasonal distribution will be an indicator of both potential yield for the farm and the variability of potential between years. It will also enable the farmer to work out water use efficiency. If available, use a standard rain gauge to collect rain. Otherwise use a large straight-sided can and measure by dipping a ruler into the water. If rainfall is very low, the water should be tipped into another much smaller can, calibrated to the large can, for measurement. Once in a week measure and then discard accumulated rainfall, preferably on the same day each week. Locate the measuring devices in the OFT plot away from buildings, poly houses, shade nets or overhanging tree branches.

Using long-term weather information

Ask collaborating farmers to assess from long-term weather data, if available, how much water is available in the average season, and how much rainfall varies among years. Explain that a crop needs a certain amount of water during its growth to reach its potential. If that water is not available when needed, yield will be lower than potential. A shorter duration variety might be more appropriate for the area as that will require less water but it may also have lower potential yield.

3.17.16 Record Keeping

Records must be collected and set out in a structured way following patterns determined largely before the trial begins. Structured data and worksheets lead to clear and structured thinking. Haphazard trials with haphazard observations and recording are generally worthless. Discuss and design the worksheets with collaborating farmers before the trial starts. Provide them with hard copies of the final design in a workbook produced for the specific trial. Encourage them to use the workbook for all data and notes.

Some rules for recording data

1. Make observations immediately after specific events. Don't postpone;
2. Do not write important observations on scraps of paper. There is a sure chance in missing them;
3. Dedicate one workbook or worksheet to one OFT. Never use a diary that mixes experimental data with appointments and other details;
4. Enter observations collected on various dates in sequential date order. Avoid mixing up dates in the workbook;
5. Always label data with its plot identifier and date. What seems obvious today will be confusing next month;
6. Organize data in tables (with rows and columns) so comparisons between replicates or treatments can be made by eye;
7. Avoid long, single columns of data;
8. Keep a standard design for tables;
9. Enter the data as it is collected straight into tables so that they can be easily summarized as totals or means at the bottoms of columns and the ends of rows. Rewriting data copied from scraps of paper, sample bags or distributed notes in a workbook can be very time consuming and prone to mistakes.

3.17.17 Analyzing and discussing OFT results

One mistake usually committed by most KVKs is of not discussing the final results of the OFT with collaborating and neighbouring farmers. This often creates a bad impression about the KVK and prevents future collaborations. Further, the purpose of conducting OFT itself is defeated in such cases since the results are meant for the improvement of the existing production practices and farming systems at large.

When SMS discuss with collaborating farmers about the trial results do it in such a way that the numbers discussed are paralleled with a mental picture of the crop. Stick initially to raw data and simple averages and trends. Otherwise the farmer may be unable to comprehend the whole story of the trial.

Get the farmers to think about why a particular trial has done better or worse. Debate its state of weediness, whether it was wetter, whether a carcass of an animal was left there a few years ago and so on. Use the farmer's knowledge and notes in the workbook to involve him/her in the numbers and guide him/her to do the interpretation. The farmer's confidence and enthusiasm will grow rapidly. This will build up a much more reliable picture of what the OFT means than a statistical analysis. If appropriate, use that analysis yourself to substantiate the farmer's interpretation and if you decide to publish the results of the OFT.

Follow-up these discussions about interpreting the data taking into consideration what these interpretations mean to future practices on the farm. Always link the data back to practicalities. As the discussions proceed, get the literate farmers to note down the conclusions, but make your own notes. Consider follow-up study with an on-farm field day to involve other local farmers in the results. Encourage them to air their views on the weaknesses and strengths of the technology tested and to suggest ideas for future collaborative OFTs.

3.17.18 Reporting OFT results

Reporting OFT results is a crucial point in KVK activity. The stakeholders are very much interested to see how the technology responded to various microclimates. The results have to be reported to the zonal level and from there it gets compiled at the national level. The common format for reporting OFTs is given below with an example. The below mentioned 16 points has to be clearly observed and reported without any scope for vagueness.

