Nurturing Interdisciplinarity in Agricultural Research through Capacity-Building

A case study of ZEF's Uzbekistan Project

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Abstract

Interdisciplinary research is one of the key strategies of Center for Development Research (German: Zentrum für Entwicklungsforschung -ZEF) of Bonn University. ZEF claims to be one of the top centers of excellence in development research, which carry out applied research relevant to developing countries. Presented in this thesis is sociological data from its Uzbekistan Land and Water Restructuring project's third phase (2007-2011), illustrating how such centers operationalize interdisciplinary research; how these design research projects, how these centers build capacity for interdisciplinary research, and then induce, implement and sustain interdisciplinarity in their research. The main question addressed in this dissertation is "to what extent and how the ZEF's longitudinal model of facilitated, structured and incremental capacity building combined with problem based interdisciplinary action research shaped interdisciplinarity amongst its teams of collaborating scientific staff, and how sustainable this interdisciplinarity was"? The mixed method approach of this study differed substantially to the single method approaches, such as interview research or bibliometric analysis, so far used to study interdisciplinarity.

The study finds that the process of designing the research proposal and devising a contextually appropriate capacity building model and the model for conducting interdisciplinary research itself became a sociological process of negotiation amongst ZEF scientists discharged with the task of designing research proposal. The power imbalances inherent in ZEF's departmentalized structure mirrored during the research design and implementation phases. The innovative capacity building model, which was tailored to build the capacity of ZEF's staff were able to assist team members in overcoming their disciplinary epistemologies after some struggle. At the initial stages of the process, some of the research team members showed dual epistemologies: the fundamental and the superficial. The latter appeared to be more a socially desirable response to their team membership. The research process dynamics identified a number of challenges and barriers that could potentially disrupt and frustrate interdisciplinarity, but many of those challenges were gradually overcome by the teams themselves, or with assistance from project managers and the facilitator. The study finds that the conditionality that ZEF faces from its research donors and its parent university determine what kind of and how much of interdisciplinarity can be achieved at ZEF. As the main vehicles to undertake interdisciplinary research at ZEF are donor funded research projects, sustaining the capacity for interdisciplinary research will remain the key challenge for ZEF. Key implications for theory, methodology and practice of interdisciplinary research are also spelled out.

Zusammenfassung

Interdisziplinäre Forschung ist eines der Schlüsselkonzepte des Zentrums für Entwicklungsforschung (ZEF) der Universität Bonn. Das ZEF hat den Anspruch, eines der führenden Zentren im Bereich der angewandten Entwicklungsforschung zu sein. In dieser Arbeit werden soziologische Daten aus der dritten Phase (2007-2011) des ZEF-Projektes „Restructuring Land and Water Use in Khorezm Region, Uzbekistan“ präsentiert, um zu verdeutlichen, wie solche Forschungszentren interdisziplinäre Forschung umsetzen. Es wird gezeigt, wie Forschungsprojekte am ZEF und in ähnlichen Zentren gestaltet, und wie Kapazitäten für interdisziplinäre Forschung aufgebaut werden. Schließlich wird gezeigt, wie Interdisziplinarität in der Forschung umgesetzt, implementiert und aufrechterhalten wird. Die Leitfrage dieser Dissertation ist, wie und in welchem Ausmaß der längsschnittartige Ansatz von systematisch begleitetem, strukturiertem und stufenweisem Kapazitätsaufbau des ZEFs, kombiniert mit problembasierter interdisziplinärer Handlungsforschung, interdisziplinäre Forschungsprozesse unter den verschiedenen, miteinander kollaborierenden, Forschungsteams beeinflusst hat. Zudem wird gefragt, wie nachhaltig diese Interdisziplinarität war. Die Nutzung eines kombinatorischen Methodenansatzes in dieser Studie unterscheidet sich substantiell von den in der Interdisziplinaritätsforschung bisher vorherrschenden Ansätzen, welche lediglich auf einer einzelnen Methode, beispielsweise Befragungen oder bibliometrischen Analysen, beruhen.

Diese Studie stellt fest, dass der Entwurf eines Forschungsprogramms und die Entwicklung eines kontextuell angemessenen Modells zum Kapazitätsaufbau, sowie die Erstellung eines interdisziplinären Forschungsmodells, selbst als soziologische Verhandlungsprozesse zwischen den ZEF-WissenschaftlerInnen, die mit diesen Aufgaben betraut waren, betrachtet werden können. Die ungleiche Verteilung von Einfluss, bedingt durch die vielgliedrige Struktur des ZEFs, spiegelte sich in den Vorbereitungs- und Implementationsphasen des Projektes wieder. Das innovative Modell zum Kapazitätsaufbau, welches dazu entworfen wurde, die Kapazitäten der ZEF-WissenschaftlerInnen durch sein längsschnittartiges und schrittweises Design zu verbessern, wurde dabei mit praktischen Erfahrungen aus der Handlungsforschung und Prozessen der Gruppenreflexion kombiniert, und konnte den Teammitgliedern dabei helfen, nach einigen Schwierigkeiten ihre disziplinären Sichtweisen zu überwinden. Zu Beginn dieses Prozesses zeigten sich bei einigen Teammitgliedern duale Epistemologien: die fundamentale und die oberflächliche. Letztere schien dabei eine sozial erwünschte Reaktion auf die Mitgliedschaft in einem Forschungsteam zu sein. Im Verlauf des Forschungsprozesses zeigten sich verschiedene Herausforderungen und Barrieren, welche möglicherweise den interdisziplinären Ansatz hätten stören und zum Erliegen bringen können. Viele dieser Herausforderungen wurden jedoch allmählich von den Teams selbst, oder mit Hilfe der Projektkoordinatoren und Prozessfacilitatoren, überwunden. Diese Studie zeigt jedoch auch, dass die Konditionalität, welche dem ZEF durch seine Geldgeber und die Universität aufgegeben wird, den zu erreichenden Grad und die Art von Interdisziplinarität bestimmt. Da von externen Geldgebern finanzierte Projekte die Hauptvehikel zur Durchführung interdisziplinärer Forschung am ZEF darstellen, wird es eine wichtige Herausforderung für das Institut bleiben, die Kapazitäten mit diesen Herausforderungen für die Forschungsprozesse positiv umzugehen, aufrecht zu erhalten. Basierend hierauf, zieht diese Studie relevante theoretische und methodische Schlüsse für die Weiterentwicklung interdisziplinärer Forschungspraxis.

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Acronyms

AL	Afforestation on marginal/ degraded lands as an alternate land use
AL Team	Interdisciplinary team working on Afforestation on marginal/ degraded lands as an alternate land use
BiGS-DR	Bonn interdisciplinary Graduate School for Development Research
BMBF	German Acronym for Ministry of Science and Education
CA	Conservation Agriculture
CA Team	Interdisciplinary team working on Conservation Agriculture
CRI	Cotton Research Institute of Uzbekistan
DAAD	German Acronym for German Academic Exchange Service
DFID	Department for International Development of the United Kingdom
DLR	German Acronym for German Aerospace Center
ETC	ETC EcoCulture Netherlands (the firm that won the bid for external consultancy)
FRI	Forestry Research Institute, Tashkent (Uzbekisatn)
FTI	Follow-the-Innovation
FTT	Follow-the-Technology
GDI	German Development Institute of the German Ministry for Development Cooperation
GIS	Geographical Information System
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit (formerly GTZ)
HR	Human Resources
IDR	Interdisciplinary research
IDS	Institute of Development Studies at University of Sussex, United Kingdom
IDTs	interdisciplinary (research) teams
ISS	International Institute of Social Studies, The Hague, the Netherlands
IWMI	International Water Management Institute
KEOM	Khorezm-wide Economic Optimization Simulation Model
KRASS	Khorezm Rural Advisory Support Services (NGO formed by ZEF project Alumnae based at Urgench)
M&E	Monitoring and Evaluation
MS/ M.Sc.	Master Studies/ Master of Science
ODI	Overseas Development Institute of United Kingdom
Ph.D.	Doctor of Philosophy
PIA	Participatory Impact Assessment
PM&E	Participatory Monitoring and Evaluation
PRA	Participatory Rural Appraisal
RFPs	(donor's) Requests For Proposals
SA	Rapid salinity assessment through induction devices
SA Team	Interdisciplinary team working on Rapid salinity assessment through induction devices
SciTS	Science of Team Science
SCMT	Scientific Coordination and Management Team of the Uzbekistan project

TDR	Transdisciplinary Research
TDTs	Transdisciplinary Teams
TIIAME	Tashkent Institute of Irrigation And Melioration Expeditions
TS	Team Science
UNESCO	United Nations Educational Scientific and Cultural Organization
UNU-EHS	United Nations University- Institute for Environment and Human Security
UrSU	Urgench State University, Urgench, Uzbekistan
WUA	Water Users Association
WUA Team	Interdisciplinary team working on Strengthening Water Users Associations through capacity-building
ZEF	Zentrum für Entwicklungsforschung (English: Center for Development Research of Rheinischen Friedrich-Wilhelms-Universität at Bonn
ZEFa	Department of Political and Cultural Change at ZEF
ZEFb	Department of Economic and Technological Change at ZEF
ZEFc	Department of Ecology and Natural Resource Management at ZEF.

Chapter 1: Introduction

This dissertation studies 'Nurturing Interdisciplinarity in Agricultural Research through Capacity-Building: A case study of ZEF's Uzbekistan Project". This implies examining, through a sociological enquiry, how Center for Development Research (German: Zentrum für Entwicklungsforschung -ZEF) of Bonn University perceives and designs interdisciplinary research, and conducts capacity building activities for enhancing its interdisciplinary research, and what it achieves as the outcomes. Specifically, I examine interdisciplinary research experience in one of ZEF's land and water research projects conducted in Uzbekistan. To better understand how the concept of interdisciplinary research was interpreted by ZEF, I examine literature that discerns between disciplinary, multidisciplinary, interdisciplinary and transdisciplinary research and then assess ZEF's conceptualization from its strategic documents. I attempt to examine ZEF's internal organization and compare it to two other similar development research institutes in Europe, i.e. Institute of Development Studies of University of Sussex in UK, and Institute of Social Sciences in The Hague, the Netherlands. Then I look at the process and dynamics of the research proposal of Uzbekistan project's third phase, that attempted to undertake interdisciplinary research. Through this examination, I bring out salient features of ZEF's interdisciplinary work package. These two aspects are discussed in Chapter 2. The theoretical and methodological framework is explained in chapter 2, which details a broad sociological suite of mixed method methodologies adopted for the study of the subject as an embedded case study. This chapter also identifies the main research question and the sub-questions used to guide the study.

Then, I examine in detail the capacity-building design and look at how the capacity development activities were implemented (of which I was a part as an interdisciplinary process facilitator). This is presented in Chapter 4. I analyze the implementation of interdisciplinary research activities, which forms the subject of Chapter 5. The characteristics and roles of facilitation of interdisciplinary research, and the individual learning by team members as a result of facilitated capacity-building are discussed in Chapter 6. Chapter 7 describes and discusses the challenges and hurdles that were faced

during the interdisciplinary research and attempts to identify the root causes and remedial measure for the challenges faced.

Running as a main theme throughout the results (2, 4, 5, 6 and 7) chapters I find three main issues which are selected for extended discussion:

1. Context and foundational conditions and interdisciplinarity: what role context and foundational conditions played in shaping the environment in which interdisciplinarity at ZEF in general and in its Uzbekistan project in particular was induced and nurtured;

2. Capacity-building and epistemology: how ZEF's chosen model of capacity building helped the staff of its Uzbekistan project to overcome their epistemic barriers and integrate various sources of knowledge?

3. Facilitation of interdisciplinarity: how the facilitation conditions, characteristics, and roles assisted in inducing and nurturing interdisciplinarity

These phenomena are discussed alongside other specific issues in chapters two, four, five, and six. In chapter seven I examine the challenges that frustrate or undermine interdisciplinarity, and in the concluding chapter eight, I discuss a series of practical, methodological and theoretical implications that arise from this research.

1.1 The Approach

In this thesis I attempt to understand interdisciplinarity in the manner in which it actually happens in research projects undertaken by agricultural research organizations, when it is induced and facilitated through capacity-building. From this understanding, I discuss how different team members understand, adapt, implement and undertake interdisciplinarity. At the theoretical level, I draw upon the literature on interdisciplinarity from the fields of agricultural sciences, health sciences, project based learning, and interdisciplinary

education and training programs in defining what interdisciplinarity implies and how it differs from disciplinary, multi and transdisciplinary research. I discuss in chapter three various forms of interdisciplinarity, and why this needs to be situated within the organizational and cultural contexts. This dominant theme of the organizational context of interdisciplinarity emerges as the key theme because it influences the project structure, the team compositions, and how interdisciplinarity is then understood and adapted by the teams of scientists.

I reflect in chapter eight on the contribution that this thesis makes to the body of theory on interdisciplinarity, and how it can be meaningfully nurtured and sustained in organizations charged with mandates to undertake interdisciplinary research.

The methodological approach attempted in this thesis contrasted sharply to other empirical studies of interdisciplinarity due to the longitudinal design of capacity building for implementation of interdisciplinarity in the chosen case study. In general, I adopted anthropological/sociological approaches of : a) living with the scientists charged with interdisciplinary responsibilities; b) having a dual 'hat' of the interdisciplinary process facilitator and researcher, being able to observe, record, study and evaluate field and analytical activities together with interdisciplinary research team members; c) keeping and analyzing my own well reflected daily field notes; d) self reported researcher profiles and perception surveys conducted to understand the demographic and epistemological variables of the participants; e) examining and analyzing process reports compiled by various interdisciplinary teams; f) examining and analyzing published and unpublished strategic documents of ZEF; and g) participant observations at ZEF's strategic meetings and symposia. Much of my field data is thus presented as case studies based on a triangulation between the specific methods of unstructured and semi structured interviews, direct observation, the use of archival and documentary data, and conducting sociological surveys.

These methods are discussed in depth in chapter three, which also elaborates ethical considerations which I took into account during the field research.

In the remainder of this chapter, I discuss the need and promise of interdisciplinarity, how interdisciplinarity in general is undertaken in agricultural research organizations and the practical and academic concerns arising out of the above with respect to the studied case of ZEF and its Uzbekistan project.

1.2 The Need and Promise of interdisciplinarity

The need for integrating disciplinary knowledge to understand and address interlinked biophysical, economic and social problems has been continuously asserted for the past several decades (Wohl, 1955; Klein, 1986; Klein, 1990; Miller *et al.*, 2008). Combining knowledge and approaches from different disciplines to solve specific scientific and practical problems has been increasingly becoming popular in various fields of knowledge due to its expected contribution to creativity, progress and innovation (Klein, 1990; Morillo *et al.*, 2003; Winowiecki *et al.*, 2011). Academicians increasingly believe that society's major problems, such as environmental problems that span beyond the scope and understanding of single disciplines (Klein, 1986; Klein, 1990), can be effectively understood and addressed through integration of approaches and boundary-crossing by various disciplines (Barry *et al.*, 2008). Various terms, such as inter-field, inter-professionalism, cross-professionalism, multidisciplinarity, interdiscisciplinarity, and transdisciplinarity, have been used in literature to describe the approaches that focus on integration of knowledge by disciplines.

Knowledge philosophers and sociologists have researched and brought out epistemological and ontological differences amongst various disciplines and the ways in which these create barriers to integration and boundary crossing by disciplines. A strand of scholarship[1], which studies the nature and degree of integration of knowledge and approaches amongst disciplines, has attempted to establish taxonomic classification of various modes of knowledge integration. Based on the degree and characteristics of integration and boundary crossing by disciplines, they tend to discern between multi, inter and transdisciplinarity of knowledge and research.

[1] Some of the contributions to this strand are those by Wohl (1955), Renn (1994), Tomov and Mutafov (1996), Klein (1990, 1999), Leroy (1997), Cash, et. al., (2002), Collins (2002), Porter, et. al. (2006), Barry, et al., (2008).

The findings tend to converge about the discerning factor between multi- and interdisciplinarity in knowledge and research that the former is only of additive nature. In multidisciplinary research the issue in question is researched from various disciplinary perspectives separately, and each of the disciplinary explanation stands of its own as a valid explanation (Porter *et al.*, 2006). In other words, each of the involved disciplines maintains its distinctiveness in multidisciplinarity (Collins, 2002), and may not necessarily include joint planning, management, and review by multiple disciplines (Kostoff, 2002). Interdisciplinarity, on the contrary, is of enriching nature as it requires exchange and mediation of knowledge and analytical approaches to arrive at a common understanding, theory, method, or explanation (Porter *et al.*, 2007). Interdisciplinary research (IDR) therefore requires joint planning, management, and review of the disciplinary research (Kostoff, 2002) and becomes a team effort (Fiore, 2008). IDR, when carried out as a team effort, requires each of the team members to play the particular role of bringing his/her disciplinary perspective in achieving interdisciplinary outcomes. While some scholars treat inter and transdisciplinary research as synonymous concepts (for example, Gray, 2008), others associate the former with integration of academic nature and the latter with integration between academic and more practice oriented knowledge sources (Mollinga, 2008).

1.3 Interdisciplinarity in Agricultural Research

Agricultural research is no exception to these interdisciplinary trends, as it represents an area of research that encompasses the domains of biophysical sciences, environmental sciences, engineering and technology, behavioral and economic sciences, and so on. While scientific and technological breakthroughs during the green revolution largely emerged due to disciplinary research in genetics, breeding, agronomy and chemistry, the negative social and environmental externalities associated with these breakthroughs dawned to environmental and social scientists immediately afterwards, and have been a cause of concern since then. These externalities call for more holistic, integrative and interdisciplinary research combining knowledge, theories, methods, and research approaches from relevant agricultural disciplines.

As agricultural systems are complex (Dalgaard *et al.*, 2003; Klein, 2004) in nature, these can be better understood through interdisciplinary research due to the link between the complexity and interdisciplinarity (Klein, 2004; Mollinga, 2009) Recent times have witnessed an increasing trend of multi and interdisciplinary research in agriculture on one hand, and emergence of new disciplines, for example agro-ecology and natural resource management, emanating from the hybridization and cross breeding of traditional agricultural disciplines, on the other. Morillio and colleagues note that *disciplines that emerge due to hybridization tend to be more interdisciplinary than the traditional disciplines* (Morillo *et al.*, 2003:1247).

1.4 Agricultural Research Organization at Universities

Agricultural research, especially the basic and fundamental research within university systems, like most other university systems, tends to be highly departmentalized and compartmentalized (Dressel and Reichard, 1970; Havranek and Brodwin, 1998; Becher and Trowler, 2001). Research is typically carried out under academic faculties, such as faculties of agriculture, animal husbandry, agricultural engineering, etc. Some of these faculties might be called as 'centre for research in ….', 'centre of excellence for…', etc. Each of these faculties is further subdivided into specialized departments focussing on a single discipline, such as agronomy, geology, soil sciences, rural sociology, and agricultural economics. Each of these departments designs its research priorities and implements research activities through its graduate students supervised by its academic staff. The departmentalized and compartmentalized system of organizing research induces what Janusz Goćkowski calls '*book keeper mentality*' of university administrators (Goćkowski, 2001:447). This way of research organization hinders the spontaneous development of interdisciplinary teams, as the team members find it difficult to fit into traditional administrative structures.

For researching complex issues, where resources available for a focussed masters or graduate research are inadequate or the problem is too complex, the research departments collaborate. Research proposals studying more complex research issues entail an overall

research concept framework, explaining how various graduate research sub-projects or 'research work packages' fit together to answer the bigger research question (Dressel and Reichard, 1970; Goćkowski, 2001; Collins, 2002). As the university graduates have to demonstrate a significant contribution to science in their specific area of inquiry, they tend to use discipline specific lenses for defining the research problem, specifying data collection methods, analytical approaches and explanatory theories so that the investigations are considered authentic and purposeful by the discipline specific peer review system (Levstik and Barton, 2001). Therefore, within each of the research work packages, the problem might be defined from the disciplinary lenses, an analytical approach might be specified using disciplinary methods and techniques, and various aspects of the problem might be rigorously investigated using discipline-specific data collection tools and methods, and analyzed using disciplinary theories.

1.5 Practical Concerns

Most of the research methods, especially in the biophysical domains of agriculture, are designed to answer research questions using hypothesis-testing, where the treatment and control results of a research trial are compared statistically. The scientific methods used by natural scientists, therefore, set a number of conditions that need to be controlled during the research process to clarify causal relationships and attribution of results, and therefore do not reflect the real-life situation, necessitating validating by the scientific findings of social science and economic disciplines, that study the real life situation. As agricultural problems in real life are not bounded by disciplines, the proponents of sustainable science, such as Brand and Karvonen (2007) advocate integrative approaches, so that the scientifically found solutions are able to address the real life problems as much as possible.

IDR requires combining knowledge, theories, methods and data from related disciplines, researching biophysical aspects together with the economic, and socio-political context in which the problem exists. IDR therefore needs to be carried out by experts, specialists,

and researchers[2] vested with knowledge and skills of all of these domains. Successful IDR would therefore, depending on the nature and scope of the investigation, either require having all the required knowledge and skills packed in a single interdisciplinary researcher (Mollinga, 2009), a rather oblique possibility, or through collaboration and team work by researchers from relevant disciplines (O'Riordan, 1995) to combine and share knowledge and come up with a holistic analysis, interpretation and solution (Brand and Karvonen, 2007). Collaboration and team work are also sometimes required in disciplinary research, but more so in case of IDR.

Research organizations, such as university departments, set up research teams comprising scholars, scientists and graduate students from relevant disciplines to work collaboratively to undertake IDR projects (Fiore, 2008). Undertaking IDR projects through teams of researchers belonging to various disciplines becomes a challenging task on several accounts. First challenge is posed by the epistemologies of the team members. This becomes particularly relevant for teams comprising bio-physical, economic, and social science disciplines while attempting to solve a scientific or real life problem through IDR, as the focus of research for the natural scientists are research objects which are governed by natural science laws, and for the economists and social scientists, behavioural and social science laws prevail (Conrad, 2002). When a scientist from a particular discipline engages with another scientist from another discipline, scientists typically find that, *their colleagues define the problem quite differently or seek different types of answers* (Lélé and Norgaard, 2005:967). While this may enthuse a few researchers, it might very well frustrate some. Even if enthused in the beginning, the enthusiasm amongst the research team members for IDR might dwindle as the IDR research project progresses and researchers find it difficult to communicate due to synaptic and epistemological differences (Lélé and Norgaard, 2005; Winowiecki *et al.*, 2011). They might face resistance from other disciplines towards acceptance and validity of terminology, concepts, methods and even data of their discipline, and may not be able to realize that all of the team members have similar difficulties.

[2] For the purpose of this study, I use the terms of scientist/researcher/scholar/practitioner/expert etcetera to denote an individual in possession of expert knowledge in one or more fields of specialization.

Secondly, the team members belong to various disciplinary tribes differing not only in theories and methodologies, but also in ages and experiences, nationalities, cultural styles and preferences (Huber, 1990). These ethnic and demographic factors might make the collaboration difficult. Even if team members find ways to overcome their epistemic, cultural, and demographic differences during IDR projects, the funding structure, the career structure, the publication and peer review structure, and other institutional elements of the IDR project itself (Mollinga, 2009), might pose additional challenges to IDR team members in achieving the desired level of interdisciplinarity.

An additional challenge is that of team composition and the interface between the team and the management. An IDR team of a research project comprises not only scientists and supervising researchers, but also project students, research assistants, and to some degree the research management staff. An IDR interaction is an interaction between all these members, each of whom might have their own understanding and interpretation of interdisciplinarity within the given context. The members of an IDR team possess varying levels of process skills about decision-making, problem solving, conflict resolution, information exchange, coordination and boundary management. Institutional incentives and disincentives might arise due to the organization specific designs of both working principles and compensation system. For example, the differentiated rewards by academic and non-academic staff, senior and junior staff, etc might impede or prevent successful interdisciplinarity (Gray, 2008). There might be tendencies of accommodating, adapting, transforming, neglecting and/or resistance towards interdisciplinarity over the duration of the research project.

Finally, the way interdisciplinarity is facilitated does influence the outcomes. The way in which the facilitating project management and leadership performs its cognitive (visioning and framing of interdisciplinary task for example), structural (for example brokering and mediating, ability to transform a situation, ability to enjoy differentiated roles), and procedural (ensuring that teams interact constructively and productively)

tasks, influences the degree of interdisciplinarity that an IDR team might achieve (Gray, 2008).

1.6 Academic Concerns

The mainstream contributions on the research about interdisciplinarity, or the science of team science as is labeled by the scholars from the field of preventive medicine (for example, Hall *et al.*, 2008; Falk-Krzesinski *et al.*, 2010), can broadly be categorized as conceptual and empirical. Within the conceptual literature on interdisciplinarity, particular strands can be identified as:

a) strand on epistemic culture of disciplines, indicating issues and challenges that IDR projects might face due to epistemological differences (Wohl, 1955; Klein, 1990; Renn, 1994; Robbins *et al.*, 2001; Schoenberger, 2001; MacMynowski, 2007; Aram, 2011)

b) strand on the need and scope for integration of disciplinary knowledge (Klein, 1986; Klein, 1990; Funtowics and Ravetz, 1993; Cai Yunlong and Smit, 1994; Yunlong and Barry, 1994; Klein, 1996; Kates *et al.*, 2001; Cash *et al.*, 2002; Collins, 2002; Dalgaard *et al.*, 2003; Brand and Karvonen, 2007; Barry *et al.*, 2008)

c) strand on characterizing interdisciplinarity and identifying taxonomic elements of interdisciplinarity (Klein, 1990; Klein, 1996; Klein, 1999; Klavans and Boyack, 2006)

d) strand discussing concepts and metrics in interdisciplinarity (Klein, 1990; Klein, 1996; Tomov and Mutafov, 1996; Klein, 1999; van den Besselaar and Heimeriks, 2001; Collins, 2002; Dalgaard *et al.*, 2003; Healy, 2003; Lattuca, 2003; Mihelcic *et al.*, 2003; Morillo *et al.*, 2003; LÉLÉ and Norgaard, 2005; Klavans and Boyack, 2006; Porter *et al.*, 2006; Reich and Reich, 2006; Porter *et al.*, 2007; Fiore, 2008; Hinkel, 2008; Miller *et al.*, 2008; Mollinga, 2008; Pohl and Hirsch, 2008; Mollinga, 2009; Huutoniemia *et al.*, 2010; Moran, 2010)

Much of research about interdisciplinarity till recent past, (for example, Cai Yunlong and Smit, 1994; Yunlong and Barry, 1994; Cash *et al.*, 2002; Dalgaard *et al.*, 2003; Brand and Karvonen, 2007) appears to be concerned about how various disciplinary epistemologies in terms of theories and methods might interact. Researchers have only recently started to attempt to analyze the human factors in interdisciplinary interactions, such as how to overcome practices that hinder scientists working in teams, the tradeoff s between meritocracy and other criteria of team success, the challenges and opportunities for scholarly publication in interdisciplinary team science (Falk-Krzesinski *et al.*, 2010), or systematic techniques of training needs analyses for IDR teams (Fiore, 2008).

As I show in chapter 3, the discussion on interdisciplinarity is so far rather academic as empirical research addressing the role of human factors in the science of IDR, is only slowly emerging. The empirical research on interdisciplinarity conducted so far has focused on showing how various institutions and their faculty staff have adapted the concepts (for example, Conrad, 2002; Porter *et al.*, 2006), which types of disciplines have undertaken interdisciplinarity, and how can it be measured (Tomov and Mutafov, 1996; Newell, 2001; Lattuca, 2003; Morillo *et al.*, 2003; Lélé and Norgaard, 2005; Klavans and Boyack, 2006; Porter *et al.*, 2006; Reich and Reich, 2006; Porter *et al.*, 2007; Hinkel, 2008; Pohl and Hirsch, 2008; Rafols and Meyer, 2008; Huutoniemia *et al.*, 2010). Only a few case studies have analyzed the actual interdisciplinary experience considering human behavior. One such experience is reported as a reflective account by participants (Winowiecki *et al.*, 2011) of an interdisciplinary research. They offer their retrospective reflections on the interdisciplinary process through which the team members passed and distill lessons for promoting and facilitating communication within the IDR teams.

Capacity building has been advocated to initiate and facilitate IDR (Porter *et al.*, 2007; Hall *et al.*, 2008) to overcome the known barriers. Capacity-building for interdisciplinarity offers potential benefits to assist the participants *in attaining interdisciplinary exposure* (Lélé and Norgaard, 2005:975), *raising awareness of epistemological barriers that will need to be overcome, and enhancing the readiness for interdisciplinarity* (Hall, et al., 2008:S246) of participants. Capacity-building might

facilitate induction and nurture of interdisciplinarity within a research organization in several ways: a) by assisting in creating awareness of and overcoming some of the epistemic barriers; b) by providing the participants with tools that facilitate cross-disciplinary interaction and dialogue, and c) by offering team building opportunities to the participants, which might assist in reducing the personality distances.

A carefully designed capacity-building program would also have a potential to nurture, enrich and sustain IDR over the duration of the research project and beyond due to providing opportunities for self and group reflection. While capacity-building might assist in inducing interdisciplinarity at earlier stages of an IDR project, how much of capacity development is adequate to sustain the culture of IDR within an organization, remains a serious question.

Research certainly is the core-business or core-activity of the researcher, but not the only motivation for life. IDR team member's motivations for their field of specialization as well as interdisciplinarity might have conflicts with their general life motivations, for example, being with the family, aspirations to work in a particular region, etc. The interactions between intellectual motivations and general life motivations might pose additional challenges to the IDR team members. To get a good understanding of interdisciplinarity, one needs to understand the dynamics and inter-relations with the disciplinary and non-disciplinary motivations of the IDR team members.

Though literature argues for nurturing and facilitating interdisciplinarity through capacity-building (Hall *et al.*, 2008; Pohl and Hirsch, 2008), pragmatic capacity-building models for IDR are only slowly emerging. The existing IDR capacity-building models that have been analyzed include:

a) the formal education models run by graduate schools (for example by (Morse *et al.*, 2007; Moslemi *et al.*, 2009; Karen *et al.*, 2010; Aram, 2011); b) event-based models that analyze single interdisciplinary training event (Winowiecki *et al.*, 2011); and
c) interdisciplinary conference models (Hall *et al.*, 2008).

Most of these capacity-building models are of a single focused event spanning over a single day to few months, but in a concentrated timeframe of a graduate course, an interdisciplinary conference, or a seminar. The nature of these models is such that the participants mainly focus on and engage in IDR related capacity building for a few days or months (Morse *et al.*, 2007; Moslemi *et al.*, 2009; Falk-Krzesinski *et al.*, 2010; Winowiecki *et al.*, 2011). Such models require the participants to undergo *graduation* (Morse *et al.*, 2007:1) or *traineeship* (Morse *et al.*, 2007:1; Winowiecki *et al.*, 2011:74), or *conference participation* (Hall *et al.*, 2008:S96) during which the participants have to put their rest of the research tasks on hold for the duration of the capacity-building and focus only on learning the skills taught to them (Morse *et al.*, 2007). The content design of many of such initiatives is that a host of *knowledge and skills (Winowiecki et al., 2011:74),* and *insights* and *frameworks* (Falk-Krzesinski *et al.*, 2010:263), are presented to the participants and the participants are then left to decide whether or not to deploy those in their actual IDR practice. Besides, such training programs are of top-down nature, *offering little or no feedback or monitoring mechanism of participant's actual practice* (Hall *et al.*, 2008:S246; Winowiecki *et al.*, 2011:74). The analysis of such initiatives does not necessarily lead to an understanding of how capacity-building might affect variably the IDR team members comprising researchers, research assistants, and project managers, with varying levels of epistemic maturity working in an IDR project.

Empirical research that discusses the role of a series of structured capacity-building events over the entire duration of an IDR project, which is also accompanied by hands on practice through action research, in initiating and nurturing interdisciplinarity is yet not available. The ways in which the capacity-building, in combination with epistemic boundaries of disciplines, donor conditionality of the project funding, project leadership and contextual factors affect the interdisciplinarity within the IDR teams are yet to be known.

This research discusses the role of structured and facilitated capacity-building in nurturing interdisciplinarity in an agricultural research organization. Analyzing a case

study of an interdisciplinary research project of the Center for Development Research of Bonn University, this research discusses how capacity building affects epistemic and ontological boundaries of researchers, and how context and foundational conditions provided to researchers of the project play out as potential barriers. It discusses ways in which some of these barriers could be overcome.

This study, attempts to provide 'grounded' evidence for a more realistic assessment of a targeted project that intended to induce interdisciplinarity through capacity building. This research aims to understand the way in which involved scientists and their assistants, as well as project managers, accommodate, adopt, transform, neglect and/or resist interdisciplinarity.

The thesis is structured as follows: chapter 2 sets the scene of this study and presents the context in which the project was implemented, as well as describes the Center for Development Research, and Uzbekistan project, through which the interdisciplinary work was carried out, and summarizes the interdisciplinary research package as it was conceived. Chapter 3 clarifies conceptual and methodological issues and distills key questions for the enquiry. In Chapter 4, the design elements of the capacity-building, as well as its implementation are discussed and assessed. Chapter 5 describes how interdisciplinary action took place, how capacity-building contributed to promote interdisciplinary thinking and action, and what was achieved in terms of interdisciplinary. Chapter 6 discusses the characteristics and role of facilitation in capacity building and interdisciplinary actions. Chapter 7 analyses the challenges and barriers to interdisciplinary action and chapter 8 finally concludes the discussion

Chapter 2: The Center for Development Research and its Interdisciplinary Uzbekistan Project

2.1 Introduction

As the context of any process influences the outcomes, this chapter informs the reader about the context in which Zentrum für Entwicklungsforschung (ZEF) carried out its interdisciplinary research about innovations. Section 2.2 introduces ZEF as a development research center, its organization, its key strengths and weaknesses that are inherent in its organizational set up. The section also briefly draws out key ways in which ZEF differs from other European development centers. Section 2.3 outlines how ZEF designed its Uzbekistan project, and how the project research and organization evolved over the three project phases, and what it implied for interdisciplinary research. Thereafter, section 2.4 entails a brief description of the Uzbekistan project's interdisciplinary work package, "Follow-the-Innovation". The design process and the key elements of the work package are discussed. The final section 2.5 concludes the chapter.

The key findings are that ZEF as a development research center has a strong focus on research than on development policy or education compared to other similar development research centers in Europe. It also accords a higher priority to interdisciplinarity and transdisciplinarity compared to other similar institutes, who contend with multidisciplinarity. It is not fully autonomous and obtains almost all of its research funding through responding to calls for research proposals. Therefore, the policies of donors and the Bonn University influence what it can undertake as research and its research implementation methodologies. The Uzbekistan projects was led, in terms of conception and management, by one of the three research departments. This departmentalized organization of ZEF led to epistemological and power dominance by the proponent research department during design and implementation of the project. The Uzbekistan project evolved from a disciplinary research project heavily biased towards bio-physical research, towards a relatively multi-disciplinary and ultimately into a somewhat interdisciplinary research project. The Follow-the-Innovation approach was an

innovation in the way ZEF attempted to introduce interdisciplinary research, but the power and epistemological contestations within the ZEF departments during the design of the project phase, as well as this work package displayed several characteristics of a social negotiation process aimed at re-balancing the skewed power distribution amongst its departments.

2.2 ZEF as a development research center

The Center for Development Research was founded in 1995 and is one of several specialized research centers affiliated to the University of Bonn. ZEF is directly subordinated to the University's senate. ZEF characterizes itself as "*an academic institute dedicated to research, teaching, and policy advice on international development*" (ZEF, 2007: 4). The aim of research at ZEF, as stated on its website (http://www.zef.de/aboutzef.html), is to find solutions to development-related issues. ZEF has identified three priority research areas: a) political and cultural change; b) economic and technological change; and c) ecology and natural resource management. A specialized department, headed by a director, is responsible for researching each of the above-mentioned priority research areas[3]. The three departmental heads form the ZEF Board of Directors, and one of them serves as the coordinating director by rotation. The Director of the United Nations University- Institute for Environment and Human Security (UNU-EHS) located also in Bonn, Germany, is an ex-officio member of the directorate.

Each of the three departments has defined its priority research areas and themes, which they pursue through their respective research activities funded by research donors as well as through the master and doctoral scholarships awarded to students by the German Academic Exchange Service (German Acronym DAAD). The actual research is largely carried out through Ph.D. students (Wall, 2006), who are either affiliated to externally funded research projects, or through scholarships granting agencies, or through their respective governments. The departmental directors coordinate activities and supervise

[3] Corresponding to the priority research areas, ZEF labels its department of cultural and political change (or social science) as ZEFa, for economic and technological change as ZEFb, and for natural resource management and ecology as ZEFc.

staff within their departments. They are also responsible for collaborations outside of ZEF, as well as finding funding opportunities for their chosen research.

The three departments cooperate with each other and with the Bonn University's respective faculties in several ways. The ZEF's formal departmental cooperation with Bonn University includes appointment of professors at ZEF as members of the respective faculties at the University of Bonn, who are entitled to promote Ph.D. students under the auspices of their respective university faculties. ZEF's Ph.D. students can only be promoted at Bonn University faculties. The formal cooperation amongst the three departments is largely limited to delivering interdisciplinary course for the Ph.D. graduates enrolled at ZEF's Bonn interdisciplinary Graduate School for Development Research (BiGS-DR) and preparation and submission of joint project proposals and implementation of the funded projects. The tendency for large funding proposals is to identify a "parent" department of the project that leads the proposal writing and if funded, the management of the project. The other two departments are requested to contribute to the write up of work packages and the management of those in case the project is funded. Smaller research grants are generally prepared and submitted by individual departmental staff pursuing their departmental research interests (ZEF, 2010).

An external, international advisory board is tasked with monitoring and evaluating ZEF research activities as well as advising and supporting the Center in its current work and future strategy formulation. Members of the Board represent the German state and federal ministries, private companies, as well as the international science and non-governmental organization (NGO) community[4].

Typically, the departmental research programs build on the methods and analytical styles of their own disciplinary research areas, and then link and integrate knowledge and capacities from these different research departments through trans-disciplinarity, which ZEF interprets as *communicating research approaches and results among scientists, politicians, and practitioners in order to achieve its goals in development research* (ZEF,

[4] The detailed composition and mandate of the board can be found at ZEF's website on the following link: http://www.zef.de/advisoryboard.html (accessed 19 June 2011)

2007: 7). Results of ZEF's research are published in its own book series, in the ZEF Discussion Papers on Development Policy, as well as in academic journals and books.

ZEF also runs the Bonn interdisciplinary Graduate School for Development Research, through which ZEF contributes to strengthening the international development research community in Germany, Europe and the developing world[5].

Universities in Germany have adopted a common framework for recruitment, promotion and compensation packages for their staff, which are adjusted for various regions based on cost of living indices. Due to its affiliation with Bonn University, ZEF is not independent in choosing or adjusting its human resource (HR) policies, procedures, or salary levels, and is required to follow the HR policies as practiced by Bonn University. Though ZEF, due to its nature of being a development research institute, needs to employ non-German staff, it can only offer employment on same terms as available to German nationals.

Permanent positions available at ZEF are limited. Amongst the academic and research staff, the three departmental directors, the coordinator of BiGS-DR, and a limited number of senior research staff hold permanent positions. A few support staff members, such as financial controller, head of information technology, public relations officer, librarian, and the secretaries to directors hold permanent positions. Rest of the research and support staff are recruited and discharged based on availability of project funds, which formed almost 80% of ZEF's financial operations in 2010 (ZEF, 2010).

ZEF's financial resources can be placed under three categories:

a) Core funds from the University of Bonn (about 19.3% of the funds in 2010) that ZEF can use at its discretion. Most of these funds in reality are, however, already earmarked for meeting its permanent staff costs and maintaining its infrastructure and facilities in

[5] As of August 2009, 206 Ph.D. students received their doctoral degrees during the first decade of BIGS-DR, and an additional 126 were enrolled for completing their Ph.D. studies. The main donors of BiGS-DR include the German Federal Ministry of Science and Education and German Academic Exchange Service. Besides, several private foundations, such as Volkswagen Foundation, and the Robert Bosch Foundation, and national governments of students provide scholarships to students (ZEF, 2009:7).

Bonn. Only a small proportion of funds (about 2% of core funds in 2010) are available flexibly at the discretion of its directorate.

b) Scholarships directly funded by donors for graduate students (about 9% in 2010). These funds are only administered by ZEF for the students on behalf of the donors.

c) Third party research project funds (about 71.7% of the total funds in 2010): These are research funds that are earmarked for meeting ZEF's research activities that it commits to undertake through its research projects. ZEF departments respond to requests for proposals (RFPs) from German and other donors in collaboration with each other as well as in collaboration with other German and non-German universities and research centers. A large part of these funds comes from German sources, which formed 94% of the total third party research project funds of ZEF in 2010.

A brief comparison of ZEF with other development research institutes in European countries, like those of Institute of Development Studies (IDS) of University of Sussex in United Kingdom and the International Institute of Social Studies (ISS) in The Hague, the Netherlands reveals several differences and similarities.

ISS is the oldest development institute that was originally established in 1952 as a legacy of the post-colonial era to train civil servants from the formerly colonized developing countries, which gradually attained the status of a degree awarding graduate teaching institute of policy-oriented critical social science. ISS claims[6] on its website to be a highly diverse international community of scholars and students from the global south and the north, that brings together people, ideas and insights in a multi-disciplinary setting and nurtures, fosters and promotes critical thinking and conducts innovative research into fundamental social problems. ISS also claims to provide high-level policy advice, and serving as a platform for debate and the exchange of ideas and engaging in consultancy. However, ISS is much more oriented towards teaching than as a generator of critical thinking on public policy on development, as it maintains strong partnerships with teaching organizations and individuals in former colonies in East Asia and Africa

[6] http://www.iss.nl/ accessed 11 April 2012

(Surinam, Indonesia, Vietnam, Tanzania) through joint MS programs, and believes that this approach leads to co-creation of knowledge and an integrated approach to research and teaching that can flourish and remain societally relevant[7]. Besides, all of ISS research and teaching staff have teaching titles, such as professors, rather than research titles, such as principal researchers. In addition, the core business of its academic staff is teaching, who can also participate in commissioned research projects as co-investigators. The management of externally commissioned research projects is not carried out by academic staff, rather is vested with a separate office of research that is also charged with policy preparation.

ISS funds its teaching activities largely through its core funds (about 40% of its budget in 2010), that are provided by the Royal Government of Netherlands through the University of Rotterdam, and it raises another 30% through tuition fees. Externally funded research projects formed only 20% of its budget in 2010.

ISS appears to be a top heavy organization. For example in 2010, more than 40% of its academic staff was titled as professors or associate professors, whereas junior researchers or Ph.D. students formed less than 10% of its staff.

IDS was founded a decade later than ISS in 1966 as an independent research institute based at the University of Sussex. Though IDS has close links with the University, it is, unlike ZEF or ISS, financially and constitutionally independent. It exists as a Charitable Company limited by guarantee, and registered in England. Unlike ZEF or ISS, IDS receives no core funding from the Royal British government. Funds are secured from a range of organizations and represent a combination of research grants and fees from advisory work, teaching, and publication sales. However, the UK Department for International Development (DFID) is the Institute's largest funding organization (about 47% of IDS funds in 2009 were provided by DFID) and it also is the main user of IDS development policy research. Several of the DFID development assistance policies have been strongly influenced by IDS work, despite DFID running its own Overseas

[7] For details see http://www.iss.nl/research/iss_research_partners/joint_teaching_programmes/ Accessed 12 April 2012.

Development Institute (ODI). IDS also receives funds from, and inspires the development assistance by, the European Union, various United Nation agencies, and a wide range of aid agencies, trusts and foundations. Many of these funds are won competitively[8].

Like ISS, IDS runs both MS and Ph.D. study programs. Many of IDS graduates pursue a development oriented career. IDS is also known for its development policy oriented research and as a generator of development assistance concepts and frameworks.

Germany had no colonial legacy like the United Kingdom or the Netherlands, and therefore ZEF did not emerge as a post-colonial tradition of development studies. However, ZEF was established as a part of Germany's ambition to have influence in the developing world as well as within the European think tanks[9] about development (ZEF, 2007). The decision to set up ZEF in Bonn was closely connected to the German Federal Government's effort to reinvent Bonn as an internationally renowned center, after moving the capital from Bonn to Berlin, for development research and policy (ZEF, 2007: 4). The decision was also closely linked to locating a United Nations University Campus in Bonn.

ZEF is much younger institute compared to IDS or ISS. ZEF does not carry out its own M.S. programs, but participates in limited number of master study programs run by the University of Bonn or other universities within Germany. ZEF's Ph.D. teaching and research program at BiGS-DR is not a degree awarding program in itself, and is rather subordinated to the University of Bonn. BiGS-DR forms a small portion of ZEF's overall research enterprise. ZEF is much more research oriented than teaching oriented as a large part of its budget is financed through externally funded projects, and therefore, achievement of its strategic goals remains prone to shocks and vulnerabilities posed by

[8] The interested reader is referred to IDS website http://www.ids.ac.uk/. Accessed 11 April 2012

[9] ZEF has been listed since 2009 for three consecutive years in the "Global Go To Think Tanks" report 2011 as number 10th of the global Top Thirty Science and Technology Think Tanks and 15th of the global Best University Affiliated Think Tanks. Think tanks from 182 countries were invited to participate in the selection process and in the end 202 of 6,545 participating think tanks were nominated as the world's top think tanks. The selection was based on the screening process carried out by journalists, public and private donors, policymakers as well as expert panelists, and academic institutions.

the changes and risks in the funding environment. Though ZEF conducts research that is relevant to development policy, the decision to mainstream ZEF's research results into development policy is not strategically targeted. Unlike ISS or IDS, the German development assistance organization responsible for external development cooperation, Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ, formerly GTZ) runs its own development institute – German Development Institute (GDI) for training and advice on development assistance. GDI is a comparable to ODI of DFID, which was originally established in 1964 with the purpose of providing post graduate training to professionals in development cooperation[10]. Research and consultancy about development were initially considered important but secondary activities for GDI. The provision of policy advice to GIZ was vested with GDI in 1999[11]. ZEF, on the other hand, was established as a research institute on development, and affiliated to a University rather than to German Ministry for Development Cooperation.

ZEF being a development research institute, and GDI being responsible for policy advice to German government and European Union about development related issues, the mandates of GDI and ZEF are closely linked. Despite several attempts from both sides, however, serious collaboration between GDI and ZEF could never be achieved. A clear separation between development research and development policy advice remains vivid with the German system addressing development, at least between GDI and ZEF, looking at the mandates and practical cooperation between GDI and ZEF. This separation largely emanates from the higher level governance structures (Interview, January 2012) and is displayed through the ways in which both institutes conduct their research. ZEF strives to undertake research using methodologies that are acceptable to academician, whereas GDI conducts research based on applied research methodologies. GIZ and GDI belong to the ministry of international development cooperation, and they are entitled to implement and advise development assistance structures in Germany. GIZ itself is the development

[10] http://www.die-gdi.de/CMS-Homepage/openwebcms3_e.nsf/%28ynDK_contentByKey%29/ADMR-7ERTP5?Open&nav=active%3AInstitute\History%3Bexpand%3AInstitute\History .
Accessed 5 May 2012

[11] More recently, GDI has become a key player inspiring European development assistance. For example, GDI, together with ODI, introduced the concept of "Water-Food-Energy Nexus", which is the main theme of European Development Report for 2012.

assistance implementation arm of the German Federal Government, and the federal ministry for international cooperation is more responsive to the ideas, concepts, and methodologies articulated by GIZ and GDI rather than those offered by ZEF.