Crop/ enterprise	**Farming situation**	**Problem Diagnosed**	**Title of OFT**	**No. of trials***
1	2	3	4	5
Rice	Rain fed low lands with farmers thriving on Rice farming system.	Water stagnation due to flash floods	Assessing Submergence tolerance of variety 'Jalkunwari' in XXX district	5
Technology Assessed	**Parameters of assessment**	**Data on the parameter**	**Results of assessment**	**Feedback from the farmer**
6	7	8	9	10
Rice cv Jalkunwari against local var. Joha	Period of submergence	8 – 10 days	Jalkunwari shows submergence tolerance of 8-12 days in various locations of the district. Thus it withstands the average submergence period of 8-10 days.	Enthusiastic of the performance of Jalkunwari which thrives under periodic submergence under flash flood; want to learn other management practices.
	Plant population	33/sq m		
	Rice yield	22.9 q/ha (Jalkunwari) & 15.6 (local Joha)		
Any refinement done	**Justification for refinement**	**Technology Assessed / Refined**	***Production per unit**	**Net Return (Profit) in Rs. / unit**
11	12	13	14	15
No	Not Applicable	Farmer's practice (Local Var)	15.6 q	NA
		Technology assessed (Jalkunwari)	22.9 q	11,622.00
		Technology refined	NA	NA
BC Ratio				
16				
1.74				

3.17.19 Publishing OFT results

Most KVKs retain OFT results with them without proper publicity. At the most, these results get published in the KVK annual reports and corresponding ZPD annual reports. The KVKs are afraid that results from on-farm trials may not be acceptable to scientific journals because of statistical considerations. But properly planned and conducted OFTs will have supporting data recorded by the concerned SMS. In the interest of the large scientific community, utmost efforts are to be made to publish OFT results. This will also help to prevent duplication of trials in similar microlocations or can also facilitate similar trials on same technology in other parts of the country. The results should also go as popular articles in local language newspapers and magazines thus spreading the timely message leading to alleviation of technology fatigue.

3.18 Examples of meaningful OFTs

In this section we present some model OFTs which KVKs can compare with their ones. These examples are based on successful OFTs conducted by KVKs under Zone – III. The examples vary from those in crop production to fisheries, animal production and management etc.

OFT: 1 Testing effect of 'CIFAX' in control of Epizootic Ulcerative Syndrome (EUS) in fishes (OFT aimed at assessment)

The KVK falls under the Mid Tropical Plain Zone where fish farming system is an important contributor to rural livelihood. The fish farmers were plagued with problem of low yield due to fish diseases. The KVK identified the problem as Epizootic Ulcerative Syndrome (EUS) which the farmers were unaware of. The EUS had lead to significant decline in fish yield.

The KVK formulated an OFT for testing effect of 'CIFAX' in control of Epizootic Ulcerative Syndrome (EUS) fish diseases and increase in fish production. The problem was clearly identified and the technology selected was never assessed in the district previously. The technology CIFAX (formulated chemical medicine) was assessed in farmer ponds. The trial had 10 ponds with same treatment in different microlocations of the district with one control pond at every location. As a supplementary measure, distribution of leaflets among the fish farmers was done in the district along with conduction of group discussions and trainings for fish farmers.

The assessment of the new technology 'CIFAX' proved that the Epizootic Ulcerative Syndrome (EUS) fish diseases could be fully controlled and this has lead to a significant increase in fish production. This meant increased income for fish farmers in place of constant loss due to fish diseases.

Lessons for other KVKs:

1. The KVK in the story clearly identified the actual problem
2. The problem was significant for a large number of farmers
3. The KVK identified the clear cut technological answer
4. The technology was worth assessing in the district
5. The technology assessed by KVK could bring solution to the problem identified

6. The technology assessed could increase farm income due to its use
7. The technology assessed now has been put for FLD and
8. The KVK succeeded in giving useful feedforward to extension system.

The KVK could achieve success in assessment and refinement of a new technology thus increasing farmer incomes in the process. The success in OFT has directly bought the new technology to FLD and it will be released for mass popularization by the KVK subsequently. Through this unique effort the KVK has justified its mandates and its role in bringing increase in farmer incomes from the existing farming systems.