On the other hand, universities in Germany and their institutes like ZEF belong to the ministry of science and education. In the particular case of this project, ZEF faced considerable pressure from the University of Bonn to avoid practical implementation (Wall, 2006: 216). The science and education related institutes are mandated to undertake research, and innovation in research, but not supposed to undertake any development related implementation[12]. The only space for implementation for the science and education related institutes would be to undertake the so called "action research" and report it as a research[13]. This task specialization philosophy became clearer within the context of Uzbekistan project. The project's field coordinator had tried several times to establish closer operational links with GIZ's field office in Tashkent. Several meetings were held with higher level management of GIZ in Tashkent, but to no avail despite promises of closer collaboration[14]. The nature of collaborations that actually happened was not beyond the participation of ZEF and GIZ staff in workshops and seminars of each other[15].

Unlike ISS and IDS, who appear to be contented with addressing development research in a multi-disciplinary fashion, ZEF recognizes the need for inter and transdisciplinary as an important way of undertaking any meaningful development related research:

> *…development research … inevitably needs to cross intra- and interscientific boundaries. One way …..… is to adopt a trans-disciplinary approach. Trans-disciplinarity in development research takes a perspective that goes beyond specific disciplines and bridges the gaps between science, politics and practice in*

[12] According to Wall (2006), the project proponents faced severe pressure from the University of Bonn not to become too practical.
[13] Discussion with the project field coordinator in May 2008 at Urgench, Uzbekistan.
[14] Personal communication with project field coordinator in February 2010 and April 2010.
[15] The potential for further collaboration was severed due to GIZ's decision to offer a position to Uzbekistan project staff without taking ZEF into confidence.

order to make research more relevant to building a better world… (ZEF, 2007: 6).

Trans-disciplinarity encompasses the interdisciplinary approach pursued by ZEF over the last ten years [1997-2007], *but also puts emphasis on policy lessons learned and stakeholder dialogue.* ZEF believes that [s]*cience without bridging between its disciplines results in an ever increasing amount of information and an under-proportional success in understanding the meaning and relevance of the knowledge produced.* It distinguishes between multi-, inter- and transdisciplinary research as: …. *multidisciplinary and interdisciplinary research … remains within the framework of disciplinary research, trans-disciplinarity aims at the more holistic understanding of the state of the present world* and *Trans-disciplinarity concerns several levels of reality at once. It is…. the innovative organization of science in a manner that disciplinary research is clarified by trans-disciplinary knowledge to contribute to sustainable development* (ZEF, 2007: 7).

The trans-disciplinary approach ZEF considers for its research aims at bridging various divides, such as: a) bridging between scientific disciplines through multi and interdisciplinary research; b) bridging between research and policy; and c) bridging between research and practice (ZEF, 2007: 7). As the main vehicles of ZEF's research are its externally funded research projects, interdisciplinarity at ZEF is achieved through the design and implementation of such projects by its three departments. At the same time, the three departments have different understanding of what the fundamental concept of development implies (Wall, 2006: 216).

In sum, ZEF as a development research institute addresses economic, ecological and socio-political dimensions of development through its three disciplinary research departments. Most of this research is undertaken by the Ph.D. students affiliated to one the three departments, which ZEF trains through its graduate program. It is autonomous in setting the research agenda, but not independent in setting its financial or human

resource management rules. As ZEF counts almost entirely on externally funded projects for its operational funds to finance its research, it remains prone to vulnerabilities. Though policy advice is part of ZEF's mandate, it experiences competition and to some degree, alienation, from the potential collaborating institutions that could use its research findings for shaping the development policies of European countries. It differs from other development institutes in Europe in that it focuses much more on research than on advising policy, but at the same time, it believes much more on carrying out inter- and transdisciplinary research than its counterparts. Interdisciplinarity being the key concern of this dissertation, I henceforth largely focus on one of ZEF's research projects.

2.2 The Uzbekistan Project

According to the project leader[16], the German Ministry of Science and Education (German Acronym: BMBF) approached ZEF's department for natural resource management, which is labeled internally as ZEFc, to design a pilot project to address land and water issues that could avert or mitigate the Aral-Sea crises in Central Asia. The ZEFc director, together with United Nations Educational Scientific and Cultural Organization (UNESCO) scientists made several reconnaissance visits to the area and met researchers and educationists in Uzbekistan. The findings of these visits were formulated into a research and capacity building project proposal for land and water restructuring in Uzbekistan's Khorezm province. The draft project proposal was shared with relevant stakeholders in a workshop in September 2000 in Tashkent. The overall goal of the project was identified as *improving the economic effectiveness and ecological sustainability of water- and land-use practices* (Vlek *et al.*, 2001: 4). The project was designed as a three phase (inventory, analysis, transfer) medium term project.

> *During several reconnaissance trips made by ZEF and UNESCO scientists and during a workshop held at ZEF in September 2000, it became clear that in spite of extensive data collections undertaken by Uzbek scientific institutes, the existing*

16 Source: Speech of the project Leader at ZEF-UNESCO Symposium on "Development Agenda for improving Land and Water Management in Uzbekistan" Tashkent, March 11, 2010

> *databases do not suffice to embark on a pilot project for land restructuring. Data for the region is still widely scattered, unreliable and contradictory, or not easily and publicly available. Therefore, the aim of the present project phase* [inventory phase] *will be to establish, an inventory, a sound basis for the design of the land restructuring concept* (Vlek *et al.*, 2001: 4).

A stakeholder approach was to be used for refining the project design after the first inventory phase with farmers and government officials participating in the development of the pilot project activities (Vlek *et al.*, 2001). However, in reality, only counterpart education and research institutes participated during the first and subsequent workshops aiming at detailing out various project phases (Field Note May 2008).

Corresponding to ZEF's departmental structure, the project research was organized, during the first and subsequent phases, in three research clusters of natural science, economics, and social sciences (Table 1), under the supervision of the relevant ZEF department. This research organization clearly points to the multi-disciplinary organization of interdisciplinary research, more during the earlier stages of the project.

Table 2.1 Research Clusters of ZEF's Uzbekistan project during phase 1

Ecological Landscape Restructuring	Module A: Land Use Systems
	Module B: Natural Resource Management
	Module C: Environmental Stress and Mitigation
	Module D: Resource inventory, GIS & Remote Sensing
Economic Analysis	Module E: Market and Farm Level Analyses
	Module F: Resource Management and Water Pricing
	Module G: Health Economics
Legal Administrative Studies	Module H: Land Tenancy and Land Use
	Module I: Water Administration, Distribution and Use
	Module K: Sales and Profits of Agricultural Products

Source: (author's summary based on Vlek *et al.*, 2001: 7)

The actual undertaking of the research was envisaged to be through education of young local and German M. Sc. and Ph.D. students. To that end, a close cooperation between ZEF's Ph.D. program, the Urgench State University (UrSU), Tashkent Institute of Irrigation And Melioration Expeditions (TIIAME)[17] and other research institutes in Tashkent was to be established over the duration of the project. While it was decided that UNESCO would be a major partner in this project, supporting the capacity building activities and the technical and administrative aspects of the project, the implementation of the project research at the earlier stages needed considerable work of MSc and Ph.D. students. Students were to be selected from Germany and Uzbekistan, in Uzbekistan particularly from the universities of Urgench, Nukus, and Tashkent. The Uzbek students could opt for a Ph.D. program at ZEF if they spoke English, or in a suitable university in Uzbekistan. Generally, one to two master students cooperated with a Ph.D. applicant. A scientist from Uzbekistan and another from ZEF or its partner institutions in the Western Europe supervised the Ph.D. students.

Through these designs, the project hoped to be able to establish a dynamic and flexible education program. However, due to lack of expertise in economic and other social sciences at the counterpart institutions in Uzbekistan, such arrangements were only possible for students who focused on bio-physical domains of research. For the department on economic and technological change, finding a counterpart was quite difficult, and for socio-political department almost impossible, as no social science counterpart institute existed in Uzbekistan. Since the project proposal was largely designed by natural resource department, it became retrospectively clear that the designed arrangements were largely only suitable for the research domains of the designing department, and almost un-workable for the other two departments.

[17] The Universities in Urgench and Nukus are aimed at providing general education and therefore lacked expertise in natural resource management. The Tashkent Agricultural University and TIIAME were the only degree awarding institutions that focuses on natural resource management, but from a technological point of view. The disciplines of agricultural economics, sociology or rural sociology did not exist at these institutions. Therefore, during the course of the project implementation, it was hard to find counterparts for researchers on economics and socio-political issues.

In addition, the project established a field coordination office that also served as the field scientific study center at UrSU that provided the intellectual framework as well as the structural facilities for students from Uzbekistan, Germany, and other countries, to carry out their studies locally in the province of Khorezm with relative ease and comfort. Laboratory and office facilities and a project guest house were set up in Urgench, providing work space and housing for students, their supervisors, and guest researchers. For social scientists, however, field laboratories are the actual villages and their residents, as their objects of research are human beings and their behaviors. The existence of a field laboratory did not, therefore, provide much of assistance in undertaking student research for ZEFa and ZEFb, apart from housing and office facilities.

The strong emphasis on teaching and training was aimed at helping achieve key intentions of creating a critical mass of scholarship on relevant issues, and to gather relevant information and knowledge on various aspects of the research problem. Besides, a series of activities were planned that would build the linkages needed to give young researchers in Uzbekistan access to the modern scientific community. Among these were: a program for Ph.D. and MSc students, special training courses, short-term stays of guest scientists at ZEF in Germany, and workshops.

Apart from the Ph.D. students, ZEF recruited supervisory research staff for carrying out the project activities. During the first project phase (2001-2004), the staff included: a) project coordinator in Germany, a project field coordinator based at project's field office in Urgench, and a locally recruited Geographic Information System (GIS) coordinator in Urgench.

During the first two project phases (2001-2007), a number of master and Ph.D. studies were concluded through BiGS-DR, various faculties and departments of the Bonn University and other European universities, as well as at Uzbek universities by the project graduates. Most of the social and economic science studies were, however, completed at Bonn University due to unavailability of supervisory capacities in Uzbekistan.

The project management during the first two phases was largely undertaken through a panel of three senior scientists, all based at the project's proponent ZEF department- the overall project coordinator, the project science coordinator and the project field coordinator. Thus, during the first two phases, the power and authority to make management related decisions largely remained concentrated in the project's proponent department. However, as the project grew in complexity towards the beginning of the third phase, and the stake of the other two departments increased, the need for more systematic and transparent project management systems also grew. There were discussions and debates within the proposal writing team about the need to make the project management more participatory, transparent, and equitable (Field Note August 2012). The senior researcher from ZEFa during the proposal formulation stage of phase III (2007-2011) proposed that instead of the three coordinators alone taking all the management decisions, the key management and scientific issues should rather be discussed at a periodic forum, where all the three departments were represented. After discussions, fortnightly scientific coordination and management team (SCMT) meetings comprising the senior staff were to be regularly held at Urgench and Bonn and the discussions and decisions were to be documented and shared. During each meeting, the minutes and the progress of the previous meetings were reconsidered and new issues brought on-board.

The objective of SCMT was to make budgetary decisions transparent and also to ensure more autonomy for departments to decide on their own part of the budget. However, retrospectively, it became clear that the attempts to achieve budgetary autonomy by departments did not succeed during implementation of the third phase. What also failed was to make explicit rules for the functioning of the SCMT, though the composition was agreed formally, but the proposal to make explicit rules for decision making and conducting meetings was resisted as exhibiting 'lack of trust' (Field Note August 2012). Informality tended to work in the favor of the powerful. The writing experience of phase

III appears to be a power struggle as it sought to rebalance the skewed balance of power between ZEFc and the other two departments[18].

As the project transitioned through its research phases I (2002-2004) and II (2004-2007) into the final and third phase (2007-2011), the research coordination and implementation became complex and the project's management design, as a result of pressure from the other two departments, evolved as follows:

1. The overall project leader – a senior professor and the Director of ZEFc based at Bonn,
2. Project's Science Coordinator – a senior researcher at ZEFc based at Bonn and also acted as departmental coordinator of ZEFc
3. Project's Field Coordinator – a senior researcher at ZEFc based at Urgench
4. Coordinator of economic research- a senior researcher at ZEFb based at Bonn
5. Coordinator of socio-political research – a senior researcher at ZEFa based at Bonn
6. Senior researchers and post-doctoral scientists as work package coordinators at ZEFa, b and c. The ZEFa work package coordinators were based at Urgench for more than 60% of their time and the balance time at Bonn. This was a strategic difference with earlier phases, as far as ZEFa senior researchers were concerned. The strategic aim was to be able to have a departmental say in project's field level management decisions through fortnightly coordination meetings[19].

Apart from the project leader and two coordinators, other staff did not have financial authority, however. Therefore, the power-balance in terms of exercising financial autonomy, remained unchanged and within project's proponent department. While each of the work packages was budgeted during the phase preparation, these budgets proved to be only indicative, as these could only to be utilized after the approval from the project's coordinators upon the recommendations and agreement of the departmental coordinators if different from the main coordinators. Besides, as ZEF operates under the overall financial authority of the University of Bonn, several financial formats, rules, and procedures had to be followed before an actual spending could be undertaken. Most of the procedural formats were only available in German language, though several work package coordinators were non-Germans.

[18] Authors reflection based on the examination of internal documents during the preparation of Phase III proposal, and personal communications with members of the proposal writing team.
[19] Author's reflection based on examination of internal documentation and informal discussions with members of the Phase III proposal writing team.

Besides the restrictions from the University of Bonn, there were additional procedural restrictions by the funding ministry that sometimes acted as constraints. For example, there were at least three work packages, two from social science and one from biophysical science, which needed special permission from the donors to de-block the funds before funds could be utilized. This time-consuming process delayed all three activities. Likewise, the allocated funds for the entire phase were only made available on a year-to-year basis, and often with some degree of delays, that created further uncertainties. Another example is that the project document of each phase had to indicate in advance the names and venues of conferences which the project staff would need to attend over the entire duration of the project phase. There was a cumbersome procedure that needed to be followed for changing the participant, location, or the name of the conference. Likewise, funds could not be easily transferred from one budget item to another without the prior approval of the donors. In several instances, such restrictions delayed the staffing and recruitment decisions, purchase of equipment, and inputs for various research activities.

The formulation phase of the third phase also had an extensive effort to organize the project not along departmental lines, rather in clusters of 'levels' in which each department participated in research at each of the three levels[20], an intentional attempt to overcome the departmentalization of research within the project. The attempt to reorganize research along levels met with resistance at the submission stages from the proponent department, however. The team members felt that their work was brushed aside by the authority having power (Field note July 2012). The argument against a project organized along the lines of "levels" would not be funded was forwarded by the proponent department. The assessment of the Phase III proposal, however, appeared to favor a design that was more integrative and interdisciplinary than once more organized along disciplinary lines (Field Note July 2012).

[20] The author has seen draft versions 13 and 14 of the project Phase III proposal, which organized the project along farm, regional and national levels, whereas the project framework in the submitted and approved version is along the lines of policies, institutions and technologies. Linking the work packages to these themes then shows that policies are largely the domain of economics (ZEFb), technologies the domain of natural and ecological sciences (ZEFc) and institutions (largely interpreted as organizations) are the domain of social sciences (ZEFa).

As planned earlier, and as the evaluation of the first two phases suggested, the main indicator for the project's ability to find innovative solutions that worked in reality was to successfully demonstrate those solutions in real life and at a landscape level. The landscape level at the third phase planning stage was operationalized as a piece of contiguous land spanning over 75 ha at the Uzbek Cotton Research Institute (CRI) around Urgench city, that was granted by the Government of Uzbekistan for use and management by the project for the duration of the last project phase.

> *The intention of this landscape development study is to verify and quantify benefits derived from the synergetic effects of innovations, analyze the overall effects of improved land and water use, and develop the best management options. In this way, a complete cost-benefit analysis of farm restructuring in terms of direct and indirect monetary terms may also be estimated*. (Manschadi *et al.*, 2008: 5)

All the technologies and scientifically proposed solutions were to be tested and demonstrated for their effectiveness in addressing land and water related issues at this farm, and served as the centerpiece of the project's research outcomes. The initial project proposal states that:

> *The goal of this project is to establish the basis needed for the demonstration of an effective and sustainable restructuring of the landscape in the district of Khorezm and to outline suggestions for the necessary administrative and legal-administrative re-organization.* (Vlek, et al., 2001: 10).

Suggesting changes for administrative and legal reorganization within the project's stated purposes, would imply that these systems are first researched properly, and the key recommendations coming out of the analysis be tested in real life at a reasonable scale. Quite contrarily, in practice however, a governmental site for testing the proposed innovations was driven by purely scientific needs of being able to control again a number of factors and being able to install devices and measurement infrastructure at technically suitable locations without interventions. As the so called pilot farm was to be managed by

ZEF, only the potential of bio-physical solutions could be demonstrated as there were no farmers and thus, the farm did not demonstrate the real life conditions of the Khorezm province of Uzbekistan (Wall, 2006: 216). Wall (2006) attributes these problems to differing epistemologies prevailing within the Uzbekistan project, and conflicts between positivist science engaged in societal perspectives, and the perspectives of local project partners. Though there was internal resistance about the usefulness of pilot testing innovations on this pilot farm, especially from ZEFa (Field Note July 2012), the idea was pushed by ZEFc, and maintained in the project proposal, and ultimately was approved and accepted by the donors after seeking several clarifications (Field Note August 2012).

Thinking about interdisciplinary research already started during the action planning stages of phase II, but it was interpreted as a set of indicators that could represent bio-physical, economic and socio-political variables in the so called Khorezm Economic Optimization Model (KEOM). The action planning group of Phase II suggested that the

> *indicators should be easy to measure, rational and time bound…* [disciplinary indicators] *need to* [be used to] *cluster indicators from the different disciplines, and according to different levels (national, regional, local, farm level)* [and] *to define how to measure interdisciplinarity of research.* (ZEF, 2004: 5).

During the phase III, the work was eventually clustered around four intervention areas of policy, institutions, (water and land management) technologies, and approaches to adaptation and experimentation (Table 2.2), but still largely maintaining departmental organization, albeit with some exceptions. The policy research was largely vested with ZEFb, institutional research was largely vested with ZEFa, and the land and water management research with ZEFc. Two key exceptions were the work packages on integrative modeling and approaches to adaptation, which were designed as interdisciplinary research. The integrative modeling was more of a synthesis and integration of indicators into Khorezm wide land and water model, and the adaptation research was designed as an interdisciplinary process whereby the scientists from various disciplines were required to work together on a single research problem.

The research was organized into 34 work packages. Most of the research packages were disciplinary studies of various issues. Three work packages, in addition to the two interdisciplinary work packages, required an input from more than one ZEF department, but in a multi-disciplinary way.

Table 2.2 Research Clusters and Work packages of Uzbekistan Project Phase III

Research Department	Research Areas	Number of Work Packages	Example Research Themes
ZEFa	Institutions	5	Understanding Governance and reform processes, Mapping agricultural service organizations, Gender and livelihoods
ZEFb	Policy, Water Management, Cross-cutting	4	Khorezm sectoral model, Operation and maintenance budget of irrigation infrastructure, Water footprint of key crops
ZEFc	Water and Land Management, Cross-cutting	20	Drainage and salinity management, Drip irrigation, Land suitability maps, Remote sensing of crop yields, Afforestation and its impacts on Nitrogen Fixation and soils, Conservation Agriculture, Integrated Pest Management, Livestock integration in cropping systems
Multi- Disciplinary	Demonstration and dissemination	3	Policy Outreach, Economic and Ecological assessment of alternative land use, Research Farm (Landscape segment)
Interdisciplinary	Integrative modeling studies Approaches to adaptation	2	Optimized land and water allocation, Testing and adapting innovations with stakeholders
Total Work Packages		34	

Source: Authors compilation based on Martius, *et al.* (2006)

As is evident from Table 2.2, the project remained heavily biased towards the research around bio-physical aspects (20 out of 34 work packages), the research domains of the proponent department of the project from ZEF. However, the project did transition through the first phase of very disciplinary (inventorying bio-physical, sociological and economic attributes of Khorezmian agriculture) to a largely multidisciplinary research, but somewhat interdisciplinary research in Phase III through integrative modeling and approaches to research about adaptation and adoption.

It becomes clear from the above discussion that a number of factors, processes, and concerns shaped interdisciplinarity research, in whatever shape it was, during the implementation of first two phases and the design stage of Phase III. These included, inter-alia,: a) ZEF's organization, that favored a disproportionate power dominance by the proponent department; b) ZEF's philosophy of dwelling on Ph.D. students as the major building block of research enterprise; c) relatively opaque decision making in management; d) epistemological contestations between positivist-constructivist and critical-realist sciences; e) a lack of coherence between stated ambitions to achieve interdisciplinarity and actual practices that allowed dominance by a single department; f) fear of loss of control and power over jurisdiction, or territorial claims; g) donor demands and funding systems; and h) local partner's demands and expectations from the project.

2.3 The 'Follow-the-Innovation' Work Package of the Uzbekistan Project

The disciplinary research of phase I and II yielded a number of innovative solutions which, to the belief of their proponent researchers entailed a plausible promise for improving land and water management in Uzbekistan, and thus carried a potential for out scaling. The Uzbekistan project proponents recognized in the phase III proposal (Martius *et al.*, 2006) that the research could only develop innovative ideas and technologies to a level of having potential for adoption. The innovation must then be taken through a process that requires a strong engagement with the potential users to get the innovations adopted and embedded in the local setting. Therefore, the need for participatory innovation research with actual stakeholders for embedding the project innovations in their setting was recognized. This process of embedding assists in adapting innovations, as well as the users, and the conditions in which the whole process occurs (Martius, et. al, 2006).

In the Phase III formulation discussions one of the topics was to operationalize the idea of a 'participatory' approach to implement project results, emanating from donor's demand to demonstrate that the suggested innovative solutions worked in reality. There was a search for a suitable vocabulary. Much was found in literature about participatory

and adoption research but not offering much advice on how actually to go about implementing scientific solutions. Besides, the University of Bonn also put ZEF under considerable pressure to not become too "practical" (Wall, 2006: 126) and restrict itself to research only, leaving implementation aspects for local implementation agencies, development projects and NGOs. Therefore, the discussions within ZEF led to the conviction that though testing, adapting and refining innovations required a lot of implementation oriented activities, it should be branded as research about implementation to avoid any conflicts of interest with ZEF's mandate.

The concepts, such as technological adaptation, dissemination, adoption and out scaling were frequently discussed and lessons drawn in literature, but concrete steps of taking an innovative solution and following it from assessing it for suitability, adapting considering users' reality, and finally assessing the adoption were rather rare. The writing team was finally convinced by Douthwaite's stepwise approach to adapting technological innovations (Douthwaite, 2002), which he captioned as "Follow-the-Technology (FTT)". The fact that Douthwaite's work was about adapting a seeder, an artifact, it had the notion of 'champions', and 'leading innovators' borrowed from agricultural adoption theories emerging from the green revolution era (e.g., Rogers, 1973), which were also incorporated into the write up of the work package, though the intentions were to also take aboard some institutional innovations for which such concepts might not be relevant.

The project intended to address technological as well as regulatory reorganization and complex innovation packages that affected farmer's and water manager's behaviors (Hornidge, et al., 2010). Douthwaite's approach was consequently re-branded as "Follow-the-Innovation (FTI)", as it sounded broader than mere technological adoption. The initially conceived steps to make this process happen were conceived as teaming up researchers around innovations, basic supportive research about the proposed innovations from relevant perspectives of natural, economic, and social sciences (such as cost benefit analysis, assessment of additional labor and skill requirement, assessment of available policy environment and changes that were required, environmental outcomes) to validate their scientific potential under real conditions and then offering the proven innovations to a group of potential users (Mollinga, 2006). This supportive research required an interdisciplinary

approach. It was assumed that the early adoption of suitable innovations would happen as the relevant scientists would find stakeholders who would be ready to test the offered innovations together with project scientists. Such interested stakeholders were subsequently termed as *innovators* or *champion.* It was believed that as the innovators would adopt the innovation, it would then lead to the eventual adaptation through more research, and adoption through promulgation/out-scaling of successful innovations.