OFT: 2 Assessing feasibility of TPS/HPS technology in Potato cultivation (Var: HPS II/67) (OFT aimed at assessment)

Under the Mid Tropical Plain Zone, horticulture and particularly potato cultivation adds significantly to farmer incomes. The KVK identified that the potato farmers are plagued with problems of low yield from traditional varieties, high disease infestation, high transport costs and production of less uniform and unattractive tubers. True Potato Seed/Hybrid Potato Seed (TPS) is a technology that was found as having a potential in solving the above mentioned problems. Also the technology was never used by farmers of the district.

The KVK identified potato variety HPS II/67 for TPS production. This variety and TPS technology both were new in the district. The KVK conducted OFT in 30 farmer fields through out different microlocations of the district. The farmer practice was kept as control. Two treatments i.e. one of raised bed and another one of flat bed were followed. Similarly in production of potato using TPS/HPS, the KVK used two treatments viz. that of transplantation and seedling tuber.

HPS/TPS technology in farmer field, KVK West Tripura

The technology tested led to successful outcome with respect to:

1. Cost effectiveness
2. Low seed rate (100gm/ha v/s 2 MT tuber/ha)
3. Negligible transport cost due to low seed rate

4. Disease free seeds
5. Resistance to late blight diseases
6. Higher yield
7. No requirement for cold storage facility

The assessment of the TPS technology by KVK helped in identifying a solution to the above mentioned burning problems which potato farmers of the district were facing till date. The trials have already evinced interest in farmers of the district and the technology is now successfully demonstrated in FLDs. The KVK could successfully find solution to the critical problems in potato cultivation there by contributing to:

1. Increased income
2. Drudgery reduction
3. Labour savings
4. Space savings and
5. Ensured supply of quality seeds

Through this innovative OFT, the KVK could find solution to an age old problem which involves, cost, disease problems and drudgery. Proper identification of field level problem and appropriate technological solution has resulted in this success.

OFT: 3 Assessment and refinement of Ginger rhizome storage measures (OFT for assessment and refinement)

The Mid Tropical Hill Zone provides enough scope for cultivation of ginger. The farmers in this KVK district were growing the crop over the years with varied results. Of late it was found that the farmers lost considerable portion of rhizomes stored by them as seed material. The method followed by these farmers was that of pit storage. The KVK hypothesis was that by providing a cheap and hygienic alternative to pit storage, the problem of rhizome loss can be solved. Accordingly, alternatives were looked for by the concerned SMS.

It was found that bamboo was easily and cheaply available in the area. Most of the farm houses were made up of clay pasted bamboo walls. These houses could withstand the winter effectively. The moisture retention in these houses was very less. The concerned SMS mooted the idea of clayed bamboo structures for storage of rhizomes. This could prevent moisture from spoiling it as in pit method. At the same time the SMS learned that agricultural engineers of a nearby research station have already developed clayed bamboo rhizome storage structures. The technology was then selected for OFT.

The technology was assessed for its performance at the end of next season. The size and shape of bamboo structure and the amount of clay and thickness of pasting were the parameters for assessment and refinement. All the above parameters were found varying from microlocation to microlocation and were refined accordingly. Today the farmers of the district store their rhizomes without loss.

Lessons for other KVKs:

1. The concerned KVK identified a felt need which was unaddressed for many years
2. The problem was significant for a large number of farmers
3. The KVK could identify a cost effective technological answer
4. The technology was worth assessment and refinement
5. The technology assessed by KVK could bring solution to the problem identified
6. The technology was refined according to specific microlocation requirements
7. The technology assessed and refined now has been considered for FLD

OFT: 4 Assessment and refinement of System of Rice Intensification (SRI)

West Godavari is the pioneering district of Andhra Pradesh in adopting latest technologies in agriculture to achieve higher production and productivity. It is considered as 'Rice Bowl of Andhra Pradesh'. Among all the crops the predominantly cultivated crop is rice. Rice farming accounts for 65-84 % of the total area sown, with an average yield of 3377 Kg/ ha during Kharif (2,47,850) and 4692 kg/ ha in Rabi (1,78,999 h). Most of the cropped area in the district is irrigated through canal network.

Important problems of rice cultivation in West Godavari

- Neglected seed production
- Stagnant rice yields
- Seeds of new varieties are not available to the farmers
- Poor varietal replacement ratio
- Incidence of panicle mite and other pests and diseases
- Indiscriminate use of fertilizers and pesticides leading to economic loss
- Micronutrient deficiencies
- Salinity and low soil organic carbon
- High cost of cultivation

Potential solution to the problems

Despite stagnant rice yields in the delta areas, the farmers are compelled to grow rice, as there is no suitable alternate crop that can be grown for assured and higher returns. In this context, the System of Rice Intensification (SRI) method of cultivation came as a boon to step-up the productivity of rice. The progressive development in rice cultivation in West Godavari district during the period 1960 to 2004 is given below as time line of rice cultivation in West Godavari district:

1960 Introduction of high yielding varieties programme. West Godavari district was selected at national level as IADP district

1970 Farmers have been motivated through entrepreneurial activities in agriculture

1980 West Godavari district became the rice bowl of Andhra Pradesh

1990 The stagnated rice yields made the farming community switch over to aquaculture and horticultural enterprises

2000 Most of the land less labourers became leased farmers of smaller holdings

2001 Acute water shortage in the entire Godavari delta

2002 Water shortage continued, rotational system introduced, panic created among farming community

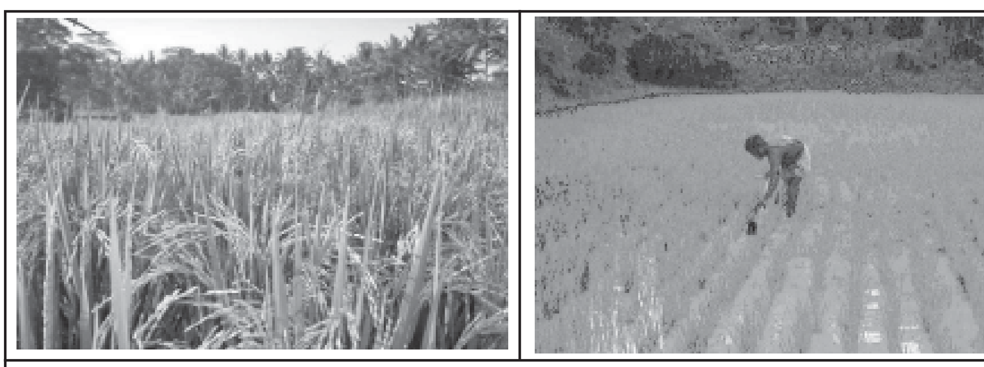
2003 KVK introduced the water saving and high yielding new technology 'SRI' – in 10 acres of KVK farm and in 10 farmer's fields as a trial. Kharif, 2003: KVK successfully organized 'SRI' system in 20 acres at KVK farm and in farmers fields in small (1acre) holding to large holding (100 acres)

2003 A good break through in stagnated rice yields by recording over 10 tonnes yields against 6-7 tons per hectare

2004 A new momentum had come in rice cultivation in West Godavari district

The system of Rice Intensification (SRI) was introduced in Kharif, 2003 and it was simultaneously experimented at University research cum extension centers and farmers fields. SRI technology was demonstrated on a large scale by the KVK, West Godavari, in its farm as well as in farmers' fields.

Pre-screening of technologies involved in SRI was done in association with the selected farmers groups through discussions and interaction sessions. Participation of farmer groups was encouraged at different stages of crop growth. At the crop harvesting stage, yield, cost benefit ratio, practicability, pros and cons of SRI method were assessed. Field days were conducted in farmers' fields as well as at KVK. Farmer conventions were organized with resourceful farmers and those farmers who have already adopted the SRI technology. This had helped for constructive interaction/ discussion among farmers themselves about the feasibility and profitability of the technology and to address the scientists by suitably modifying the techniques of SRI, as perceived by the farmers.