This work package represented a research activity in which an interdisciplinary process was to be facilitated by trained and experienced staff, which would then result into a transdisciplinary approach to innovation development that was advocated by ZEF. This approach appeared to fit well for Uzbek conditions where the state and its administrative bodies are excessively involved in agricultural decisions at the farm, districts, regional and national scales. The state apparatus in Uzbekistan has a strong role vis-à-vis farmers through its 'state order' system on agricultural production decisions of what to grow as well as gives detailed orders on when and how to plant and harvest (Wall, 2006). This influence leaves little space for agricultural producers to independently take decisions on their agricultural production processes. The window of opportunity (Röling, 2009) within which farmers can actually innovate in Uzbekistan, is therefore comparatively small. The need for research ideas / developed innovations to be tested and refined jointly with actual users of these innovations was therefore especially pressing in Uzbekistan.

The FTI approach clearly rests on the conviction that the farmers are the ones who know best and are well aware of their window of opportunity within which they themselves can take agency (Giddens, 1984) and independently decide to innovate. Röling points out that due to the generally small window of opportunity for farmers to innovate, *much research output is simply not appropriate for farmer's conditions* (Röling, 2009: 15).

Since the project's research recommendations emanated from the disciplinary research of master and Ph.D. studies of the project graduates, these were largely undertaken through scientific field level experiments (Wall, 2006), which controlled key disciplinary variables, and completely ignored non-disciplinary variables. A farm level research by an agronomy student, for example, had only studied the impact of conservation agriculture

practices on crop yields, and soil salinity levels of fields, ignoring the investigation of reasons and rationales of existing practices undertaken by farmers, or the financial costs and benefits analysis comparing the existing and recommended practices, constraints about the availability of suitable machinery, fuel, etc. required to practice conservation agriculture, or the administrative constraints imposed by state control. Therefore, in an environment as the one found in the agricultural sector of Uzbekistan, much of the recommendations generated through master and doctoral level research might just not be appropriate especially because the 'window of opportunity' to innovate due to strict state control is even smaller than elsewhere.

To ensure the successful diffusion of innovation packages, the work package 'Implementing, improving and adapting with target groups: "Follow-the-Innovation" (FTI)' consequently focused on the integration of research with local stakeholders, joint testing, validating and finalizing the developed innovations to a degree from where the actual users would start adopting and adapting the innovations. Based on these processes and experiences, it was the aim of the project to, together with the local stakeholders, develop a locally-embedded approach to diffusing the innovations developed. This approach was expected to lay the foundations for later out scaling for widespread adoption of developed ideas and research-based innovations by implementing agencies. Within the project team, the work package provided a training ground for staff to be trained in participatory innovation-oriented research, approaches and methodologies.

The work package designed (as outlined by Mollinga, 2006) critically referred to the Transfer of Technology (ToT) approaches. Mollinga argued that the success and widespread use of ToT approaches goes back to the seed-based green revolution. Seeds are technologies that have all innovations 'packed in', and therefore their actual use in real-life situations requires relatively few changes in the agricultural production process. Such approaches, therefore, may not work for more complex innovations, such as conservation agriculture.

Besides, ToT approaches implicitly assumed that scientific knowledge is superior to farmers' knowledge, independent of context and universally applicable. The resulting failures in innovation diffusion (farmers did not take up innovations as 'they should have' according to the ToT approaches) were initially ascribed to the 'unwillingness' (Groenfeldt and Moock, 1989 : 8), 'lacking expertise' (Dakora *et al.*, 2008: 25) or 'backwardness' (Panday, 1989: 105) of farmers, rather than to the impediments of the linear approach. Farmers proved not to be the passive recipients who welcome innovations diffused to them, but instead to be active agents and most of the time sole decision-makers on whether to adopt, adapt or dismiss the offered knowledge.

A wide range of influential critique of ToT approaches is available from the 1980s onwards. The often remarked 'lack of fit' of externally developed innovations in local systems argued for the necessity to strongly involve local stakeholders in the process of developing innovations that are thought to take hold in the local system. Röling (2009) offers an overview of conceptual and methodological developments in innovation diffusion redrawing earlier approaches. Each of those concepts and approaches in some local contexts and settings led to successful innovation diffusion and in other contexts, involving other stakeholders or lacking facilitation of the process failed. Since the 1980s researchers repeatedly stress the importance of innovations being deployed in the specific social, political and cultural context for getting them to work. Innovation diffusion is therefore and through the involvement of the local stakeholders:

"a process of simultaneous creation of new material and social order […] a process of embedding, in which both the technology/artifact itself, users, and the social and institutional arrangements for their functioning are reconfigured in an iterative process till a degree of 'closure' or consolidation is reached, or the innovation is abandoned" (Mollinga, 2006: 179).

Comparing the FTI approach adopted by the project with ToT and other agricultural adoption approaches, it becomes clear that FTI at its design stage was a mere extension of FTT approach, a step wise action research approach carried out by a team of scientists in close collaboration with a real life stakeholder. The approach aimed at establishing,

through inter and transdisciplinary research whether or not the chosen innovation was suitable for out scaling in Khorezmian context. If it was found unsuitable, it was perceived that the process would lead to identification of technical, socio-economic and policy constraints that made the innovation unsuitable. The approach did not target actual dissemination or out scaling as such, and left this task to other work packages as well as to technical assistance agencies and agricultural development projects by donors and the government (Mollinga, 2006).

2.4 Design of the FTI Work Package

The FTI work package explicitly looked at developing a context specific approach, together with local stakeholders, to jointly test, adapt and finalize as well as then spread the innovations. This work package was thought to be supported by a work package looking at the national, regional and local governance structures, decision and policy-making procedures in order to offer models not only for innovations within the existing windows of opportunity of farmers to improve their agricultural production processes, but also models and research-based recommendations on the policy and institutional levels in order to *stretch* the windows of opportunity. The work package was captioned as "spread-the innovation- STI"

The STI work package became epistemological controversy right from the conception stage. Most likely due to the brand name chosen, the writing team members from bio-physical research domains saw it as an approach towards dissemination of technologies, economists saw it as an attempt at studying wide scale adoption, the sociologists interpreted it as a research process exploring the governance structures and systems, a research process about innovations, but at an innovation system level, and the project managers saw it as an attempt to research the government (Field Notes November 2009 through November 2010).

As a starting point, the project chose the FTT framework (Douthwaite, 2002). Like almost all participatory approaches to technology development and innovation, it is

composed of a set of steps or stages. The basic idea is that once there is a technology with a 'plausible promise' that may work and raise interest of users, innovators engage in a process in which the technology is experimented with in real situations by a group of users ('product champions' and 'partners'). The process itself is one of trial and selection, leading, finally, to a point where the technology is sufficiently robust to be released more widely (if that hasn't happened already during the process) or abandoned because it has proven to be unsuitable for the situation. The methodology "follows the technology, using this intervention as the entry point into a complex situation, and then allowing what is discovered to determine what is important" (Douthwaite, 2002).

This idea of following the technology was adapted according to the specific context of the project and widened it from its technology orientation to cover all kinds of innovations, including technical and institutional innovation packages. Consequently, the project named it as the 'Follow the Innovation' approach, partly also to show that the project was not repeating what Douthwaite had already worked on, rather to give it a new ZEF branding. At the design stage, a distinction between innovation implying an artifact or recommendation / improved way of doing something, and innovative process of undertaking adaptation research was clearly made (Mollinga, 2006: 21).

As main steps the following were planned (Mollinga, 2006): (a) basic supportive research; (b) early adoption of suitable innovations by innovators or champions; (c) the eventual adaptation through additional research; (d) and promulgation/out-scaling of successful innovations.

An important objective of the work package was its perceived contribution to develop ZEF's internal staff capacity through capacity building opportunities for innovation-oriented research and out scaling (Mollinga, 2006:19), and experimenting with, and learning from models of undertaking interdisciplinary research. Therefore, the internal agenda of the work package was also to get a process going within the ZEF team to address interdisciplinarity more seriously and build more capacity in that respect. The 'implementation logic' of the process was to satisfy the donor's and Uzbekistani

counterpart concerns about sustainability of the project outcomes, but the more important outcome for ZEF itself was the work package's potential contribution to further interdisciplinary research, and future capacity for interdisciplinary research at ZEF, while abiding by the rules of games set by the Bonn University and at the same time delivering on the demands of the project donors.

2.5 Conclusion

ZEF as a research center specializing in development research is unique compared to other similar European centers of excellence in that that it has a strong focus on research due to task 'specialization' philosophy prevalent in the German system. Though it claims to be an autonomous body, it is not free in setting its human resource policies or rules for conducting business. As ZEF raises most of its operational funds through restricted research projects, it remains vulnerable to frequent adjustments in its strategic direction. The administrative systems and conditionality imposed by the University of Bonn as well as the donors of its research projects, constrain it ability to recruit and retain best research staff. ZEF is structured along strict disciplinary lines of its three departments. The organizational departmentalization is evident in the structure of its research projects and the research content, such as the one discussed in this chapter. In case of the Uzbekistan project, the proponent ZEF department of the project resumed, and exerted disproportionate power in terms of decision making regarding research agenda, approaches, and organization. The Uzbekistan project, from its project framework appears to be an interdisciplinary project, but remained heavily biased towards bio-physical aspects of research throughout its three phases. The work packages were designed and implemented along strictly disciplinary lines, but the project demonstrated a small but noticeable shift from disciplinary to incorporation of multi-disciplinary and then interdisciplinary research as it proceeded from its inception (2001-2003) to final phase (2007-2011). The shift displays internal learning in an attempt to address, both, donor concerns about making the research outcomes more relevant to societal needs, and ZEF's strategic direction to become more interdisciplinary research institute. The gradual shift towards accommodating and incorporating concerns from other disciplines in

making its research more relevant to the needs of Uzbekistan context show that the writing team recognized that the disciplinary and somewhat multi-disciplinary research its graduates had conducted during the first two phases needed to be questioned for its relevance to the context and needs of Uzbek agriculture.

The FTI approach was an innovation in the way ZEF carried out its project research. However, the design of the work package was a negotiated outcome, or a boundary object (Owen, et al., 2008), in which different perspectives and agendas from the three departments were combined. This outcome was influenced by power and epistemological contestations within ZEF as well as within the context of Uzbekistan, within which the research had to be carried out and the recommendations to be implemented. Therefore, designing interdisciplinary research within ZEF's Uzbekistan project remained a social process of problem definition, identifying an appropriate approach to the solution, and finally undertaking activities to resolve the problem. The design process for the FTI work package displayed all the characteristics of the social process that it sought to achieve through its research.

Chapter 3: Conceptual and Methodological Framework

3.1 Introduction

The aim of this chapter is to elaborate key concepts related to interdisciplinary research and delineate the methodological framework to undertake this research. In section 3.2, the concept of interdisciplinary research and what it entails is explained. Other concepts, such as disciplinary, multi and transdisciplinary research are compared and key differences are distilled. Section 3.3 presents key theories that are relevant to an empirical study of an interdisciplinary exercise. Section 3.4 examines pertinent empirical work on interdisciplinarity and draws out lessons for the current study. Section 3.5 presents the research questions and sub-questions for this study and in section 3.6, key methodological features of the research are elaborated and the rationale for choosing those methods is discussed. The final section 3.7 concludes the discussion.

Key findings indicate that since the project's interdisciplinary teams (IDTs) were tasked to identify, understand and resolve actual practical problems around designing and conducting experiments for the adaptation of agricultural innovations, these exercises contained elements of both project based and problem -oriented research. The capacity-building was intended at contributing to enhanced participant learning. Besides, each of teams was to collaborate within themselves, and thus these were sociological processes of group formation. Thus, I draw on theories relevant to the study of learning, team building, project and problem based learning, and the dynamics of small sociological groups. I also draw on the empirical literature related to facilitating collaborative and inter- and transdisciplinary research. Since the study needed to assess the effectiveness of a longitudinal capacity-building model, that was coupled with action-based learning, a mix method research methodology suited the study.

3.2 Interdisciplinary research as a concept

The aim and scope of this study do not allow a thorough discussion of the history of academic science and its disciplinary or otherwise organization in any detail. However, to understand the concept of interdisciplinary research (IDR) it is important to differentiate between and clarify the conceptual basis of several terms used while describing interdisciplinarity, including discipline, multi- , inter- , and transdisciplinarity.

Most interpretations of the concept of 'discipline' in the literature define it along organizational and cognitive dimensions (Hinkel, 2008). On the organizational dimension, scientific disciplines are defined with respect to the existence of institutions such as university departments, education programs, conferences and journals. On the cognitive dimension, scientific disciplines are defined with respect to their member's sharing certain cognitive structures, such as concepts, theories, methods and problem definitions. Disciplines are believed to be the product of the professionalization of scientific practice and can be identified as fields of specialization for study and investigation (Becker and Trowler, 2001; Hinkel, 2008; Mollinga, 2009).

Most technological and scientific advances are claimed as evidence of the usefulness of having science organized into various disciplines. Research, however, notes that disciplinary organization of science is not a static phenomenon in itself, rather a continuous transition occurs and transforms disciplines through two antithetic processes, differentiation and integration (Klein, 1990). As time proceeds, a growth in the number of disciplines can be witnessed in terms of ever increasing numbers of disciplinary and specialized teaching programs, text books and journals addressing various fields.

Despite the advantages of research being organized along disciplinary lines, there has always been an urge and the need to overcome the disciplinary organization of science (Wohl, 1955; Klein, 1990). One reason for such an urge is that the cooperation between disciplines has been an important source of innovation for advancing individual disciplines (Kostoff, 2002; Hall *et al.*, 2008). Another reason is that many of the scientific and practical problems society faces cannot be solved by the knowledge of a single

discipline alone (Funtowics and Ravetz, 1993; Kates *et al.*, 2001; Cash *et al.*, 2002; Komiyama and Takeuchi, 2006; Yoshikawa, 2008).

The fact that the number of disciplinary scientific journals is far higher and ever increasing compared to those which publish cross disciplinary work indicates that the urge to undertake and publish cross-disciplinary work meets challenges owing largely to disciplinary epistemic cultures, as the members of disciplines act as tribes and communities (Becher and Trowler, 2001) and resist attempts that might result into losing their disciplinary identities and cultures. The contestation amongst scientific disciplines is often a proxy for paradigmatic differences in view of and approach to science by various disciplines, however (ibid).

Interdisciplinary research, therefore, is still not a mainstream phenomenon despite its potential advantages. Scholars studying and promoting interdisciplinary research increasingly believe that the existing organization of science into disciplines constrains promotion of any cross-disciplinary work, and institutional arrangements and incentive structures need to reconsidered (Newell, 2001; Stokols *et al.*, 2008) to promote and nurture interdisciplinary practice in science..

A vast amount of literature has attempted to understand the conceptual aspects of the interactions between different disciplines. The banners of multidisciplinary, interdisciplinary and transdisciplinary have been used for referring to different forms of cross-disciplinary collaboration, albeit by different authors differently (Klein, 1990; van den Besselaar and Heimeriks, 2001; Collins, 2002; Barry *et al.*, 2008; Fiore, 2008; Aram, 2011)[21]. Likewise, the labels of boundary crossing, for example (Mollinga, 2008; Owens *et al.*, 2008), integrative research (Tress *et al.*, 2005), and synthesiology (Yoshikawa, 2008) are also used to refer to cross-disciplinary interactions in science.

The simplest form of collaboration between disciplines is often called multidisciplinary, whereby an issue is researched from the perspectives of various disciplines, but each

[21] See Klein (1990: 55–73) for an overview.

discipline produces its own results. The distinction between multi and interdisciplinarity is that in multidisciplinarity interaction several disciplines cooperate but remain unchanged, working with standard disciplinary framings and in interdisciplinarity there is an attempt to integrate or synthesize perspectives from several disciplines. Therefore, Klein (1990:56) characterizes multidisciplinarity as "additive not integrative" in nature, and interdisciplinarity as "integrative and holistic".

Scholars[22] tend to refer to a form of scientific collaboration as 'interdisciplinary research (IDR)', in which a common scientific problem is solved jointly by different disciplines, and in doing so, knowledge from several disciplines is not simply added up but integrated. Thus, IDR aims to produce one common perspective rather than segregated disciplinary perspectives. IDR integrates information, data, techniques, tools, perspectives, concepts, and/or theories from two or more disciplines or bodies of specialized knowledge to advance fundamental understanding or to solve problems whose solutions are beyond the scope of a single discipline or field of research practice (CoFIR, et al., 2005).

Interdisciplinarity, therefore, implies a practice of working across traditional disciplinary boundaries (Dalgaard *et al.*, 2003). IDR can be operationalized as research that spans over and crosses the boundaries of more than a single discipline, and thus *releases inquiry from the restrictions of disciplinary boundaries of a single discipline. The overarching goal behind IDR is the systematic integration of ideas* (Fiore, 2008). IDR, therefore, needs to lead to the design of new types of complex empirical approaches along with integrated analyses combining methods and concepts from participating disciplines (Klein, 1996).

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[22] In order to provide open access to scientific information to the larger public on advances in interdisciplinarity a specialized transdisciplinary network (td-net) was launched in 2000 by the Swiss Academic Society for Environmental Research and Ecology and taken over by the Swiss Academy of Sciences in 2003 for facilitating interdisciplinarity and transdisciplinarity through offering a database of interdisciplinary literature. The network also organizes conferences, expert consultations and other forms of dialogues to discuss emerging topics in inter and transdisciplinary research. Since 2008 the td-net for transdisciplinary research has been a project of the Swiss Academies of Arts and Sciences. Interested reader is referred to their website http://www.transdisciplinarity.ch/e/About/

Analytical and theoretical links between different scientific disciplines are required in IDR. The interaction between disciplines and disciplinary specialists in an interdisciplinary venture may range from communication and comparison of ideas, and the exchange of data, methods and procedures, to the mutual integration of organizing concepts, theories, methodology, and epistemological principles (van den Besselaar and Heimeriks, 2001). A successful IDR exercise would, therefore, imply a common problem definition, conceptual frameworks and methodical standards; and organizational preconditions allowing for a suitable working basis (Conrad, 2002).

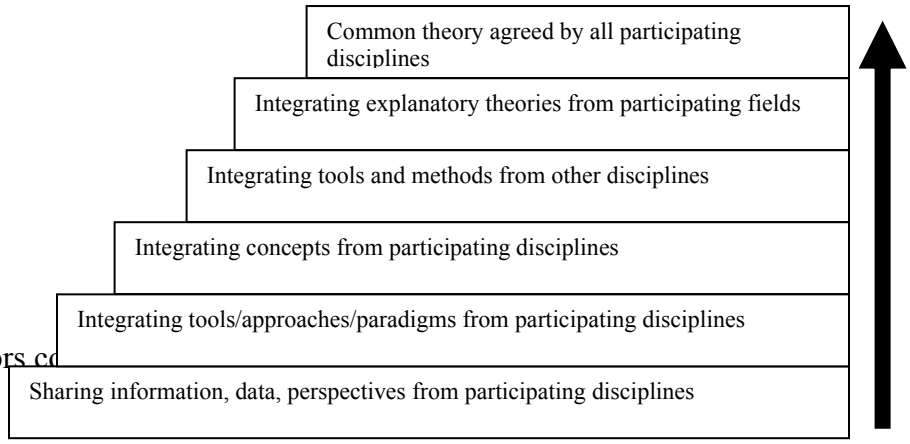
Klein (1996) differentiates between two spectra of IDR as instrumental and critical. In the former, societal and academic problems are solved by borrowing and adapting tools and methods from various disciplines. In the later, the explanation and theorizing by one discipline is reflected upon through use of concepts and theories by another field of specialization. Knowledge and critique from various disciplines is unified. What is implied in these two forms is the degree and rigor of IDR. IDR would be called 'instrumental' if, for example, one discipline only borrows tools or concepts from the other, and it would be called 'critical' if the integration between the disciplines produces new and common theoretical explanation by various disciplines, or the basic assumptions behind the disciplinary explanation are reflected upon (Burawoy, 2005) using the lenses from another discipline[23].

Another typology of interdisciplinary research is offered by (Morillo *et al.*, 2003), who differentiate between 'big' and 'small' interdisciplinarity. In their view, the former happens when collaboration between two or more distant disciplines, for example, engineering and sociology takes place and the latter happens when disciplines close by cooperate. An example of the latter would be collaboration between chemistry and biochemistry.

[23] For a detailed discussion on the distinction between the concepts of instrumentality and reflexivity in public sociology, interested reader is referred to Burawoy (2005)

Summing up the above discussion, one could visualize several levels of interdisciplinarity that could possibly take place in an IDR exercise (Figure 3.1). The minimum level at which a research venture would qualify for being called IDR would be where only information exchange takes place amongst the participating disciplines. It would increasingly progress towards a common theorizing of the problem following the stages of exchange of ideas, borrowing and integrating concepts, integrating tools from other disciplines into those used by the major field, borrowing, adopting, and integrating theories and explanations from other fields. It is to be noted that to achieve the highest level in IDR, all other levels of IDR have to be passed. In other words, no IDR exercise could achieve a common theorizing unless it passes through all the stages below it in Figure 3.1.

Figure 3.1 Increasing levels of expected interdisciplinarity in IDTs



Source: Authors co

In recent decades, scholarship has increasingly also attempted to undertake empirical research to understand and elaborate various aspects of interdisciplinary research (for example Conrad, 2002; Morillo *et al.*, 2003; Santoro *et al.*, 2003; Fiore, 2008; Lyall *et al.*, 2011). Most IDR exercises are, depending on the nature and scope of the research, a team exercise (Fiore, 2008), as scientists from various disciplines collaborate. In order to practice IDR successfully, it requires the participants to have the capacity to communicate. Scholarship tends to discern cross-disciplinary exercises that transcend disciplinary boundaries, and in this venture, have discerned interdisciplinary research from transdisciplinary research (TDR).

'… ideas of interdisciplinarity and transdisciplinarity imply a variety of boundary transgressions, in which the disciplinary and disciplining rules, trainings and subjectivities given by existing knowledge corpuses are put aside or superseded' (Barry *et al.*, 2008: 1).

While IDR transcends through various academic disciplines and attempts to answer scientific and academic questions, TDR[24] transcends through academic and practical disciplines to assist in solving practical issues and real life challenges (Mollinga, 2009) and providing advice to policy makers. While both of these forms aim at integrating knowledge, the former appears to be more of an academic and scientific nature, while the latter focuses on solving real life problem (Hinkel, 2008). Both these forms of cross-disciplinary integration can not be seen as substitutes to disciplinarity, but as a complementary problem-orientated research principle; implying lateral thinking against established disciplines, methods and institutions without however aiming at creating necessarily new disciplines (van den Besselaar and Heimeriks, 2001).

In Hinkel's view, TDR is a research principle that aims at overcoming disciplinary insularity in those cases in which disciplinary concepts and methods do not match the problems to be solved. This is particularly true for problems that are raised outside of the scientific system, such as, e.g., problems associated with climate change in general. When the concept of transdisciplinarity is used in a wider sense to refer to the collaboration between scientific and non-scientific participants, coded, tacit and traditional knowledge integration remains the central aim of transdisciplinarity (Komiyama and Takeuchi, 2006).

Transdisciplinary problem-oriented and problem solving in the wider sense is frequently also labeled as 'assessment' instead of research (Hinkel, 2008). Examples are integrated assessment, vulnerability assessment, environmental impact assessment, technology

[24] An exception to these general differences between IDR and TDR can be noted in IDR about medical sciences, where they tend to equate TDR to IDR (for example, Gray, 2008).

assessment and sustainability assessment. The term ‘research’ appears to be reserved for the intra-scientific practice of problem solving whereas the term ‘assessment’ appears to refer to the joint problem solving amongst science and other stakeholders. In assessments, problem solving is driven by the purpose to inform policy and decision-making, rather than to advance knowledge for its intrinsic value (Hinkel, 2008).

The proponents of IDR in medical studies (for instance Hall *et al.*, 2008; Stokols *et al.*, 2008; Falk-Krzesinski *et al.*, 2010), have called IDR as a team science (TS). They have also coined the term describing research about IDR as “science of team science (SciTS)” to refer to conceptual, methodological, and empirical inquiries aimed at understanding and enhancing the processes and outcomes of collaborative, team-based research. SciTS is concerned with understanding and managing circumstances that facilitate or hinder the effectiveness of collaborative cross-disciplinary scientific research.

What transpires from the discussion in this section is that the differences between disciplinary, multi- and interdisciplinary research are pronounced and vivid. Disciplinary research aims to provide explanations and theorizing from a single perspective, multidisciplinary research provides several explanations from various perspectives and interdisciplinary research aims to consolidate, synthesize and integrate perspectives, knowledge, approaches, and tools at various levels. These levels of integration can be multiple and progressive, as explained in Figure 3.1. Lowest levels of integration take place when, for example, more than one discipline use and regard each others’ data as valid data, despite having different epistemological assumptions and methods. Highest level of integration happens when a common explanation and theorizing is agreed between two or more disciplines, or a new and improved explanation is arrived at through reflection on two or more disciplinary explanations.

The difference between inter and transdisciplinary integration is that in the former, the sources of knowledge that is integrated are scientific and coded, whereas for the later the sources are both, scientific knowledge as well as local and practical knowledge.

The present research is an inquiry into the role that capacity-building, together with other factors, plays in nurturing interdisciplinarity amongst scientific teams, and therefore, falls into what is above described as science of team science. As is explained in Chapter 2, the interdisciplinary problem ZEF's IDR teams faced was to come up with a suitable approach towards testing a scientifically developed innovation further together with the real life stakeholders in their real life situations. Each of these teams faced two distinct problems: a) to develop itself into an interdisciplinary team (IDT) around an innovation by integrating knowledge, skills, and expertise of the team members from different disciplines; and b) to engage with and integrate the knowledge of actual stakeholders into these IDTs and gradually transform their respective IDT into a transdisciplinary team (TDT). Each of the IDR teams comprised researchers from natural, economic, and social sciences (Chapter 4).

The section that follows examines various theories explaining team behaviors, members' learning, and team effectiveness.

3.3 Theories relevant to study of Interdisciplinarity Teams

Interdisciplinary collaboration is, like any other collaboration, characterized by high labor intensity, conflict proneness, and needs substantial preparation, practice and trust amongst team members (Stokols *et al.*, 2008: S96). These characteristics pose unique risks to participating scientists who are especially concerned about establishing strong scientific identities within their field of specialization. Four types of theories (Stokols, et al., 2008) offer useful insights into team members learning, team formation and team effectiveness: a) andragogy; b) business sciences and cyber-infrastructure; c) problem and project based learning; and d) social group theories. A brief discussion on these theoretical sources and their suitability for the present inquiry are discussed in the following.

3.3.1 Adult Learning Theories

Education occurs whenever individuals engage in sustained, systematic learning in order to affect changes in their attitudes, knowledge, skills, or belief systems. Learning, instruction, and developmental processes remained the primary foci of educational psychology, generally focused on school and college children and university graduates. A branch of education psychology realizes that there are key differences in the ways adults and general graduates learn (Knowles, 1990). A number of educational psychologists have specifically studied learning and development in adulthood. These efforts have resulted in what is now called adult education (for example, see Smith and Pourchot, 1998), or andragogy.

The field of andragogy, largely drawing on educational psychological theories, draws its inspiration from Maslow's Hierarchy of Needs Pyramid (Maslow, 1943). Maslow's theory postulates that an adult individual's behavior and attitude are determined by how well his/her needs are met. The needs are depicted along a pyramid, whereby safety is at the base, followed by belonging, and other needs. Self actualization is at the apex of the pyramid. Learning is considered as a part of an individual's self actualization needs. The implication of learning as one of the apex needs would be that an individual would only learn once he/she manages to satisfy all other needs (safety, belonging, etc). However, andragogists differ from Maslow, as they believe that an adult keeps on learning all his/her life based on his/ her reflexive thinking.

Androgogical theories[25] address a wide range of topics including: who are adult learners? how do adults learn? why are adults involved in learning activities? how does the social context shape the learning that adults are engaged in? and how does aging affect learning ability? Transformative theory (Mezirow, 1991), for example, shows that adults learn by making meaning of their experiences through a dynamic process. An adult's habits of expectation serve as perceptual and cognitive codes to structure the way one perceives, thinks, feels, and acts on one's experience. Learning transforms the individual through instrumentalization, communication, and reflective thinking. Reflection can change or

[25] For a summary of andragogical throries, see for instance Knowles (1990); Smith and Pourchot (1998), and Mezirow (1991).

transform both meaning schemes and meaning perspectives of an individual. However, there can be distortions in meaning perspectives that can limit one's ability to make meaning of experiences. As the perspective transformation plays a significant role in adult development, an intervention in the perspective transformation process through education and training can act as an accelerator.

However, most of these theories provide only psychological understanding of the learning processes and cycles at an individual's level and do not offer much insight into the study of teams and groups, such as IDTs, unless each and every member of the team is researched as an individual psychological subject, which is beyond the aim and scope of the current investigation. The useful insight that the field of andragogy provides for this inquiry is that it challenges the assertions, such as that disciplinary training, especially in a university research setting generates 'trained incapacities' (Morse *et al.*, 2007: 1) in professionals who lack preparedness to collaborate across disciplines, or epistemic cultures play a major role in determining the nature and extent of IDR collaborations (LéLé and Norgaard, 2005). Huber (1990) asserts that, when working in scientific collaborations, disciplines and disciplinary scientists might compete and may have differing pecking orders within and between them, as the tacit knowledge and hidden assumptions of disciplines differ, and their specific patters of communication, publication, division of labor, hierarchies and careers also differ and sometimes compete.

Nevertheless, it is also evident from the above discussion that any IDR collaboration might equally be shaped by the personality of the individual researcher and the interactions he/she might have with other personalities in the team. For example, some researchers might be more collaborative by nature than many others, but as they interact in a single team, even the non-collaborating members might learn to collaborate better over time.

3.3.2 Theories from Business Sciences

Team formation is one of the key research areas in the business sciences, which has been studied for past several decades. A group of employees from different functional

departments or various areas of work responsibility in a business, working together is called a "multi-functional team" (Tzu-Liang *et al.*, 2004), which poses several challenges during its formation process. Team formation stages have been described using Tuckman's seminal work on small groups (Tuckman, 1965; Tuckman and Jensen, 1973).

Tuckman's model explains that as the team develops maturity and ability, relationships establish, and the leader changes leadership style. Beginning with a directing style, moving through coaching, then participating, finishing delegating, the leader almost detaches himself/ herself from the team. At this point the team may produce a successor leader and the previous leader can move on to develop a new team, and the team members move on to new tasks and teams. It is one of the best known team development theories in business studies and has formed the basis of many further ideas since its conception. Tuckman's theory focuses on the way in which a team tackles a task from the initial formation of the team through to the completion of the project through four stages of forming, storming, norming, and performing. Tuckman later added a fifth phase, that of adjourning and transforming to cover the finishing of a task. Several empirical studies have verified the applicability of these stages of team formation, and tools and formats are available online (for example, Clark, 2009) to assess the level of development a particular team has achieved. These phases or stages might well be recognized in some way by participants - but there may only be a limited consciousness of the changes and their implications. One of the implications is that if team members could develop a better appreciation of the processes surrounding group development then it would be possible to enhance group effectiveness and functioning. Thus, Tuckman's theory captures only the outcome related factors of the team development process and ignores establishing a causal relationship between the process dynamics and the changes that occur due to these dynamics. Secondly, this model is linear as the stages described are successive in nature. The group members tend to seek a balance between accomplishing the task and building interpersonal relationships in the group. At one point the focus will be on the former, at another on the latter. The result is, effectively, a movement between *norming* and *performing* stages.

Tuckman's theory provides a helpful framework for generating explanation of how effective a team is and what stages it passes, and the expectations of the team from the team leadership at various stages. While Tuckman's model might provide useful insights into understanding 'how mature' an IDT is at a certain stage, it is of not of much assistance in understanding the team dynamics and growth as a result of a targeted capacity-development program.

Cyber-infrastructure scholars, for example (Dignum *et al.*, 1986) tend to divide the team process of cooperative problem solving into four stages. First, finding potential team members, and then forming a team followed by constructing a plan for that team. Finally, the plan is executed by the team. They present a theory for team members that are able to discuss the team formation and subsequently work as a team until the collective goal has been fulfilled. They assert the need for continuous structured dialogues amongst potential team members, with an emphasis on persuasion by the leadership, to lead to the required team formation.

The above theory assumes a top-down classical industrial work situation, in which the task is known by someone in advance who has the responsibility to identify the most suitable team members, somehow 'form' these members located at distant locations into 'a team', construct a plan for them and ask them to implement it. The task for the team members is rather simple of following the passed down instructions by the leader and use best of his/her skills and knowledge to deliver his/her piece of the output. While several of similar processes might take place in research teams, the nature of the task might be different. In the case of scientists collaborating on making a scientific innovation or idea practically work in the field, the task might require much more intellectual exchange rather than merely following the orders passed down.

The theories from the business sciences generally tend to focus too much on the team outcomes, that is effectiveness of the team in achieving the desired results, and much less on the processes and dynamics of team formation, team composition, influence of contextual factors and learning behaviors of the team members. The relevance of such

theories to the present inquiry appears not to extend beyond assessing the stage at which an IDR team usually performs.

3.3.3 Theory of Enhanced Problem-and Project- Based Learning

Scholarship on problem and project-based learning[26] identifies four design principles for project based learning. Firstly, defining learning-appropriate goals that lead to deep understanding, secondly, providing scaffolds such as beginning with problem-based learning activities before completing projects and using embedded teaching, teaching tools, and sets of contrasting cases; thirdly including multiple opportunities for formative self-assessment; and finally, developing social structures that promote participation and a sense of agency. The scholarship tends to argue that students' abilities to accomplish projects with understanding can be greatly enhanced through tailor-made training programs implemented in a classroom setting. Careful attention to the social organization of the learning environment can promote problem- and project-based learning. Training can provide ways to support the learner's movement from a passive receiver of already established knowledge to an active, reflective learner. Small group interactions, opportunities to contribute, peer review, and having access to data about how others have thought about the same problem are all methods that can support active, reflective learning.

For example (Barron *et al.*, 1998), who designed an approach to design, implement and evaluate problem-and project-based curricula through a long-term collaboration with teachers, show that project-based learning in classroom environments provided the opportunity to complete something tangible to graduate students, and has been a significant factor in the sense of pride and accomplishment expressed by students. They show examples, when the aim of training is not only to "do with understanding " but also to "learn with understanding.", of how the process of reflecting on one's own learning and

[26] Project-based learning refers to an approach to training adults where a group of trainees is engaged in a practical activity spanning over a few days in order to achieve a tangible result, for example designing a building model, a software, etc. Problem-based learning differs from project based learning in that the target might be something intangible, e.g., devising recommendations to solve a problem.

improvement can be facilitated by the provision of resources and the encouragement to take responsibility for one's learning. They describe how this process has an especially important potential of project-based learning because they can provide room for student agency.

Barron et. al.'s examples can provide useful insights, in the case of this inquiry, into understanding the work of IDTs during the formative stages, when teams undergo structured capacity-building, as well as during the successive 'action stages' of IDR when the teams implement and reflect on their actions.

3.3.4 Small Group Research

Research on small teams e.g. (Bowers *et al.*, 2000; Valenti and Rockett, 2008; Algesheimer *et al.*, 2011; Schilpzand *et al.*, 2011to cite a few) shows that differences among group members cause individuals to interact in ways that may enhance or weaken group performance. Dissimilarities among members may cause the development of negative attitudes about work groups, leading to dysfunctional performance (Schilpzand et. al, 2011). Demographic factors influence individuals' tendency to form network ties within their organizations (ibid). Likewise, the groups that are homogeneous with respect to gender, ability level, and personality achieve higher levels of performance than teams that are heterogeneous on these attributes. However, the influence of these factors depends on the type and difficulty of the task used in the investigation.

Schilpzand et al. (2011) examined the relationship of team members' openness to experience and team creativity. Their work is based on the assumption that not every member of the team is equally open to share his/her experiences with other team members. They found openness of members to experience sharing related to team creativity and productivity. Furthermore, teams that are diverse on openness to experience have the higher levels of team creativity, as long as they have some team members that are low on openness and others that have a moderate level of openness to experience (Algesheimer *et al.*, 2011).

In other cases, individual differences in gender and tenure of work at the organization predicted whether employees interacted within their work groups on advice and friendship dimensions, respectively, but did not affect the establishment of working relationships (For example, Valenti and Rockett, 2008). Group members showed increasing tendencies to form stronger friendship ties within their respective work groups, gender, and tenure.

These examples show how individual team member's ethno-demographic characteristics influence the way in which the members of small teams form and sustain associations and ties at work and how these relate to the team dynamics and overall work performance of small teams. These examples typify characteristics that might be present across all kinds of teams, including IDTs, and therefore, provide useful insights into factors that should be considered when evaluating the performance of an IDT assembled around an innovation.

3.4 Empirical Literature on Interdisciplinary Research

After examining the concept of interdisciplinary research and what it entails, as well as theories that explain team behaviors, in this section I discuss pertinent empirical literature that has attempted to study interdisciplinary team processes.

3.4.1 Classification of Empirical Literature on Interdisciplinarity

Literature on IDR has specially increased in terms of quantity, depth and breadth since the 1990s. A bird's eye view[27] would inform that several specialized journals, for example related to bio-science, ecology, humanities, preventive medicine, informatics, as well as research and science journals have published credible work on interdisciplinarity. The published literature can be categorized in several ways. Table 3.1 presents a

[27] The interested reader is referred to the website of the Network for Transdisciplinary Research (td-net) (transdisciplinary http://www.transdisciplinarity.ch/e/Publications/) where a compilation of links to notable research on inter and transdisciplinary research is listed. The compilation includes pertinent literature from 2004 onwards.

categorization of recently published typical literature, and gleans that major work since 2000 has attempted to address four dimensions of IDR:

a) The first dimension of interdisciplinarity that the literature has attempted to explore and elaborate is the logic and potential of IDR, various concepts that help understanding IDR, comparing concepts, theories around IDR, as well as analogies between interdisciplinarity and system and complexity theories. The work includes (e.g.,(Klein, 1986; Klein, 1990; Klein and Porter, 1990; Funtowics and Ravetz, 1993; Klein, 1996; Klein, 1999; Newell, 2001; van den Besselaar and Heimeriks, 2001; Collins, 2002; Dalgaard *et al.*, 2003; Lattuca, 2003; Klein, 2004; Lattuca *et al.*, 2004; LÉLÉ and Norgaard, 2005; Draggan, 2007; Barry *et al.*, 2008; Fiore, 2008; Hall *et al.*, 2008; Mollinga, 2008; Mollinga, 2009; Huutoniemia *et al.*, 2010; Moran, 2010).
b) The second dimension is an examination of the history of IDR, stock-taking of various developments in IDR, nurturing mechanisms used, and proposing methods to assess IDR. The scholarship includes (Wohl, 1955; Tomov and Mutafov, 1996; Schoenberger, 2001; van den Besselaar and Heimeriks, 2001; Healy, 2003; Morillo *et al.*, 2003; Santoro *et al.*, 2003; Tzu-Liang *et al.*, 2004; LÉLÉ and Norgaard, 2005; Research) *et al.*, 2005; Klavans and Boyack, 2006; Porter *et al.*, 2006; Reich and Reich, 2006; MacMynowski, 2007; Morse *et al.*, 2007; Porter *et al.*, 2007; Gray, 2008; Hall *et al.*, 2008; Hinkel, 2008; Miller *et al.*, 2008; Owens *et al.*, 2008; Pohl and Hirsch, 2008; Rafols and Meyer, 2008; Stokols *et al.*, 2008; Stokols *et al.*, 2008; Moslemi *et al.*, 2009; Huutoniemia *et al.*, 2010; Karen *et al.*, 2010; Lyall *et al.*, 2011; Winowiecki *et al.*, 2011).
c) The third dimension that has been studied is the assessment of the levels and degrees of IDR when attempted. Typical work includes (Conrad, 2002; Morillo *et al.*, 2003; de Boer *et al.*, 2006; Porter *et al.*, 2006; Porter *et al.*, 2007; Pohl and Hirsch, 2008).
d) Most of the scholarship described in above categories uses literature surveys (bibiliometric analysis or synthesis research) as their data. Literature that uses empirical data (case studies of projects and initiatives, interview research) from

actual practice is rather limited. Pertinent examples include (Conrad, 2002; Kostoff, 2002; de Boer *et al.*, 2006; Morse *et al.*, 2007; Pohl and Hadorn, 2008; Stokols *et al.*, 2008; Karen *et al.*, 2010; Aram, 2011).

As we move from conceptual and theoretical to empirical work, the amount of scholarship reported leans down. For example the literature proposing various methodological and nurturing avenues for IDR (category b above) is relatively less compared to that available on concepts and theoretical foundations of IDR (category a above). Likewise, when it comes to indicators assessing degree and levels in IDR as well as analyzing actual IDR practice (category c and d above), the literature is much leaner than the one reported on categories a and b above. This might be due to the relative infancy in which the science of team science is, and partly could be attributed to the challenges that are faced while attempting to operationalize theory into research methodological practice.

Table 3.1 Pertinent literature on IDR

Theme of IDR	Main aim of research	Example work
Conceptual / theoretical foundations of IDR	Elaboration and comparison of concepts; Links with other system and complexity theories and disciplines	Klein (2004); Moran, 2010; Dalgaard (2003); Lélé and Norgaard (2005); Hall, et al. (2008); Barry, et al. (2008)
Measuring progress in IDR	Stock taking of development, nurturing mechanism, methodologies and metrics for gauging	Porter, et al. (2006) Gray (2008) Falk-Krzesinski, et al. (2010) Pohl and Hirsch (2008)
Degree of IDR	Quantitative indicators for assessment of degree of IDR amongst disciplines Quantitative indicators to assess individual's IDR	Morillo, et. al., 2003 Porter, et al. (2007)
IDR practice	Identify limitations and barriers to IDR Understanding IDR as practiced	Conrad (2002); Stokols et. al. (2008) Kostoff (2002) Morse, et al. (2007) Aram (2010) de Boer et al. (2006)

Source: Authors compilation based on IDR literature listed on TD-NET

The above table shows that much of the analytical work that has been undertaken on interdisciplinarity focuses on conceptual and theoretical foundations of IDR, relatively

less on measuring the progress, or indicators to objectively assess degrees and levels of IDR. Most of the empirical work is based on review of published literature, and comparison of published cases. In-depth studies that actually analyze a single case study of IDR practice has only been conducted by Aram (2011), and der Boer et al. (2006). Aram examines interdisciplinary graduate schools and the views of the faculty directors about interdisciplinary teaching programs they directed, and der Boer and colleagues provide a reflexive account of researchers about their interdisciplinary experiences from an interdisciplinary project. Both of these studies do not examine, however, the role of capacity building on actual nurture of interdisciplinarity practice.

Relatively more relevant literature to the current inquiry would be the literature analyzing actual capacity-building aimed at nurturing interdisciplinarity. The existing IDR capacity-building models that have been empirically analyzed include:

a) The formal education models run by graduate schools (for example by Morse *et al.*, 2007; Moslemi *et al.*, 2009; Karen *et al.*, 2010; Aram, 2011);
b) event-based models that analyze single interdisciplinary training events (MacMynowski, 2007);
c) interdisciplinary conference models that analyze a multi-day interdisciplinary training or discussion events (Hall *et al.*, 2008).

The sub-section below distills key findings from the empirical literature indicated above.

3.4.2 Key Findings from Empirical Literature

a) Feasibility of IDR for Problem Oriented Research

Conrad (2002) based on the study of two comparative international problem and policy oriented social science research projects asserts that in problem oriented interdisciplinary research, main level of scientific explanation is (qualitative) description and assessment on the basis of appropriate taxonomies. Since substantive technology development as well as policy recommendations assume the feasibility of strategic intervention, problem oriented research projects require at least some functional explanation and concept of

system control (Conrad, 2002:14). However, apart from basic disciplinary premises, problem oriented research tends to mainly combine concepts from different scientific specialties (e.g. innovation theory, organizational learning, theory of policy games, theory of economic structural change in the social sciences), and not from scientific disciplines in general (Conrad, 2002:13). He further argues that interdisciplinary theory development and problem oriented research typically remain separate activities (Conrad, 2002:14). Finding the right balance between sufficient theoretical orientation and sufficient problem concern in problem oriented research usually requires practical solutions specific to each case and that substantive general statements concerning interdisciplinarity are hardly feasible in this respect. Therefore, the chosen frameworks and models in an IDR exercise in a problem oriented research context, such as that of Uzbekistan project, may vary not only due to prevailing disciplinary norms and interests (Conrad, 2002:14), but also due to the quest for solutions for the problem within the given context. Similar views are echoed by Lélé and Norgaard (2005), who found that collective judgments and synthetic interpretation made in IDR may have to be more interpretative, as in some social sciences, than the positivist approach of the natural sciences and mainstream economics.

b) IDR is a negotiated outcome

Conrad (2002) argues that, "[o]*ne should usually not expect generalized theory building in problem oriented research"* (Conrad, 2002:13), even if the projects clearly acknowledge the multidimensional (and interdisciplinary) character of research which involves questions and problems relating to both nature and society. In his research, he found out that "…..*project* [did not] *provide an adequate* [interdisciplinary] *explanation….as was the original intention* (Conrad, 2002:1). These views are equally shared by Miller, et al. (2008), who conclude that in an IDR exercise, " *a reorganization of multiple, potentially equally valid ways of knowing requires a negotiation governed by the specifics of the question and the composition of the research team*" (p. 12).

c) Funding and Sustainability of IDR

IDR and team science initiatives typically entail substantial multiyear commitments of monetary, human, and material resources (Stokols, et al., 2008: 96), but its contribution to scholarship, training and society may not be evident for several decades. IDR and TDR initiatives are highly labor intensive, conflict prone, and require substantial preparation, practice and trust among team members to ensure a modicum of success (Stokols, et al., 2008). However, many of the large research sponsoring organizations are structured along the lines of monodiscipline university departments, and their review panels tend to have similar structures. As a result, monodiscipline research proposals fare better than IDR proposals (Kostoff, 2002:939) during proposal evaluations. Hall et al. (2008) share these views and assert that the funding mechanisms accord relatively lower priorities to inter and tarnsdiciplinary research. They pose serious questions regarding the sustainability of IDR in institutions that heavily rely on external funding to conduct IDR, as their findings indicate that once IDR specific funding is removed from a research team, center or institution, the earlier collaborative efforts may not be sustained (Hall, et al., 2008:S245).

d) Role of foundational conditions in facilitating IDR

Individual and team level efforts to undertake IDR need to be complemented by major institution level changes in curricula, incentives, evaluation criteria, and accountability mechanisms. For example, recognition, promotion and reward system within the institution and organizational culture contribute to determining how much the involved researchers will be interested in undertaking interdisciplinary research (Kostoff, 2002:939). The scientific peer review systems within research and academic organizations generally is oriented towards evaluation by monodiscipline reviewers, who give less marks to less intense advances made across a range of disciplines (Kostoff, 2002:939). Some of these institutional constraints can be eased at the outset of major IDR projects (LéLé and Norgaard, 2005). Hall et al. (2008) argue that institutional support for interdepartmental and cross disciplinary collaboration, the breadth of disciplines, the degree of previous collaboration, the spatial proximity of member's

offices and laboratories, and availability of electronic linkages positively contribute towards team's success in IDR .

e) Role of Process Leadership in Facilitating IDR

Gray (2008) investigated the role of leadership for successful interdisciplinary collaboration amongst scientists. She found that critical to promoting effective collaboration are leaders who have the credibility to get the right people together to create visions, solve problems, and reach agreements about implementation actions. These leadership tasks do not necessarily need to be performed by a single leader. Instead these could be handled in a distributed fashion by multiple members within a team (Gray, 2008: 128). These findings are equally shared by Stokols, et al. (2008), who argue that leaders substantially influence collaborative processes and outcomes because leader's intelligence, self confidence physical appearance, educational status, task relevant knowledge and sensitivity to members socio-emotional needs contribute to effective team leadership.

Process skills, for example decision making, problem solving, conflict resolution, information exchange, coordination, and boundary management, have been found as crucial determinants to successful IDR collaborations (Gray 2008:S125). The absence of such skills has been noted to lead to conflicts regarding legitimacy, power differences, and heterogeneity of aims of collaboration (Gray 2008:S125). Leaders with the skills to manage collaboratively may make the difference between success and failure in IDR.