SRI Cultivation

Several experiments were conducted at KVK farm as well as in farmers' fields with the supervision and technical guidance of the KVK. The KVK also helped in developing location specific and cost effective devices like line markers and weeders. This had encouraged other farmers to modify accordingly and had become an eye opener to scientists and extension workers too. The active participation of farmers from the beginning of technological introduction had motivated many others to adopt the technology in larger areas in the ensuing crop season.

At the KVK farm, demonstrations on SRI technology were carried out in 10 acres during Kharif 2003-04. Performance of SRI cultivation in comparison with direct seeding, dibbling and transplanting was demonstrated in 20 ha during Rabi 2003-04. To make SRI technology suitable to local conditions various modifications were also demonstrated with improved varieties, viz. MTU 1071, 1061 7029,1010,1038,2036, and BPT 5204, JGL 384, 1798, 402 and WGL 14.

Demonstrations carried out at the KVK Farm during 2003-04

- Demonstration of SRI technology was conducted involving six major steps.
- Demonstration of different rice varieties with SRI technology, different age of seedlings and different spacing. The demonstration was conducted on one acre with 11 treatments on age (8 days and 24 days), number of seedlings/ hill (1 and 2 seedlings) and spacing (20x15 and 25x25, 50x25 cm).
- Demonstration of varietal interaction with different age of seedlings. This was done in three acres with two varieties and different age seedlings.
- Demonstration of new rice varieties with varied number of seedlings/ hill. This was done with eight varieties in two acres.

SRI Technology at farmers' fields

During Kharif 2003-04, the Krishi Vigyan Kendra conducted SRI technology demonstrations at eight locations in farmers' fields. The KVK provided technical guidance and conducted regular field visits, training programmes and field days. The results indicated that in farmers' fields the production levels were quite encouraging. In Uppuluru and Ballipadu villages the realized yield was 11500 kg/ ha and 10688 kg/ ha respectively under SRI as compared to 6400 kg/ha and 7625 kg/ ha respectively in conventional methods.

Performance on farmers' fields during Rabi 2003-04

During rabi 2003-04, the Krishi Vigyan Kendra conducted SRI technology demonstrations at farmers' fields. The results indicated that the productions levels were quite encouraging. In Ballipadu and Kaikaram villages the yields realized was to the extent of 14500 kg/ ha and 11697 kg/ha respectively under SRI as compared to 9750 kg/ ha and 8437 kg/ha respectively in conventional method.

Advantages of SRI

SRI had the potential to meet the challenge by virtue of its capacity to double or even triple the productivity and less water requirement. SRI encourages rice plant to grow healthy with:

- Large root volume
- Profuse and strong tillers
- Non-lodging
- Big panicle
- More and well-filled spike lets and higher grain weight
- Resists insects and allows rice to grow naturally

The actual benefits of SRI are:

1. Higher yield of both grain and straw
2. Reduced duration (by 10 days)
3. Lesser chemical inputs
4. Less water requirement
5. Less chaffy grain
6. Increase in grain weight without change in grain size
7. Higher head rice recovery
8. Capacity to withstand cyclonic gales
9. Cold tolerance
10. Soil health improves through biological activity

Lesson for other KVKs

KVK West Godavari revitalized rice growing farmers by introducing System of Rice Intensification (SRI) method by following various dissemination mechanisms including training and demonstrations. This could increase the net profit of rice cultivation by Rs. 6700/ha using less water. The KVK not only identified the most burning problem but also addressed it through innovative technological options and bought about agricultural development in the district.

3.19 Specific considerations for OFT with Livestock

On-farm research with livestock poses unique challenges. While sometimes difficult, livestock trials can yield substantial rewards if properly carried out. Ensure reliable measuring instruments and check them frequently with a correct balance (basket for the fodder, pot for the milk etc). Animals unexpectedly die during trial period. Record the date, cause of death and weight of the dead animal as soon as it is discovered. These records are helpful in accounting for the feed and production of the dead animal. Think about what you are measuring. Animal growth or weight gain, feed intake, days on feed and milk production are common measurable livestock outputs. Livestock trials should also be based on a felt need or problem existing in the district. Ex: “OFT on efficacy of XXXX vaccine against FMD” is needed only if FMD is prevalent in the district and found causing substantial loss to livestock farmers.

3.20 OFTs involving Social Science concepts

Many SMS belonging to Social Science disciplines are found to have no OFT and FLD conducted in their subject area. They are often involved as helping hands for other SMS. In Social Sciences, concepts take the place which technologies do in life sciences. Like technologies, these concepts also can’t fit directly to any social systems. Hence, just like assessment and refinement of new technologies, these new concepts in social sciences too have to be assessed and refined to find solution to social problems in various microlocations of the district.

One question which is always heard repeatedly is: Can SMS (Agricultural Extension) conduct OFTs and FLDs? The answer is YES. Proper conceptualization of farm life dynamics and innovative extension methodologies can open up umpteen opportunities of assessment, refinement and demonstration of social concepts for extension SMS.

Here are some hypothetical examples of OFTs in extension discipline.

OFT: 1 Assessing effect of Group Formation on Social Capital and Rural Livelihoods.

For sustainable rural livelihoods, a high level of social capital is a must in rural areas. It implies the idea that social bonds and norms are important for sustainable livelihoods. In most villages farm families often resort to individual efforts which pay only average dividends. Social scientists have proven beyond doubt that group formation and positive management of group dynamics thereon results in significant build up of social capital thus contributing to increase in economic capital (Sajeev, 2006, Sajeev and Gangadharappa, 2006). The success of Self Help Groups and Farmer Interest Groups in improving rural incomes all over the world has proven this fact.

The SMS (AE) observed that in various microlocations of the KVK district, farm incomes are abysmally low coupled with poor avenues for farm women and rural youth. Village surveys revealed that spirit of group activity is lacking among the rural population. This also resulted in poor response for various developmental initiatives by KVKs and other agencies. Building social capital by way of group formation was recognized as the solution for this social problem. Accordingly, the SMS (AE) conceived an OFT titled ‘Assessing effect of group formation on social capital and farm incomes’. The OFT was conducted in 5 different locations of the district with the following four treatments:

Treatment 1: Self Help Group (SHG) with 20 farmers focusing on group farming.

Treatment 2: Self Help Group (SHG) with 20 farm women focusing on savings and income generation.

Treatment 3: Farmer Interest Groups (FIG) with 15 farmers which are product focused.

Treatment 4: Farmer Interest Groups (FIG) with 15 farm women which are enterprise focused.

In every location, the above four treatments were followed. In total, the OFT covered 200 SHG members and 150 FIG members.

The SMS after initial period of establishment of SHGs and FIGs started making his observations of the OFT. The parameters recorded in the first phase were:

1. Build up of group spirit
2. Spread of 'self help' message
3. Dynamics of groups formed
4. Build up of social capital
5. Increase in saving habit and
6. Initiation of group farming

The SMS could clearly notice a significant improvement in all the above parameters. The data was collected for every three months through village surveys and compared with previous ones to reach at conclusions. The formation of SHGs and FIGs also helped the KVK in finding collaboration from farmers for all their programmes. The other SMS of the KVK also got benefited by these groups. Several hidden benefits were also noticed such as:

1. Outflow of extra income to family savings
2. Better health and education for children from extra savings
3. Group feeling among villagers
4. Increase in cooperative efforts
5. Spirit of entrepreneurship
6. Reduction in farming costs due to group farming
7. Build up of farm assets from extra income
8. Development of better marketing models for rural products through FIGs
9. Culture of hard work among rural youth and
10. Better status of women in villages due to income from SHG and FIG activities.

The success of above mentioned OFT has compelled the SMS to continue the groups for demonstration purpose for farmers of other villages. So the groups will now become part of a 'FLD on impact of group formation on social capital and farm incomes'.

OFT: 2 Testing applicability of 'e-village' concept in providing efficient farm decision support

In recent years, Cyber extension has gained popularity and we have numerous successful cyber extension initiatives under public and private domain in India. The most important role of cyber extension in development is fostering a knowledge intensive sustainable livelihood security system in rural areas, since ICT can enable us to reach the unreached and include the excluded information, knowledge and skill empowerment becomes easy. Any inclusive knowledge society requires the effective harnessing of ICTs to combat poverty and foster development.