Leadership tasks include cognitive tasks of providing a vision, sense making and influencing mental maps of participants. Transformational leaders high on charisma are seen as powerful shapers of their follower's aspirations, which positively affect team performance. IDR team leaders need to be able to envision how various disciplines may overlap in constructive ways that could generate scientific breakthroughs and new understanding in a specific problem arena (Gray, 2008).

Process leadership task, which include activities by the leader that ensure constructive and productive interactions amongst team members, have been found to contribute towards success of collaborative teams. Important set of interpersonal skills are required for the leaders. Interpersonal tensions generate negative emotions that erode open exchange of ideas. Interdisciplinary process leaders need to facilitate effectively by demonstrating good listening skills, empathy, and the ability to re-orient the team effort to long-term goals (Gary, 2008: 128).

For small and collocated teams, a single, centralized leader may be sufficient to provide the charisma and coordination functions to promote effective collaboration. The centralized leaders can maintain close connection to others in the team and enjoy informal, face-to-face connections that foster exchange, coordination and emotional support. Process interventions that instill creativity and teambuilding are not only feasible but likely to improve outcomes. Without institutional champions higher up in the organization, even these small collaborations could experience limited success (Gray 2008: 129).

f) Team Composition and Characteristics

Team members familiarity with each other and greater social cohesiveness lead to increased productivity. Good performance leads to enhanced social cohesiveness (Stokoles, et al.: S99). Strong network ties are more likely to form among members sharing demographic and educational criteria compared to those who do not. Heterogeneous teams perform better on tasks that are creative and intellectual (Stokoles, et al., 2008:S100). Familiarity among team members, however, negatively influences performance with the passage of time, suggesting that temporal factors play a crucial role in member's efforts to establish and sustain high levels of performance in collaborations. This decline is explained through social loafing and groupthink phenomenon. The labor intensity of interdisciplinary collaborations may particularly pose unique challenges to younger researchers who are particularly concerned about establishing strong scientific identities within their chosen fields (Rhoten and Parker, 2004)

Team size determines the level of effectiveness of IDR teams (Stokols, et al., 2008). Optimal team size is likely to vary depending on the kinds of teams and organizations under study. Smaller (<20) and medium sized (21-50) centers were found more conducive to the generation of interdisciplinary knowledge than larger centers (>50) (Rhoten and Parker, 2004). A flexible attitude of researcher with regard to one's own position assisted in intense exchange (Pohl and Hirsch, 2008:116).

Virtual and Distributed Teams refer to those arrangements in which team members are geographically dispersed. Spatially, and often temporally and culturally separated teams are called virtual and distributed teams, respectively, which may face technologic, environmental and socio-cognitive and emotional challenges (Stokols, et al., 2008).

Technological challenges are related to adequacy of infrastructure in terms of availability, appropriateness, and technical support mechanisms. Tacit behaviors taken for granted in face-to-face communication become major impediments in virtual teams (Stokols, et al., 2008). The unawareness about the emotional and mental state of remotely interacting members becomes an impediment. It becomes critical for dispersed team members to be explicit about information that is normally tacit in collocated teams to ease the collaborative processes (Stokols et al., 2008). Misunderstanding due to linguistic differences, disparities in management styles, and status conventions in different cultures can constrain the effectiveness of global teams.

Building and sustaining trust are the most crucial conditions virtual and dispersed teams must achieve to be successful. Trust is especially fragile and transient in virtual and dispersed teams, as members do not share a common socio-physical context, norms, values, and expectations, nor do they have opportunities to monitor each others behavior. Face-to-face contact early on may be a prerequisite for successful remote collaboration. Effective and sustained communication is an essential element for creating common ground as a precursor for trust building.

g) Team Communication

The lack of adequate feedback and communication is a major impediment to team performance. Regular group communication involving the exchange of organization-relevant knowledge among employees, and good communication amongst members was found to encourage feelings of trust and psychological safety that enables teams to better manage issues of size, compatibility and cohesion. The use of brainstorming to promote communication and idea generation was found especially useful for those teams that communicated electronically (Guzzo and Dickson, 1996).

h) Importance of Reflexive Learning

Engaging in research collaboration opens up new possibilities for reflexive and democratic engagement within scientific communities (Pohl and Hirsch, 2008). Contrary to their disciplinary training, participants of IDR and TDR need to be self reflective about the value judgments embedded in their choice of variables, and models, willing to give respect to and also learn more about the "other" and able to work with new models and taxonomies used by others. The IDR project teams need to keep thinking flexibly and allowing for plurality and incompleteness (LéLé and Norgaard, 2005). To understand the diverse scientific and societal views of problems and engage in mutual learning and integration is a core challenge of IDR (Pohl and Hirsch, 2008:114). The first step in mutual learning and integration is to acknowledge the diversity of perspectives and explore and clarify their differences (MacMynowski, 2007; Pohl and Hirsch, 2008).

i) Facilitating Factors for Interdisciplinarity

Familiarity of team members with each others' way of thinking, which can be harnessed through prolonged and regular exchange of ideas, and the development of informal personal relationships (Creamer, 2004) Off-site retreats have been found to promote communication, amongst team members, reduce interdisciplinary tensions and stimulate intellectual integration (Stokols *et al.*, 2005). The leadership skills of team leaders and senior management, especially tactfulness in conflict resolution and the ability to encourage cooperation among team members are important assets for successful IDR teams (Stokols, et al., 2008).

j) Barriers to Interdisciplinarity

Barriers to expanding beyond traditional disciplinary research in graduate programs include a lack of funding for interdisciplinary research, a lack of historical interdisciplinary cooperation, extended time requirements, differences in methodologies and disciplinary norms, turfism, and egos (Brewer, 1999; Golde and Gallagher, 1999; Younglove-Webb *et al.*, 1999; LéLé and Norgaard, 2005; Eigenbrode *et al.*, 2007; Morse *et al.*, 2007). These factors can be especially burdensome in a university research setting in which graduate students are required to meet traditional departmental graduation requirements (Morse *et al.*, 2007).

Interdisciplinary research can be challenged by individual personalities, disciplinary disciplines, and programmatic design (Morse *et al.*, 2007). Interdisciplinarity faces intellectual and institutional constraints (Eve, 2010). Disciplines might overcome epistemological barriers through training, collaborative experiences, but economic and pragmatic superstructures, that both control the disciplines and also bestow them their power, impose hard limits (Eve, 2010).

Groupthink, a phenomenon in teamwork that leads to suppression of differences within a team due to its inability to bridge power differences, may lead to so called *Challenger*

disaster, implying that the team members having different views may not express and share their differential views due to power distortions within the team (Gray 2008:S125). In agricultural research collaborations, the need for integrating local knowledge does not match the scientists' preferred approach to the topic under research (Gray 2008:S125). Unrealistic expectations for complete cooperation and harmony, ambiguity of goals and intended outcomes, can impede team's collaborative efforts (Stokols, et al., 2008). Collaborative IDR requires substantial preparedness, practice and sustained effort.

Factors like lack of time, scarce resources, insufficient appreciation or recognition, competing institutional demands, loss of autonomy in decision making, frustration due to lack of progress, and inter-professional conflicts impede IDR and TDR collaborations (Stokols, 2008:S105). Member's incentives to remain involved should exceed personal costs they incur through their participation. The incentives can be financial compensation, training and educational opportunities, and peer recognition.

k) Adequacy of Time is critical for meaningful IDR

Sufficient time is required for any meaningful interdisciplinary collaboration to learn techniques, cultures and traditions of other disciplines (Kostoff, 2002:939). These views are echoed by Conrad (2002:13):

> *Sufficient time, which is usually lacking, should be provided to acquire and to utilize a common conceptual (theoretical) framework in problem oriented research….because a project team's substantial (i.e. emotional) internalization, and the subsequent implementation/ utilization of such a newly developed conceptual framework is undoubtedly a time consuming process which requires repeated feedback loops of social learning*.

l) Strategies to overcome barriers

Pohl and Hirsch (2008) argue that differences in disciplinary languages complicate the IDR processes, which can be addressed by preparing glossaries of terms or deliberately avoiding using scientific terms. But they also recognize that everyday language is ambiguous and contextualized, and therefore, having a common language might not be *a universal panacea* (Pohl and Hirsch, 2008:115). They also argue that experimental implementation enables learning processes through providing means for reflection for teams and individuals. Proactive planning and continued reflection on the process of reflection throughout the project cycle has been found helpful in navigating through many potential barriers and in identifying other prospective bridges (Morse *et al.*, 2007). They also argue that the process of integration can be furthered through documentation of experiences and processes (Morse *et al.*, 2007). Stokols and colleagues assert for participatory goal setting, which enhances team performance by encouraging feeling of inclusiveness among team members and providing them structure, connection, and shared beliefs as well as enhancing collective efficacy (Stokols, 2008: S101). They also argue that team development strategies (e.g. capacity building, experiential learning, and appreciative inquiry) are useful in facilitating member's efforts to reach consensus about shared goals and aspirations.

m) Role of training in facilitating interdisciplinarity

Hall et al. (2008) argue that training pre and post-doctoral scholars, and researchers assists in enhancing readiness for team science. They also assert that supervising scientists also need to be trained during IDR training models, as they are charged with mentoring and management responsibilities within IDR initiatives (Hall, et al.2008: S246). Besides, they stress the importance of retrospective and prospective evaluations of the processes and outcomes of the training at different stages of an IDR initiative, which should be incorporated within the design of IDR initiatives (Hall, et al., 2008: S248).

What becomes evident from the key finding of empirical literature on IDR is that IDR in a problem oriented research setting remains a unique challenge, because the research problem tackled has both intellectual and practical dimensions. IDR in such a context is further complicated by the foundational and contextual factors, as well as team size, characteristics and composition. Training, capacity-building and team development activities can ease some of these challenges, but are not panacea for all problems experienced during an IDR exercise. As a result, one can argue that the IDR becomes a social process which results into a negotiated outcome as a result of an inter play of the factors mentioned above.

3.5 Research Question and Sub-questions

The IDR capacity-building models so far analyzed (Section 3.4 above) differ substantially from the model that ZEF used in its Khorezm project in several respects (for details of the ZEF model, see chapter 4). Firstly, most of the above mentioned capacity-building models are of a single focused event spanning over a single day to few months, but in a concentrated time span, whereas the model under investigation spanned over at least five events of five days each spread over a period of three years. Secondly, the above mentioned models require the participants to focus on and engaged in IDR related capacity building for a few days. Such models require the participants to put their rest of the research tasks on hold for the duration of the capacity-building. The ZEF model, on the other hand, required the participants to not put their regular tasks on hold, rather use the delivered skills and tools to enhance their job performance. Thirdly, the content design of many of above mentioned initiatives is that a host of knowledge, skills, insights, frameworks, and tools are presented to the participants and the participants are then left to decide whether or not to deploy these in their actual IDR practice. The ZEF model required the participants to modify, adapt and use the skills, knowledge and tools delivered in actual practice and provide a feedback to the process. Finally, the above-mentioned training programs are of top-down nature, offering little or no feedback or monitoring mechanism of participant's actual practice. The ZEF capacity-building model, in contrast, was by design a reflective mix of both top-down and bottom up designs. ZEF initially conceived the major themes of the successive trainings, but the content, style,

organization, and even the choice of the trainer was influenced by the participants through their feedback. Each training session had lessons from the previous one incorporated into the design, content and method of delivery (see Chapter 4).

These differences in capacity-building pose new research questions compared to those which are addressed in the literature so far. The following section elaborates the main research question and the sub-questions relevant to this inquiry.

The main research question for the present study was:

> To what extent and how did ZEF's model of structured and longitudinal capacity building shape and nurture interdisciplinarity amongst its innovation teams of collaborating scientific staff?

The main research question is studied through several sub questions, which were used as guidance for the study:

3.5.1 Role of longitudinal capacity-building in nurturing Interdisciplinarity

a) The FTI teams went through a tailored and targeted capacity-building program to equip them with essential concepts, approaches and tools to work inter- and transdisciplinary. Questions to be addressed on this include: What were the characteristics, strengths and weaknesses of the longitudinal capacity-building model that ZEF used in nurturing interdisciplinarity and did it contribute towards understanding of the team members? Has the capacity building program facilitated their understanding of the need to work interdisciplinary and transdisciplinary? Has it facilitated collaboration? These questions are largely discussed in Chapter 4.

3.5.2 Epistemological and demographic factors and Interdisciplinarity

How did the differences in disciplinary background, nationality, age, and location of the member scientists shape the team processes and impact the team performance within various FTI teams, and in what way?

The disciplinary differences to a large extent tend to reproduce in most situations and disappear very slowly (Mollinga, 2008:18), the collaboration amongst disciplines may result in serious communication problems right from the outset. Besides, each of the FTI teams comprised of members from different age groups and nationalities, differing in professional maturity, cultural styles, languages, etc. These differences might have influenced the teamwork. These issues are discussed in Chapter 5.

3.5.3 Method of Appointment and Interdisciplinarity

Does the voluntary and involuntary participation in IDR teams influences the achievements in IDR?

For various FTI teams most of the scientists did not choose their FTI group themselves in the first place, and were largely appointed to various groups depending upon the perceived relevance of their disciplines to the chosen innovation in question. Only a few Ph.D. students chose their groups as a research interest. Many of the FTI team members therefore might not have wanted to collaborate in the first place with other members of the team. Chapter 5 examines issues related to method of appointment.

3.5.4 Location of Team member and Interdisciplinarity

Did physical location of team members influence the team collaboration, and in what way? FTI team members were located at the research sites in Urgench, in Tashkent, and in Bonn. Many times, they needed to collaborate virtually through emails, telephones, and other internet-based messaging software. The teams whose most members were located at spatially different locations undertook more virtual communications than those teams whose members were most of the time located at one place. Such virtual teams might have experienced additional communication and understanding issues. The performance and challenges of collocated and dispersed teams are discussed in Chapters 5,6, and 7.

3.5.5 Contextual and managerial factors and Interdisciplinarity

How did facilitation, project management, and other contextual factors in which these collaborations took place, fostered or impeded IDR? As explained in Chapter 2, ZEF's projects are carried out in a specific context. The nature and organization of Uzbekistan project, its management and facilitation mechanisms might have influenced the nature, degree and outcomes of the IDR. These are deliberated in detail in Chapter 2 and further discussed as a running theme throughout the study.

The inductive nature of the inquiry needed grounded evidence for which empirical data were required. The data were collected using various methods and techniques which are discussed in the following section.

3.6 Data Collection Methods

This section discusses various data collection methods deployed during this inquiry. As far as understanding the role of structured and facilitated capacity-building in nurturing IDR amongst teams of scientists comprising more than a single discipline in ZEF's Uzbekistan project, the study had to be conducted as an empirical case study. The nature of the study required, both qualitative and quantitative data. Since this inquiry aimed at providing a grounded explanation of the IDR and how it was influenced by the structured capacity building in ZEF's Uzbekistan project, a mixed-method methodology incorporating authors own observations as the process facilitator and reflections on those observations, structured surveys with the participants, various training and process notes, notes documenting field events and interactions, and semi-structured interviews with a selection of FTI participants seemed appropriate.

The use of mix-methods in social science research has increasingly become popular and is generally accepted as a valid, but separate research methodology since the third methodological movement in social research (Tashakkori and Teddlie, 2003). The

advantages of mixed method approaches compared to single data collection approach is that the former ensures availability of essential data, as well as ensuring internal validity and consistency of data on two accounts. Firstly, such an approach neutralizes the disadvantages of using either quantitative or qualitative methods, and secondly, its ability to assist in grasping complexity of reality is high, which otherwise might be perceived too simplistic (Creswell *et al.*, 2003). The purpose of a mixed method approach was to strengthen the analysis as both kinds of data would compliment each other and provide deeper insights into the complex processes of nurturing interdisciplinarity.

However, before discussing the data collection methods employed during this inquiry, I examine the methods so far employed for the empirical studies analyzing interdisciplinarity and what lessons could be learned from those studies for the present inquiry.

3.6.1 Methodological Challenge: Facilitation and investigation roles combined

Primarily, I was recruited as an in-house facilitator, whose role was to coordinate, facilitate, and manage the process and get the process of innovation testing and adaptation going. This clearly was an action role, which required a thorough understanding of team characteristics, dynamics, and dilemmas and a mentoring and coaching style, whereby I was to advise teams how to resolve issues and challenges they faced. The focus of this role was much more on helping the teams to getting closer to the intended outcomes of the process. The innovation testing and adaptation exercise was not a stand alone project of its own. It was embedded within the overall Uzbekistan project, and thus required me as the process facilitator to liaise with project managers and departmental coordinators, and sort out conflicting issues within the overall management systems of the Uzbekistan project. There were often contestations between what was desirable for a perfect interdisciplinary process to take shape and what was possible within the constraints and limitations of the project, such as availability of staff time, scheduling of various activities and limitations to financial resources.

As a researcher, I faced several challenges. First challenge was to be a neutral observer of the team processes, and understand the causality of why things happen in a specific way. This clearly confronted with my facilitation role, as the facilitation role did not allow to be a neutral observer only but to be an observer with an intervention agenda. The facilitation role required me to focus more on setting the process right rather than being a neutral observer. The second challenge was how to analyze one's own role as a facilitator objectively avoiding biases. These two challenges could not be addressed fully, but I tried to document the challenges I faced as a result of the combination of these two roles on a daily basis, and reflect on my notes frequently. The third challenge was more of an administrative nature. What in a researcher's view would be the right methodology to document and analyze the process would not necessarily be desirable from a process facilitation perspective. For example, to document the over time changes in trainee's perceptions about their own epistemology, and to understand changing team performances as a result of each of the training events, required me to repeat the perception surveys after each training event, but repeated surveys were considered over burdening by my ZEFa supervisor, and I was not allowed to repeat these after the first survey. I tried to address this limitation by complementing the perception surveys with semi-structured interviews with FTI participants towards the end of the exercise, as well as by documenting informal conversations at lunch table, at tea breaks, and at smoking area. An advantage for me as a researcher was that I lived considerable amount of time at the project's guest house, where most of the FTI participants stayed, and thus was able to establish rapport with them and got frequent opportunities to discuss work related issues in more informal setting than during structured and semi-structured interviews. Living with the participants gave me access to information that otherwise would not be possible to obtain.

3.6.2 Methods employed for empirical interdisciplinary research

Table 3.2 attempts to present an overview of methods used by pertinent empirical studies on IDR. There appear to be two analytical approaches employed so far. One strand follows survey of literatures (for example Morillo, et al., 2003 and Porter, et al., 2007) and then using mapping techniques for bibiliometric analysis of publications to

understand the degree of IDR in practice (Table 3.2). These methods identify which disciplines collaborated with which ones, and how deep the resultant interdisciplinarity was. Such methods, however were not suitable for the current inquiry as these methods could only be deployed to understand IDR practice in the past and are of not much assistance in analyzing an on-going IDR exercise. Besides, such methods only assist in analyzing IDR as an outcome and do not offer much assistance in understanding the processes through which participating scientists achieve IDR outcomes.

Table 3.2 Research methods used for empirical study of IDR

Theme of IDR	Research / Analytical Methodologies	Example work
Degree of IDR	Cluster analysis of bibiliometric records of ISI CV based publication analysis	Morillo, et. al., 2003 Porter, et al. (2007)
IDR practice	Comparison of case studies Text mining In depth analysis of a single case Interview research Case study analysis	Conrad (2002); Stokols et. al. (2008) Kostoff (2002) Morse, et al. (2007) Aram (2010) Pohl and Hirsch (2008), de Boer et al. (2006)

Source: Authors compilation based on IDR literature

Another strand of scholarship analyzes actual practice of IDR using interview research (for example Aram, 2011), and single or comparative case studies (e.g., Conrad, 2002; de Boer, et al., 2006; Morse, et al., 2007; Pohl and Hirsch, 2007; and Stokols et al., 2008); or text mining of the existing text from the internet (Kostoff, 2002).

As is clear above, most empirical studies analyzing interdisciplinary research have used single research methods, either positivist approaches of quantitative analysis, or qualitative and anthropological methods of interview research, case study analysis, or text mining. In that respect, one novelty of this research was that it employed a mixed methods methodology data collection design which encompassed trainees' self reported surveys, as well as semi-structured interviews, participant observations, observing participation, methods of institutional ethnography to analyze textual reports of the project, reports produced by the FTI teams, and the capacity-building consultant, as well as the publications produced by FTI teams. Another novelty, and potential limitation of

this research was that I had two conflicting roles during this research- that of the process facilitator, as well as that of an investigator and researcher. These methods are briefly elaborated below.

The overall data collection approach for this inquiry was as presented in Table 3.3 below:

Table 3.3 Data Collection: Tools, purposes, and relevance to research questions

Data Collection Technique	Purpose	Relevant research sub-question
Perception Surveys	-understand the team development stages - understand researcher's understanding of and attitude towards IDR -Understand the role of voluntary/involuntary appointment to IDR	3a 3c
Semi and unstructured interviews	-Understand member's role, activity, ideas, problems and challenges faced during working within FTI teams -Understand the overall experiences of participants	3a,3b,3c.3d
Team Member Profiling	-Understand the role of sociological variables on IDR (ethnic background, age, gender, experience, epistemological affiliation) -Understand the role of virtual team members and communication issues to IDR	3b 3d
Textual analysis	-Understand the role of contextual and organizational factors, project management, facilitation, on IDR within Uzbekistan project	3e

Data were collected from all the members of teams engaged in the FTI process, as much as possible. This encompassed the following data and collection methods.

Self Reported Surveys:

Team Member Profile Survey (August 2008)

A structured format was prepared and handed over to all FTI members requesting them to fill highest level of education, previous job experience, age, ethnicity, and gender

Epistemologies of participants

A structured self reporting perception survey about understanding and attitude towards working interdisciplinarity before engaging in actual FTI work

Clark's Team Work Survey (Clark, 2009)

A structured format was circulated requesting participants to score team members perceptions about what were the major patterns of team behaviour within various FTI teams to determine the stage of team development (carried out once during month 10 of the activity)

Semi- and unstructured interviews with senior and junior FTI team members

- Member's role, activities, ideas, problems and challenges faced during working within FTI teams
- Informal discussions and reflections on FTI experience with FTI team members;
- Interview on the overall FTI experience with four FTI team members at the closure of FTI
- All FTI trainings were reported in great detail by the consultant. These reports included the objectives of the training, main themes addressed, and a summary of process issues and challenges discussed at the training. Each group discussion during the training was documented by one of the training participants, and annexed to the main report. These discussion notes provided useful data about the team issues, as well as group reflection on those issues.
- Detailed field notes were prepared during field visits to sites together with FTI team members where innovations were being validated. The researcher often participated in these events as an observer, and sometimes as an active participant.
- Textual analysis of key project documents, particularly related to earlier process documentation of the FTI experience, ZEF's IDR strategy, the project phase III, and the work package on FTI were thoroughly read, analyzed and used as important sources to contextualize this inquiry

The process notes, together with other qualitative data were entered into Atlas.ti® software together with researcher's reflection on these notes. The notes were coded and later used for analysis.

3.7 Ethical Considerations

As the data collection through various techniques involved the research staff of the project, several ethical considerations had to be taken into account during both data collection as well as the reporting stage of the study. All data collection instruments, especially perception surveys, formal and informal interviews, group discussions, participant observations were conducted with the informed consent of the interviewees. The process documentation reports by various groups as well as the training and other project and ZEF reports are properly referenced.

The analysis presented in the following chapters does not mention any names of participating scientists or their actual designations. The participant's disciplinary affiliations are, however, not masked, but presented in such a way that a direct association between the FTI member and his/her discipline in terms of the level reflecting level of expertise and responsibility (for example senior agronomist, Ph.D. student in social science, research assistant in economics, etc.) cannot be identified. The names of key staff that had coordination responsibilities for the entire project, or a ZEF department, are not mentioned but referred to by their designations.

3.8 Conclusions

This chapter examined various concepts relating to interdisciplinarity and how it should be understood considering other related concepts of disciplinarity, multi- and transdisciplinarity. I operationalize the concept of interdisciplinarity as research aiming at consolidating, synthesizing and integrating perspectives, knowledge, approaches, and tools at various levels. These levels of integration can be multiple and progressive, as explained in Figure 3.1. I also concur with scholarship that differentiates between big and small interdisciplinarity, the former happens between distant disciplines and the latter between allied disciplines. The relevance of various fields of scholarship to the current inquiry is elaborated. Theories explaining team behaviors from educational psychological perspective, business science perspective, small group research, and project and problem

based learning perspective provide useful insights into the study of various aspects of interdisciplinary teams.

The main research question for this inquiry is how a structured longitudinal capacity-building design, a novelty attempted by ZEF's Uzbekistan project, together with in-house facilitation and nurture mechanism shaped interdisciplinarity. The methodological novelties of this study were the use of mixed methods data collection approach as opposed to single method approaches, on which most empirical interdisciplinary research has so fare dwelled. The research methods encompassed self reporting surveys, participant observations, observing participation, semi-structured interviews, documentation of informal conversations, and institutional ethnographic methods of text analysis, A unique methodological challenge for this inquiry was that the roles of process facilitation and investigation were packed in one individual, which offered unique advantages in data collection as well as posed some additional challenges to the inquiry.

Chapter 4: Capacity-Building for Nurturing Interdisciplinarity in the Uzbekistan Project

4.1 Introduction

To kick start the process of interdisciplinary research in its Uzbekistan project's third phase, the Center for Development Research (ZEF) chose an innovative design of training its Khorezm project staff through a series of capacity building events spanned over a time of three years and combining it with learning-by-doing through taking actions based on the knowledge gained through the training. This chapter examines the capacity development of staff by ZEF's Uzbekistan project for undertaking interdisciplinary research. Section 4.2 examines the planning process of this capacity-building strategy. Section 4.3 discusses the implementation of training events. In section 4.4, I discuss participation in these events. Section 4.5 discusses participant evaluations of various events, and the final section 4.6 concludes the discussion.

The main findings are related to the foundational conditions around ZEF's IDR exercise that framed the experience of nurturing interdisciplinarity within ZEF's Uzbekistan project, as these conditions delayed the recruitment of the process facilitator, and did not allow key Urgench-based staff to participate in the first training, that was supposed to lay the foundation stone of interdisciplinarity. The critical role of foundational conditions in nurturing interdisciplinarity was also visible from the overtime participation of staff in FTI training events, which dwindled all along the duration of the phase.

The literature discussion sessions as a follow-up of the critical discussions during the first training, could potentially act as a first bridge in narrowing epistemological gaps prevalent within ZEF's three departments, but these exercises further confused those participants who were not exposed to the critical discussions that took place during Training I in Bonn on why interdisciplinarity was needed in the first place. The choice of

innovations during training II for FTI process mirrored the past history of interdepartmental hierarchical power distribution within ZEF.

The combination of delivery methods (power point presentation, group work, energizers, visualizations and charts, discussions in plenary sessions) used during various trainings was found useful by participants. The participant expectations were generally met in almost all training events. A section of participants, most likely the research assistants, desired rather prescriptive style of training. This once more points to the complexity involved in training staff on participatory and social science research methods of research in organizations where positivist analytical methods generally prevail.

Despite the above-mentioned issues and challenges, the incremental, additive, and longitudinal design of capacity-building appeared to work in general for FTI teams. The gradual learning amongst all FTI teams about the complexity of their respective innovations, system complexity, importance of processes and process variables, and the need to adapt the innovations further to fit the local context did happen. The proponents of innovations, who initially believed that the innovation was "great" were moving forward to understand that it is not the innovation alone that can address the problems Khorezmian agriculture faces, rather each of the innovation has to be tailored to work in a bigger context that is shaped by not only the variables addressed by a single discipline..

4.2 Planning for Capacity-Building in Interdisciplinary Research

The rationale for kick-starting interdisciplinary research (IDR) processes in the project through capacity-building was the perceived complexity involved in scientific collaboration amongst staff from various disciplines, as well as a lack of capacity and knowledge within most of ZEF research staff about how to organize it[28]. The capacity-building was foreseen as a route "*towards attitudinal changes and skill enhancement that*

[28] The observation and experience of the researcher responsible for writing the social science part of the third phase proposal was that there was a general lack of reading and capacity on IDR within ZEF (Personal communication, July 2012).

were required [to kick start] *an intensive process of team building, training about participatory research methods and innovation processes, and design of an* [interdisciplinary research] *approach fit to the Khorezm context"*(Martius et al., 2006: 181). Thus, capacity building was assumed to inculcate knowledge and attitudinal changes amongst the participating staff members to recognize the validity of other disciplines and to overcome their own disciplinary biases towards others, to equip the participants with needed additional skills for being able to work interdisciplinary, and to facilitate interdisciplinary team building processes. It was hoped that through capacity-building and facilitation, the participants would be able to design an approach towards innovation adoption that would fit the Khorezm context. In parallel, the 'innovation packages' to be taken up for concrete implementation were to be assessed, selected, and research started on innovations of lower degrees of maturity, and supporting research started on issues relevant to the design and implementation of the interactive processes (Martius *et al.*, 2006: 181).

The plan was that during year 1 of the third project phase, interdisciplinary teams would be formed around the selected 'innovation packages'. This process of team formation was to be led and facilitated by a senior staff member, an FTI facilitator, exclusively responsible for the overall management and facilitation of the capacity-building as well as actual FTI process. The initial aim of the capacity and team building processes was inclusion of three to four innovations for IDR experimentation, and the ability of the teams responsible for the selected innovations to produce their specific IDR work plans. The first year experiences were to serve as early case studies and learning occasions for the whole FTI team. The resource persons for actual carrying out of the trainings about IDR were to be recruited as short-term external consultants, for which financial resources were earmarked in the project proposal.

The FTI work package (Mollinga, 2006) presented an outline of main capacity building themes as a) background (overview and experiences) on participatory technology development approaches; b) tools for stakeholder mapping and analysis; c) design for FTI processes for identified 'innovation packages'; and d) communication, interaction and process documentation skills for the FTI process. Though not explicitly articulated in

the work package, one of the implicit objectives was to expose the participating staff to, both the need and mechanisms of undertaking interdisciplinary research within the project. The structured capacity-building process had to be undertaken within the first fifteen months of the project phase, after which actual implementation had to start. The duration of these capacity-building events was initially foreseen to be around 7-10 days each (Martius *et al.*, 2006; Mollinga, 2006).

These ideas of structured capacity-building were further discussed and elaborated into an FTI training plan (Table 4.1) between the author of the work package from ZEFa, project's science coordinator from ZEFc, and project's field coordinator[29] from ZEFc.

Table 4.1 FTI Training Plan

Main Theme (planned timing and location)	Contents
Training 1: Concepts of agricultural innovation and interdisciplinary research (February 2008, Bonn)	- Concepts of interdisciplinarity, hard and soft systems thinking, positivist and constructivist schools of thought - Concepts of technology, innovation, adoption and adaptation
Training 2: Participatory research methods and communication styles (June 2008, Urgench)	-Participatory research and the roles of different actors. - The values and knowledge of different actors - Issues of stakeholder involvement - Issues of contextual factors and their influence on the nature of participatory research and dissemination and result utilization. - Communication mechanisms among research teams -Develop a framework to report processes and results.
Training 3: FTI research and activity plan design (Urgench, 2009)	-Identify promising innovations for the FTI research - Identify potential users and stakeholders, understand their specific situations, forming user groups, joint meetings between research teams and potential users to identify activities, define responsibilities, clarify procedures and institutional arrangements -Develop monitoring and evaluation procedures - Training on process documentation and systemic analysis of processes, experiences and lessons, user records (diaries, drawings) and researchers' notes -Basic monitoring and evaluation (indicators, monitoring methodologies and tools)
Training 4: First monitoring training/workshop (Bonn,	-Reflection and joint monitoring with inputs and observations by stakeholders: research teams, and users on implementation of the FTI research and the planned activities -Further refinement of indicators, tools and procedures
Training 5: Second monitoring training/workshop (Bonn)	- Internal evaluation of the first year implementation - Reflection and improvement -Design of the second year plans -Discussion and possible inclusion of additional innovations into FTI process

Source: Minutes of discussions on FTI training plan, July 2007

[29] The outcomes of these discussions were reported in an internal note written by the social science author of the work package, which was made available to me.

The discussion above suggests that the capacity-building plan devised by ZEF for nurturing interdisciplinarity within ZEF's Uzbekistan project, contrasted sharply with usual ways of capacity-building for IDR in several ways. Firstly, it was not a single-shot exercise, like a one shot training workshop, seminar, conference, or a training course. Rather, it was a longitudinal program that aimed at gradual and incremental capacity-building. Secondly, it was accompanied by project-based learning through carrying out implementation activities within the teams as well as with the stakeholders. Thus, the trainees were required to put the knowledge and skills gained at these training workshops into practice during the implementation, learn lessons regarding the learned knowledge, and improvise the tools and skills that were taught to them. Thirdly, they were also required to critically reflect upon the taught knowledge, its relevance in their work and draw lessons regarding their team work, innovation in question and the innovation process.

4.3 Implementing the Capacity-building Plan

4.3.1 Recruiting the Facilitators

Once the funding for the project phase was approved in March 2007, a senior researcher at ZEF's department of political and cultural change was assigned the task of translating the work package requirements into the job description for the FTI facilitator, getting it approved by the project's scientific coordinator and the departmental director, and placing it on ZEF's website to initiate the recruitment process for identifying the FTI facilitator. The key responsibilities for the facilitator included facilitation and management of the FTI process, with additional roles of documenting the processes and researching it. This analysis was aimed at learning lessons from the experience gained, making strategic choices in the flexible approach adopted, and consolidating this learning into described methodologies for the Khorezm region during the final project year. The FTI facilitator's role was also to supervise implementation and to organize regular feedback sessions and targeted additional trainings if required. He/ she was also

responsible to organize feedback to the project through a consolidated report on the FTI implementation activities every year.

However, during the first selection round, the chosen candidate was unable to accept the job offer. The main sticking points were related to the tenure of the offered contract and the terms offered. The externally funded project positions required ZEF to issue annual contracts only, which could be extended based on the annual assurance of funds from the donors. Besides, the compensation levels and salaries that ZEF could offer were not commensurate with compensation levels and other benefits, such as re-location costs, children's education costs, housing allowances, and paid home leaves, offered by development assistance agencies. In addition, the job required the incumbent to be based at a relatively difficult duty station for major part of the year. Considering ZEF's inability to offer attractive terms, the selected candidate wanted a perpetual contract for at least five years, which ZEF again could not offer due to restrictions imposed by the university and the donors. This made the recruitment process span over almost another year, and it was only in April 2008 that a candidate considered suitable by the recruitment committee of the project was finally recruited for whom the offered terms were also acceptable. ZEF had to reconsider its ambition to recruit a Ph.D. and settled for a Master's degree with considerable research, management, and facilitationexperience.

In parallel, as envisioned in the work package, the bidding process for commissioning the consultancy inputs was initiated in March 2007. The primary criteria that were used to evaluate the external consultancy inputs were devised. The fivefold criterion comprised (ZEF's advertisement for the consultant, March 2007):

a) demonstrated professional expertise and standing of the consultant in the subject and facilitation experience;
b) fitness of consultants' expertise with project approach to agricultural innovation and training;
c) knowledge and availability of human resources that the consultant could draw on in his/her organization or environment;

d) budget for trainings fitting within the project budget; daily rates within the range of normal practice in this field; and
e) fitness within project timeframe.

The secondary criteria were availability of regional experience and knowledge of Russian and/or Uzbek language skills. The selection of the consultant was finalized in early 2008. While the selected consultant met all the primary criteria, ZEF had to settle for a consultant that did not have knowledge and experience of the region or the local languages.

In essence, FTI facilitator's recruitment proved to be the first experience in ZEF's history, where it targeted to get someone on board that was both an academic and development expert. The project researchers generally ZEF recruited in the past were not required to undertake any action, rather objectively focus on gathering data and information and analyze it using appropriate research methodologies. The job of FTI facilitator required a delicate balance between research, facilitation and coordination. The ideal candidate would not only be an experienced researcher, but also adequately familiar with managing and dealing with teams. This implied recruiting someone from the job market of development professionals that was outside the traditional job market of researchers ZEF would normally target for recruitment. ZEF being a research institute, and additionally bound by the financial and managerial restrictions imposed by the donors and the parent University, lacked knowledge of, and ability to offer, the terms and conditions while recruiting outside of its 'usual' job market. The only flexibility ZEF was allowed was to compromise on the formal education requirements of a Ph.D., and replace it with considerable experience in the field. Consequently, all these restrictions resulted in a considerably protracted recruitment process, which compromised ZEF's original intentions, at least in the beginning phase of IDR. ZEF's experience of recruiting FTI facilitator demonstrates how the foundational conditions shaped by super structures, such as donors agencies and parent universities, of a research organization strategically aiming at attempting to undertake IDR through its externally funded projects can frustrate its attempts right from the start.

The delays in the recruitment process also implied that ZEF had to make a strategic choice of either to delay the entire exercise of FTI till it would recruit an FTI facilitator or to kick start the FTI capacity development process without the FTI facilitator. The project management and the social science coordinator settled for the latter and consequently, the first FTI training was held in Bonn on February 11-14, 2008, though without the availability and presence of the FTI facilitator. The subsequent FTI trainings took place in Urgench, Uzbekistan. These trainings were reported in detail by the external consultant and ZEF's FTI facilitators (van Veldhuizen, 2008; Wettasinha and Bayer, 2008; van Veldhuizen *et al.*, 2009; van Veldhuizen *et al.*, 2010). A brief description of the objectives, processes and main outcomes are presented in the sub-sections that follow.

4.3.2 Training I: Concepts of Agricultural Innovation and Inter-/ Transdisciplinary Research

FTI Training I 'Concepts of Agricultural Innovation and Interdisciplinary Research' took place in Bonn, Germany from 11th to 14th of February 2008. A detailed account of the planning and conducting these trainings are reported in Wettasinha and Bayer (2008). It was facilitated by two representatives of the consulting firm. Out of the 18 participants, 5 senior, 11 junior researchers and one project assistant participated[30]. Also, one senior researcher from the project's partner, German Aerospace Center (German Acronym DLR), whose task was to conduct research on the use of remotely sensed imagery and geographical information systems to improve water and land management, participated (Wettasinha and Bayer, 2008).

The main objectives of this workshop were to enable participants:

- to have a clear understanding of the concepts of innovation, its different aspects or characteristics and the various approaches used to stimulate this process;
- to develop an understanding of concepts of technology adoption and adaptation;

[30] After the training, a detailed report on main objectives, methodology, program, decisions made was shared with the whole project team (see Wettasinha and Bayer, 2008).

- to include users and technology characteristics as these influence the diffusion and adaptation processes;
- to distinguish between multi-, inter- and transdisciplinary research – the hard and soft systems thinking - and be equipped to work as a collaborative inter-disciplinary team in partnership with local stakeholders.

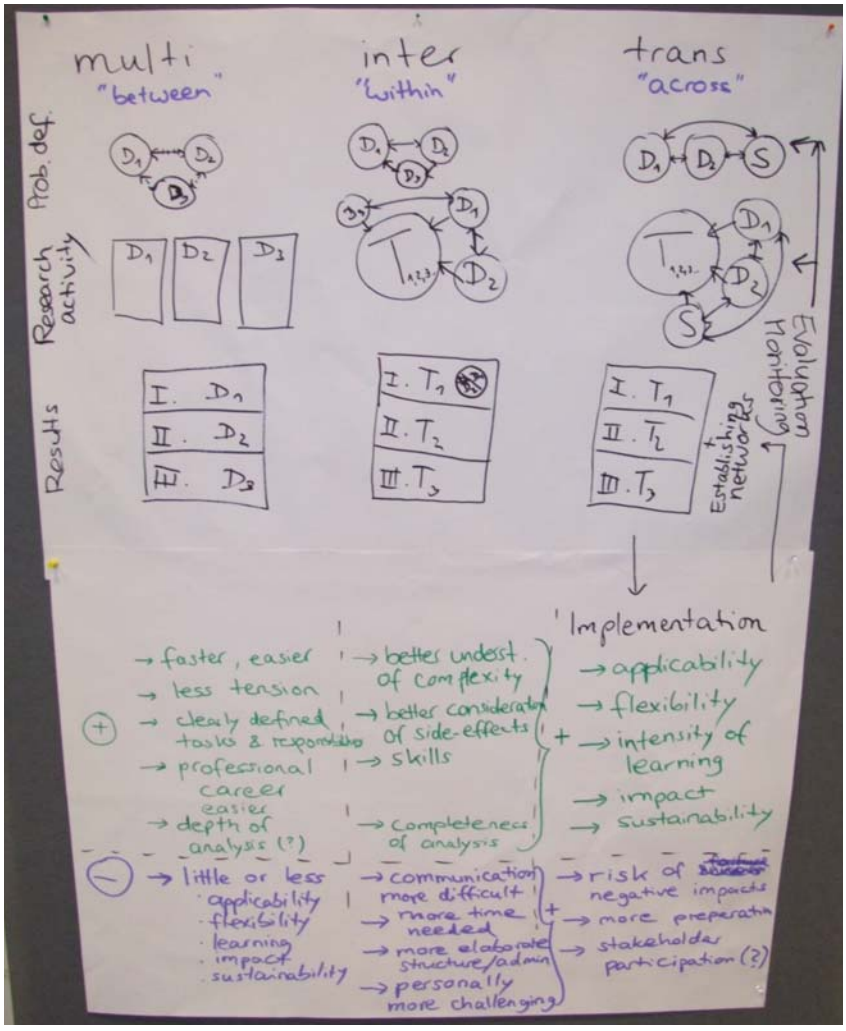
The four-day program comprised of the following broad blocks:

- gallop through the history of science, technology research and agricultural system research
- discussion on the concepts of multi-, inter- and transdisciplinary research and approaches to research
- discussions on the concept of innovation and the existing approaches of innovation diffusion
- discussions on project's stakeholders and how they differed from partners

Out of the 11 junior researchers, three were those who were almost in the final stages of their Ph.D. thesis defense, and were to join the ranks of senior researchers upon the receipt of their degrees. For the first time since the project's start seven years earlier, the overall project team was invited to collectively reflect on the project's definition and conceptualization of 'inter- and transdisciplinary research', 'innovation' and the project's 'stakeholders'. The simple exercise of bringing the team together and reflecting on these basic conceptualizations of the key parameters of their work provided an opportunity to discuss their epistemologies openly and potentially learn about other epistemologies, about interdisciplinarity, innovations, and the link between science-based solutions and the reality in the field. The participants discussed in three groups their understanding of disciplinary, inter- and transdisciplinary research. The groups presented and discussed their work in a plenary, where the participants came up with their operationalization of IDR (Photograph 4.1). This operationalization included elements that are essential for any research to be called interdisciplinary. The participants came up with the following main points for their working definition of IDR:

- *Interdisciplinarity and integration are different from just sharing/ transferring information and we need to find ways of achieving integration*
- *Arriving at a (working) definition is a dynamic process, but the definition should be stable*
- *Interdisciplinary interactions imply 'equal partnerships', process, systems perspective, ownership by all involved, ensuring 'good' communication within the team, and research activities along thematic issues rather than disciplinary groups* (Wettasinha and Bayer, 2008:22)

Figure 4.1 Group work by participants of FTI Training I discerning Disciplinary, Multi- and Interdisciplinary Research



Source: Wettasinha and Bayer (2008)

This suggests that the participants collectively discerned interdisciplinarity from mere knowledge sharing as well as from disciplinary and multi-disciplinary research in several ways. In their operationalization of interdisciplinary, the participants acknowledged that it could not be achieved merely through exchange of knowledge gathered by various disciplines; rather strategic actions were needed to achieve it. They also acknowledge the process nature of defining what interdisciplinarity research was in their specific case, and that it was a process that evolved gradually through interaction and exchange amongst various disciplines that were considered equal. This implied that the participants recognized that there were disciplinary superiority complexes within the project team that considered some disciplinary perspectives superior to others, which needed to be neutralized through a process of interaction, communication and dialogue. The need for ownership of this process of achieving interdisciplinarity by all was also recognized.

At the same time, the participants acknowledged that the way the research was organized within the project required additional work to achieve interdisciplinarity:

> *Interdisciplinarity within the project's research can be achieved through identifying gaps, working on reducing limitations/difficulties, to measure with appropriate indicators 'how much of interdisciplinarity we undertake', understanding the approaches and methods used by different disciplines, preparing joint publications/systems perspectives, refining and redefining administrative management structure and assigning tutors from other disciplines to PhD students.* [Wettasinha and Bayer, 2008:31)

The training participants shared their views on the concepts of innovation, various approaches to stimulate innovation processes, and to include stakeholders and innovation characteristics in the analysis of interdisciplinarity as these influenced the adaptation processes of innovations (Participant recorded session notes in Wettasinha and Bayer 2008). As a result, the participants became more aware of the distinctions between hard and soft systems thinking and had reflected on the meaning of working as collaborative interdisciplinary teams in partnership with local stakeholders. After controversial

discussions on the project's conceptualization of 'innovation' the researchers present in the workshop on the following definition of innovation:

> *"All ideas and 'plausible promises' developed by the project are as of now merely 'inventions' which after a process of testing, adaptation and acceptance by stakeholders become 'innovations'" (*Wetthasinha and Bayer, 2008: 8*).*

The participant's distinguishing between "mere inventions" and "innovations" reflected a critical perspective present amongst some of the participants that the disciplinary research during the earlier project phases only produced novelties that offered a potential for improvement, but this potential was not in reality realized, as these novelties were 'discovered' using only scientific experiments. Thus, the plausible promise and potential that those novelties offered had to be put to test for proving the relevance of project research to the local context. Once tested, adapted and their potential ascertained through transdisciplinary research integrating the knowledge, perspectives, and needs of the local users, only then those novelties would qualify as "innovations".

During intensive work in small groups on identifying the project's stakeholders, it became obvious that this varied depending on the innovation at hand. While for most developed innovations, farmers and water users were identified as the main stakeholders, for other innovations, such as assessing and mapping salinity using advanced methodologies, the national research institute, in-charge of assessing salinity levels in the regions of Uzbekistan, was identified. The mode of selecting the future cooperation partners had to be discussed, but was postponed to after the workshop.

Overall, the training was perceived by the consultants as successful in initiating discussion within the project team for the attempted process of innovation diffusion and creating increased levels of understanding of the topic, the approach and next steps (Wettasinha and Bayer, 2008). The main drawback of the training was the absence of three key staff members in the context of FTI, the process facilitator, the author of the FTI work package, and the project's field coordinator. The absence of project's field

coordinator and FTI facilitator was especially a constraint as both these staff members were key to several conceptual, methodological and logistical issues that IDR teams would face while undertaking IDR in practice, and also for motivating younger staff and attaching the required level of relevance and legitimacy to the process.

Besides, the decision to hold the first training in Bonn assumed that resources would be made available for Urgench-based scientists to participate, who would, as latter discovered, lead the actual implementation activities. Only one of the senior researchers belonging to ZEFa, who was part-time based at Urgench, was able to attend the training because he was already present at Bonn. It was considered to be expensive for the project, and the costs for travel for the Urgench-based staff were not budgeted into the work package design, and the funds from other line items could not be spent on traveling for FTI because these were already allocated to various research implementation activities. This appears to be a usual problem with agricultural research projects, where activities of process nature are involved. The donors' project planning frameworks are usually result-oriented, where the applicants are required to prepare logical framework indicating objectives, activities, timeline of activities, indicators, and key assumptions and match the funding requirements to the planned activities. As the project experience indicated for the first FTI workshop, the process nature of activities, such as decision to hold the workshop in Bonn was contingent upon several variables (for example, location of most staff members at the time of the workshop, suitability of venue, cost considerations for the consultant team), all associated costs could not be foreseen and budgeted in advance. Another option would be to approach the donors for allowing ZEF to re-do the budget for making travel funds available for Urgench-based staff to travel. However, this could not be done, because the *procedures for seeking approval of the donor to change budget line items were too complicated* (Interview project science coordinator, June 2008).