The SMS (AE) observed that in different microlocations of the KVK district, farm incomes are meagre due to poor access to market intelligence coupled with low productivity due to pests and diseases. Even though information on the above aspects already existed, the farmers were unable to make use of the same due to inaccessibility. At this point the SMS (AE) mooted the idea of setting up an 'e-Village' on a pilot basis. Accordingly he formulated an OFT titled: "Testing applicability of 'e-village' concept in providing efficient farm decision support" in a selected microlocation of the district. Under the OFT, a computer with internet connection was provided in the village. Selected farmers were trained in internet usage and data retrieval. Farmers were also introduced to the various websites on pest and disease management as well as market information.

Upon initiation, the SMS recorded the following aspects:

1. Usage of internet by farmers
2. Utilization of market information from internet
3. Utilization of pest and disease information
4. Utilization of other information such as package of practices and
5. Increase in farm income over a period due to 'e-village'.

Women getting trained on e-village

The SMS could clearly notice a significant improvement in all the above parameters. The data was collected for every three months through village surveys and compared with previous ones to reach at conclusions. The various benefits from 'e-village' noticed were such as:

1. Better decision making in farm management by farmers
2. Reduced losses from pest and disease attacks
3. Better crop and animal management
4. Reduction in farming costs due to better information
5. Reduced exploitation by middlemen due to better informed farmers
6. Increased farm income due to better marketing practices

7. Outflow of extra income to family savings
8. Better health and education for children from extra savings
9. Build up of farm assets from extra income and
10. Development of better marketing models at village level

The success of above mentioned OFT has compelled the SMS to continue the facility for demonstration purpose for farmers of other villages. So the facility will now become part of a 'FLD on 'e-village' concept in providing efficient farm decision support'. It is expected that the success of the OFT will create a multiplier effect thus forcing other villages to take up the technology. The SMS in story bought the latest cyber extension technology available to give efficient farm management and marketing decision for the farmers thus bringing a significant increase in their farm incomes.

Other options for OFTs and FLDs in Extension discipline.

Extension SMS should also take into account the OFTs and FLDs conducted by other SMS of their own KVK. They can formulate their own OFTs so as to assess the suitability of various extension methodologies in popularizing the various technologies assessed and refined by other SMS. Through such assessment and refinement of various extension methods they can find out and demonstrate those methodologies best suited to popularize the various new technologies found suitable for the district. This leads to extension methodology backstopping parallel to the technology backstopping done by other SMS thus aiding better technology adoption and diffusion in the district.

This can be explained with a suitable example from one of the KVKs. Let us look in to the OFTs proposed by other SMS of a KVK.

No	Thrust area	Crop/Enterprise	Identified Problem	Title of OFT
1	Situation Specific Variety	Sugarcane	Low Yield	Assessing performance of Rice variety "Lohit" in Nagaon district
2	Nutrient Management	Sugarcane	Low yield and Imbalanced fertilization	Assessment and refinement of soil test based fertilizer application in Sugarcane in Nagaon district
3	Integrated Pest Management	Sugarcane	Injudicious use of Pesticides	Assessing IPM practices on Sugarcane

No	Thrust area	Crop/Enterprise	Identified Problem	Title of OFT
4	Nutrient Management	Boro rice	Imbalanced Fertilization	Assessing soil test based fertilizer application in Boro Rice.
5	Nutrient Management	Boro rice	Potassium Deficiency	Assessing performance of Potassium Management in Boro Rice.
6	Integrated Pest Management	Sali rice	Injudicious use of Pesticides	Assessing performance of IPM on Sali Rice in Nagaon district.
7	Situation Specific Variety	Turmeric	Low Yield & Poor Quality	Assessing performance of Turmeric variety “Megha 1” in Nagaon district.
8	Production Technology	Banana	Low Yield	Assessing performance of High Density Planting in Banana in Nagaon district.

It can be noticed that the KVK has tried to intervene in production of four crops with eight OFTs assessing eight different technological options. The options assessed (and refined later) may be found suitable or not suitable for the district. But the question of proposing the best extension method for popularizing the technologies among the extension personnel and farmers of the district will still remain. Many a times, it is found that KVKs suggest less effective extension methods for popularization of successful technologies thus leading to low adoption and diffusion of the same in the district. This leads to an increase in the already existing technology fatigue. The Subject Matter Specialist (Extension) can formulate OFTs to assess and refine the extension methods most likely suited to popularize the above technologies.

For example, in case of the OFT: ‘Assessing performance of IPM on Sali rice in Nagaon district’, proposed by SMS (Entomology), the SMS (AE) can formulate an OFT titled: ‘Assessment of suitability of Farmers’ Field School (FFS) as a method to popularize IPM on Sali rice in Nagaon district’. Suitable refinements in the method can also be thought about in later seasons. Likewise, various extension methodologies as well as various participatory techniques also need to be assessed and refined for suitability and effectiveness in various microlocations of the district so as to aid in their popularization among extension personnel which in turn will aid in successful adoption and diffusion among farmers of the district[1].

[1] ***The above examples hold good in case of FLDs also and hence are not discussed separately in Chapter – IV on Technology Demonstration.***

3.21 Participatory Technology Development (PTD)

KVKs aiming at farmer driven OFTs (Type III) which are a step above the present extension driven ones have to resort to Participatory Technology Development (PTD) process. It is an approach, which involves encouraging farmers and other stakeholders to engage in experiments in their own fields so that they can learn, adopt new technologies and spread them to other farmers. In its purest form PTD is a process in which:

- problems for which solutions have been sought are identified and prioritized by farmers,
- alternative solutions to be tested are defined by farmers
- design of experiment is decided by farmers,
- the implementation is done by farmers,
- monitoring is decided and executed by farmers and
- evaluation is done by farmers

A growing number of documented examples in recent years reveal that PTD has got accepted as a research approach in agriculture, animal husbandry and natural resource management (NRM). It has been recognized that research is effective in improving farmers' livelihoods if farmers play a vital role in the process.

The objectives of PTD approach are to:

- Empower clients to develop and use livestock technologies
- Develop appropriate livestock technologies suited to the farm holdings
- Empower stakeholders, especially the marginalized ones, on their own decision making so that their capacity to make effective demands on research and extension organizations is strengthened and
- To improve the functional efficiency of formal research

The steps in PTD process involves:

1. Getting started in field
2. Understanding problems and potentials
3. Looking for readiness to try
4. Designing experiments
5. Trying out
6. Evaluation of the experiments
7. Sharing results with others
8. Sustaining PTD process and
9. Scaling up/ Phasing out

Obstacles to PTD as viewed by farmers are as follows:

- Research would take too much time
- Too great a risk in their production systems
- Fear that they may be punished, if the technology fails
- Lack of intention to experiment an option, which they consider risky, insignificant, or having delayed benefits
- Lack of communication link with scientists and
- A general feeling that their problems are unimportant to scientists

Obstacles to PTD process from Scientists' view point is as follows:

- Results could be spoiled by mismanagement of factors outside the researchers' control
- Failure of technologies in farmers' fields may be construed as inadequacies of scientists
- Risk of exposing farmers to too many uncertainties
- Lack of skills and experience in participatory research and
- Lack of time, motivation and communication skills to approach farmers

Benefits of PTD process in research/extension include:

- Encourages farmer experimentation
- ITK of farmers can be gainfully tapped
- Farmers' knowledge and creativity are harnessed to develop appropriate technology
- Farmers are motivated when their views are respected
- Technologies are more rigorously tested under users' conditions.
- Technologies to suite diverse agro-ecological & socio-economic situations
- Technologies are more likely to be adopted
- Technologies are in users hands more rapidly
- Complements station-based research

The success of an OFT should not be confused with success of the technology tested. A negative result of a technology tested shows that the technology is not suited for the specific microlocation of the district. This finding also refers to the success of the trial. Some technologies may not need refinement thus qualifying directly for frontline demonstrations. Some may successfully undergo refinement and reach the demonstration stage while some technologies fail to get refined in the farmer field. The technologies which successfully come out of On Farm Trials are then recommended for Frontline Demonstrations (FLDs).