The content of this training was the first attempt to induce a critical thinking about disciplinary epistemologies and trying to breaking disciplinary barriers, as several of the sessions discussed the role of agricultural research from a broader system perspective,

and therefore, attempted to challenge the researcher's usual paradigm of "research for publishing" and make a gradual shift in their perspectives for "research for development and impact". One way of addressing this limitation was seen by the workshop participants as an initial, but additional FTI activity that could potentially bring the Urgench-based staff aboard, who could not attend the first training, to find, select and discuss appropriate literature relevant to FTI. As the FTI facilitator was yet not available, this responsibility was temporarily assigned to the ZEFa Urgench based senior researcher for Urgench, and the social science coordinator at Bonn. The workshop decision was revised in the sense that the pertinent literature would be presented and discussed at Bonn as well as at Urgench. This is further elaborated in the following sub-section.

While the consultant's report claimed that the training was a success in terms of content, organization, and facilitation, the internal review discussions on the FTI training within the project management concluded that one of the external facilitators, appointed by the consultant firm, was rather too theoretical and the choice needed to be reconsidered. Several e-mail exchanges between the social science coordinator of the project and the consulting firm culminated in the agenda of a meeting between the representatives of the project and the consulting firm. The meeting took place in the end of April 2008 at ZEF, by which time ZEF already had recruited the FTI facilitator, and project's concerns were discussed. It was agreed that the consulting firm would replace the staff members whose facilitation skills were questioned by the project, while retaining the inputs of the second staff (Minutes of the meeting April 2008). The participants of the meeting also reviewed the content and design of the remaining training plan, and decided that all the rest of the training events would be held in Urgench, Uzbekistan, as most of the participants of IDR teams lived and worked there.

4.3.3 Literature Discussions to Further Enrich Knowledge

Following the first workshop, a series of literature discussion meetings took place to review, discuss, and reflect upon a number of critical literature sources related to participatory technology development and innovation systems research. These

discussions were organized as informal discussions in Bonn as well as in Urgench. These discussions took place between February and May 2008 without the presence of the FTI facilitator, but once I moved to Urgench in early May, I took responsibility for these discussions in Urgench, while the social science coordinator kept on organizing these in Bonn. Each discussion was publicized in advance, the text was circulated by email for an advance reading of the participants. Apart from myself, there was one more senior researcher from ZEFa, and two economists. There were four other social scientists, but all of them were Ph.D. students. When volunteers were requested for presentations, generally the Ph.D. students would volunteer. Economists never volunteered for presenting the literature. The discussions were designed for one hour each. The volunteering FTI member would summarize and present the selected article for half an hour and then the participants would discuss both the content, and its relevance and insights for FTI. All the senior research staff of the project and Ph.D. students were invited. The discussions generally met the interest of project staff. Most researchers and students who participated during the first training, as well as the researchers based at Urgench who did not participate in the first training attended these discussions as long as there was no conflict with their field research activities. The discussions were quite active with the level of understanding of the topic of FTI as an IDR activity still being quite low (Field Note May 2008). The general tendency was that the debates and discussions were more active at Bonn than in Urgench (Field Note July 2008). In Urgench, a few social science Ph.D. students were the more active presenters and discussants than the economists or natural science participants (Field Note June 2008), who generally sat through silently unless explicitly invited to speak. Reflecting on the experience of literature discussions, the following statements typify the feelings of natural and social science participant perspectives:

> Natural Scientist1: *…remember literature discussion? It was a disaster – did not understand what is expected, new literature, no proper introduction, could not relate to it at all* (Interview June 2010)

> Natural Scientist2: *missed almost all literature discussions …I was on assignments for most of those* (Interview June 2010)

> Ph.D. student (Agricultural Extension): *Literature – there was quite some literature discussed in the beginning yes it contributed….we could have more background on FTI if we could continue but with under control* [mandatory and monitored] *reading. (*Interview June 2010)
>
> Economist: it *was interesting, but was not continued systematically, not everyone took part and in the end it was over* (Interview June 2010)

The natural scientists found the literature out of context, unrelated, and also did not understand the terminologies and concepts used in the presented papers, or even by the discussants. They often found the language as "difficult" (Field Note June 2008).

This reflects the difficulty faced by a non-disciplinary researcher due to the origin of the literature that was discussed. Most of the research discussed at these events was about sociological and institutional perspectives on agricultural innovations, lessons from agricultural adoption research, and systems thinking, whereas most of the participants of literature discussions at Urgench were natural scientists and economists[31], who used different disciplinary languages.

4.3.4 Training II: Operationalizing the 'Follow the Innovation' Approach

Training II "Operationalizing the Follow the Innovation Approach" was organized in Urgench, Uzbekistan from 01st to 04th of June 2008[32]. Contrary to expectations, only one staff member of the external consultant was available as the other member fell ill suddenly. The training as a result needed to be then co-facilitated by the project's FTI facilitator. Thirteen senior and seven junior researchers of the project participated, including one senior staff member from German Aerospace Center. Five of the Uzbekistan based senior researchers including the project's field coordinator, especially working on natural science aspects of the project, participated for the first time.
The main objectives of the training were to enable participants:

[31] Due to a large number of work packages addressing bio-physical and economic domains of Khorezmian agriculture, the proportion of staff members appointed by ZEFc and ZEFb at Urgench was always far higher than those belonging to ZEFa.
[32] The details about this training are reported in van Veldhuizen (2008)

a) to have a clear understanding of different stages and possible activities of the FTI approach;
b) to learn participatory research methods and tools that could be applied during the FTI process at all levels and develop their skills in using these tools; and
c) to organize themselves in FTI teams with agreed mandate and agenda

The four-day program comprised of the following blocks:

- Review of previous training and participant expectations;
- FTI Approach and its operationalization into the following three stages:
    - Stage 1: Starting up, identifying and engaging with stakeholders and learning and practicing relevant tools ;
    - Stage II: Design, implementation and evaluation of joint experimentation and learning;
    - Stage III: Sharing of results and sustaining the process; and
- Preparing a road map for FTI implementation

The first session, where the participants were asked to record their expectations from the training showed a considerable degree of interest in making innovations work as their statements expressed:

- *make research useful to stakeholders*
- *how to work together*
- *to learn how to make theory work for practice*
- *best innovation approaches to farms*
- *how to implement innovations/ technology successfully*
- *practical methods to implement CA technologies amongst the farmers*
- *contribute something small for big changes*
- *innovation dissemination strategy in Khorezm*
- *skills on effective extension*
- *get stakeholders interested in our results*
- *first practical steps to attract stakeholders and overcome scepticism*
- *how to successfully work with farmers*
- *how to approach or extend stakeholders*

- *regional scale and product awareness raising*
- *implementation tools*

Likewise, there was also considerable attention to interdisciplinarity:

- *work together with other project members*
- *improving team work skills*
- *team building strategy*
- *approaches to bridge between disciplines as operational as possible*
- *synergy*

Source: Extracts from Training II Session I Notes reported in (van Veldhuizen, 2008: 1)

Several participatory tools were introduced to the participants who practiced these tools in group exercises and feedback sessions. The tools included SWOT-analysis (Strengths, Weaknesses, Opportunities and Threats – SWOT), Venn Diagrams, Participatory Rapid Appraisal Tools (Transect Walks, Resource Mapping, Scoring and Ranking), Meta plan, and conscious listening.

During the final session, the workshop participants listed and ranked the project's prospective innovations for choosing four key innovations that in their opinion held the highest plausible promise and were ready to be taken out to stakeholders for further testing and refinement. An initial list of 14 possible innovations was prepared through consultations with senior researchers and the project's field coordinator before the start of the training (Minutes of Senior Staff Meeting May 2008). During the final session it was expanded to include 17 prospective innovations as some innovation listed in the draft list comprised more than one. This list comprised 11 innovations from bio-physical domains sciences (agronomy, soil science, hydrology, remote sensing), 2 from economics and 3 from socio-institutional aspects of water management.

The participants considered the following criteria to rank the innovations (Ul-Hassan, et. al. 2009):

1. Maturity – is the innovation ready? For which level (field, farm, system, regional, national)?
2. How much supportive research has already been done?
3. Availability of suitable sites for experimentation
4. Potential wider impact
5. Anticipated political support from policy makers and implementers (opposition/ neutrality/support)
6. partners/ stakeholders' willingness and readiness to cooperate
7. Project's internal (human and material) capacity to implement the innovation

Out of the 17 potential innovations, the top four were chosen for inclusion into the FTI process. The chosen innovations were ranked as follows (van Veldhuizen, 2008: 21):

1. Conservation Agriculture- including precision leveling, intermediate tillage, permanent beds, residue and nutrient management- (CA hereinafter) – 8/32 votes
2. Afforestation on marginal/ degraded lands as an alternate land use (AL hereinafter)- 7/32 votes
3. Rapid salinity assessment through induction devices and improved irrigation scheduling (SA hereinafter) – 6 /32 votes
4. Strengthening Water Users Associations through capacity-building (WUA hereinafter)- 4/32 votes

Initially, salinity assessment and improved irrigation planning were considered two separate innovations and voted for separately (van Veldhuizen, 2008:22). Considering a ranking of five innovations, the ranking of the social science innovation was sandwiched between two natural science innovations on top and two below. Therefore, it stood in the middle. None of the economic innovations was considered suitable for testing by the participants, as one, that proposed to focus on working with rural administration for promoting cotton processing instead of exporting cotton lint was voted only by its proponent alone, and for a farm level economic planning model, the proponent of the innovation did not participate in the training. Salinity assessment and irrigation

scheduling scored equal votes (3 votes each). The group decision was to take them both aboard. However, upon suggestion of project's science coordinator, these were both lumped under one team's responsibility due to the thematic link between soil and irrigation. The ranking after twinning of salinity and irrigation changed and the social science innovation stood at the bottom of the rank.

Though un-intentional, the final ranking also reflected the power dimensions of the project in the past and the power struggles during the third phase. The project was largely designed and managed by ZEF's department of natural sciences (ZEFc), which retained its control over the project through keeping highest number of work packages, staff and students in the project (Chapter 2), and therefore, highest number of potential innovations, and likelihood of their being voted in. Both ZEFb (economics) and ZEFc (bio-physical) are largely positivist sciences, which heavily rely on quantitative methods as their analytical methods, and share epistemological values and standards. Within the Uzbekistan project, their close alliance was always visible, for example in the way the project was titled "economic and ecological restructuring of land and water use"(Vlek *et al.*, 2001; Martius *et al.*, 2006; Manschadi *et al.*, 2008). This alliance warranted a slice of both project research as well as resources automatically being shared with ZEFb. The project had produced highest number of Ph.D. graduates in economics after natural sciences. The social science department (ZEFa), on the contrary, remained at a distance in the beginning and produced only three Ph.D. studies during the first two phases, but became more active during the design stage of Phase III proposal (See chapter 2), and argued for more space and say in project's affairs, or at least making it more inclusive and transparent. Due to the past neglect, it did not have much to offer in terms of innovations. None of the socio-institutional innovations that were proposed for FTI actually emerged from the previous Ph.D. studies undertaken at ZEFa. The WUA related innovation came from the past work experience of ZEFa researcher who led work package on socio-technical analysis of water management, and was also partly the focus of a previous Ph.D. study, while the other two suggested innovations were "work in progress" of that work package (Field Note July 2008).

Around each of the selected innovations FTI teams comprising the scientists from various disciplines, such as hydrology, soil science, agronomy, economics, and social sciences were formed. Each of the IDR FTI teams comprised a mix of scientists from the appropriate disciplines that formed the core of the group. Besides, considering the limited number of available staff, the disciplinary gaps were also filled by the Ph.D. students as supporting members, who had an interest in the specific innovation. In case of the three natural science innovations, two of the appointed team leaders (CA, SA) were those who undertook their Ph.D. work on those innovations. In case of AL, the team leadership was assigned to the head of a collaborating institute on forestry, and the responsibility for leading social science innovation team was vested in ZEFa senior researcher, who also coordinated a work package related to water management institutions, and had considerable prior experience in working on water management institutions. Thus, a researcher from the core discipline of the innovation led the group. Reason for this separation between core and support members was the presumption that Ph.D. students, due to their high work load and focus on their own Ph.D. research, could not be asked to act as main carriers of the process. Besides, various Ph.D. students were at different stages of progress and would not be available after they would finalize collection of their data.

Since the second workshop, similarly to the first, still largely aimed at the actual implementers of and researchers scientifically accompanying the FTI process, it also provided an opportunity to the participants who had not attended the first one to catch up and involve themselves in the FTI team process. The group work on the taught tools during the practice sessions of the training indicated that the tools to which the participants were exposed, were well understood (van Veldhuizen, 2008: 11). The evaluation by selected group of participants found the tools relevant, and considered the exercise as, "*...good practical work and team building events during the day*" and that the tools were, "*applicable and could be used in the local context*" (Four evaluators reported in van Veldhuizen, 2008: 13). However, some skepticism towards the applicability of participatory rural appraisal (PRA) tools, such as transect walks, was also expressed.

Participant: *Transect Walk might not be practical for the project* (daily evaluation team of participants quoted in Veldhuizen, 2008: 13)

Workshop Facilitator: *It is usable for implementation of innovations, therefore part of the training* (van Veldhuizen, 2008: 13).

FTI facilitator: *It is an exercise to work with field –level stakeholders* (van Veldhuizen, 2008: 13)

As latter discovered, several of the Ph.D. students involved in FTI used resource mapping and other PRA tools during their own research, and shared relevant data and findings with the team members. Overall, the second training acted as kick-start for the FTI process in the field. The innovation packages to focus on in the beginning were selected, teams were created, tools and methods for the next steps to take were taught and the next steps of the process for each of the four teams were outlined in group work.

4.3.5 Training on Facilitation Skills and Effective Communication as building Blocks

A third training workshop was agreed to be held before the end of the second project year to take stock of the initial experience in FTI implementation and provide additional insights, methods and tools[33]. During the planning meetings of various IDR teams, it was felt that the facilitation and communication skills of many of the group members, and especially those of the group leaders needed to be strengthened. Consequently, the author, being the FTI facilitator started an e-mail discussion on the need to have such training, and to identify suitable timing for the majority. Members from various teams concurred with the idea, and the potential dates were agreed for August 2009 (Ul-Hassan, 2008). Due to financial reasons, it was thought appropriate to limit the participation to the project staff based at Urgench only. The training was facilitated by the FTI facilitator. Five senior and nine junior research staff attended the training.

[33] A summary report of these two trainings was prepared by Ul-Hassan (2008) and circulated amongst all FTI participants

Training on facilitation skills

The training on facilitation skills started with an energizer. A facilitation game was used to highlight the importance of facilitation and cooperation to lead to win-win solutions for partners. This energizer was followed by presentations on the following topics:

a) How facilitation helps in group work, for example conducting meetings, discussions, brainstorming sessions;

b) Relevance of facilitation for IDR teams working on FTI as they conduct group meetings/ consultations, work and meetings with stakeholders; each IDR team is composed of several members from various disciplines, having their own perspectives about the situation, work and the way the work should be conducted. Everyone's opinion needs to be considered, and the group members and stakeholders need to be encouraged and facilitated to get involved and not to isolate;

c) The decision-making with the IDR teams needs to be democratic and not autocratic. Facilitator's role is to ensure that;

d) Each FTI team has a longer term goal of forming highly motivated teams who successfully carry out their FTI experiments together with the stakeholders. Most of the group members being specialists and expert of their respective subjects may not be able to differentiate between the role an expert plays vs. the role a facilitator should play.

e) A facilitator was defined as an individual whose job was to help to manage a process of information exchange. While an expert's role was identified as to offer advice, particularly about the content of a discussion, the facilitator's role was to help with how the discussion proceeds. The facilitator's responsibility was identified as to address the journey, rather than the destination.

f) Capabilities and characteristics of a facilitator (Box 4.1) and facilitator's role during preparing and conducting meetings/ workshops (Box 4.2) were also discussed.

Box 4.1 Characteristics of a facilitator discussed at the training

a) asking rather than telling and paying compliments for inputs
b) initiating conversation rather than waiting for someone else to
c) asking for other's opinions rather than always having to offer one's own
d) negotiating rather than dictating decision-making
e) listening without interrupting
f) adopting more persuasive style than just following sequence of steps
g) more enthusiastic than systematic
h) more like a coach than a scientist

Source: Author's extraction from Ul-Hassan (2008)

Box 4.2 Preparing and Conducting Meetings

Tasks for preparing for a facilitated meeting/ event:

a) Arrangement of space and other facilities/ supplies
b) Thinking and arriving at decisions about the meeting times
c) Preparing the agenda keeping in mind the objectives of the meeting
d) Deciding if the facilitator needs support
e) To inform the participants on time and send reminders, if needed
f) Actual facilitation of the meeting

During a meeting, there are task roles and maintenance roles for the facilitator:

g) The task roles include: Helping participants to keep to the agenda, reworking the agenda if needed, maintaining group focus, recording decisions and action points, testing for agreement by the participants, and evaluating the meeting
h) The maintenance roles include: establishing common ground for participants (why we are here, what we want to achieve?), bringing out and resolving conflicts, and maintaining democracy and participation

Source: Author's extraction from Ul-Hassan (2008)

Training on Effective Communication Skills

A presentation was used to illustrate that the following and similar problems arise out of problems in communication:

a) Understanding someone's talk can be partial because someone else nearby was talking loudly
b) Tried to explain something but people understood something different
c) Asked someone to do something, but found out that (s)he was doing it wrong

Several games and exercises were used to indicate the importance of communication, and clarifying that one's own one-way perception of things or situations might be misleading.

Communication was introduced as a process of meaningful two-way interaction among human beings, in which a person does not only act or tell, but also invites and expects a certain reaction

During the training, the participants were facilitated to differentiated the following four types of communication and discuss their characteristics and use during FTI:

a) Intra-personal
b) Inter-personal
c) Inter-group
d) Mass Communication

The classical Sender-Message-Channel-Receiver (SMCR) model (after (Berlo, 1960) of interpersonal communication was used to illustrate the potential problems with content, sender, structure, channel and receiver during the communication process. A game was used to illustrate the model further. The awareness about communication filters and distortions was raised using games and exercises as well. Besides, five types of listening behaviors were also introduced as ignoring, pretending, selective, attentive and emphatic. Through a presentation, rules for provision of specific, usable, requested, accurate, feedback using "I-Statement" were also discussed. Finally, the tips to reduce distortions in communication were discussed. Some tips were about adopting a receiver orientation, increasing similarity of receiver and source, keeping message short, using good organization of message content, reducing number of links in the chain of communication, and increasing repetition.

4.3.6 Training III: Deepening the Understanding of the 'Follow the Innovation' Approach

The third training workshop 'Deepening the Understanding of the 'Follow the Innovation' Approach' took place in Urgench, Uzbekistan from 17th to 21st of November 2008. It was facilitated by a consultant from ETC EcoCulture and co-facilitated by the

project's FTI facilitator as well as the coordinator of the social science work packages in the project.

It brought together 21 participants, the core of which were 10 senior researchers out of which seven were based at Urgench, several research assistants as well as three representatives of, the Ashirmat Water User Association (WUA) and one representative of the Forestry Research Institute in Tashkent. The workshop was thus the first training event in which project stakeholders actively participated. This was the first time that the intended users of two of the innovations tested under the interdisciplinary research process of FTI participated to design and influence the planning and critical review of the research process itself. The project stakeholders participated from the beginning to the end of the four day training event. They contributed considerably, also in the more conceptual and process oriented discussions. The drawback was the need for plenary translations of most formal presentations, as they could not understand English and many researchers did not understand Russian or Uzbek, leading at times to delays and decrease of active participation.

The specific objectives of this workshop were to enable participants:[34]

- to review and reflect on initial FTI implementation and increase the understanding of its potential and relevance in Uzbekistan
- to learn additional participatory research methods and tools for use in the FTI process and develop skills in using them;
- to re-assess how FTI teams are organized and operate and take measures to improve or re-strategize where needed.

The four-day program comprised the following blocks:

[34] After the training a detailed report on main objectives, methodology, program, decisions made was made available to the whole project staff (see van Veldhuizen, *et al*., 2009).

- Welcome, introductions, participant expectation, background to FTI process and the workshop program
- Recap of FTI training II
- Review of FTI approach: FTI Implementation and main lessons learnt
- Participatory Monitoring and Evaluation
- Field study on Participatory Monitoring and Evaluation (PME)
- PME Facilitation
- Process documentation
- Working in teams: Food for thought for FTI groups
- Organization and planning of further FTI process: Plenary review of FTI groups: focus and composition
- Review of FTI communication and support mechanisms:
  - Way forward, next workshop
  - Evaluation of training and closure

While the workshop was considered to be a success both, by the consultants and ZEF's relevant staff in terms of participation, topics covered and the level of engagement of participants (Hornidge *et al.*, 2009; van Veldhuizen *et al.*, 2009), it also became obvious that the progress of most FTI teams until November 2008 had been less than expected. Three out of four IDR FTI teams had prepared roadmaps until Training III. Yet, out of the four teams, only one highly involved the key stakeholders of the innovation at hand for jointly designing the roadmap. Two of the remaining three FTI teams had – at the time of the training –only just begun to involve stakeholders; one was still in the planning process.

As discovered later, many of the full-time senior researchers, perceived this process of taking the developed ideas and critically reviewing them together with the stakeholders as an extra task, separate from their main research that did not find the attention and focus that purely scientific research in laboratory conditions might have received.

> Agronomist: *I have several duties. I am responsible for …experiments at the landscape segment* [pilot farm of the project- see chapter 2] *and need to make sure all operation are done on time and in planned manner, I supervise Master students who conduct their MS research at the pilot farm on* [names his area of specialization], *I am responsible for the research collaboration between the project and International Centers* [names two international centers] – *we conduct experiments together with them and when their scientists visit, I need to allocate all the time to attend to them because they visit for a few days only. I need to write and submit research papers for conferences. I give lectures at the Urgench University, and I am working on my habilitation* [second Ph.D.] *to qualify as a professor. I lead FTI on ….There is only one me, and so much to do. It is especially difficult during the vegetation season* [March-October] *to plan and act according to the plan. Something unexpected comes up so frequently- equipment breaks down, pump does not work, fertilizer is not available, some visitors decide to come,* and [names project field coordinator] *calls a meeting and asks to do something additional. I do FTI work on the way to my main work…* (Field Note May 2009).
>
> Soil Scientist: …*when I listed my innovation back in June 2008, I thought it was just like another seminar- one gives ideas about what innovations can work and someone else will take it up and implement. But now me being responsible for FTI process of* [names his innovation], *I realize that it is too demanding on my time. It* [FTI process] *takes time, the process is not automatic, but we still need to do it, we realize* [the amount of time it needs and the complexity of the process] *with time*. (Field Note November 2008)

The statements above typify the problems that the project's senior researchers engaged in FTI in general, and natural scientists in particular faced. Their primary responsibilities, for which they were held accountable in terms of work planning and delivering results, were their work packages and associated activities. For some of the researchers, training assistants and students, monitoring their field research and data collection, and analyzing the data to write and publish scientific papers consumed major part of their time. Others, as was the case with the agronomist, were even more involved in field level planning, and overseeing field operations as these happened. The continuous flow of visitors and collaborators from elsewhere, which was far higher during the vegetation period, added to the demands on staff time. As a result, FTI was seen as an additional activity demanding another slice of researcher's time.

Therefore, process of testing and adapting the developed ideas in a real-life context together with the actual end users of the innovation packages was regarded as 'outside' the actual research work rather than as a research approach assuring the sustainability of the developed ideas and research results (Hornidge *et al.*, 2009). Furthermore, the rather late introduction of stakeholder involvement in relation to the overall time span of the project did put special stress on the process and left even less room for the yet unconvinced to familiarize themselves with it.

Nevertheless, initial interaction with stakeholders at various levels led to a number of important issues and lessons related to the proposed innovations. This resulted, for example to the strategy to "un-bundle", un-pack, certain innovations, such as flexible water management and conservation agriculture, to allow stakeholders to experiment with (combinations of) selected components (van Veldhuizen *et al.*, 2009: 48 & 56). Furthermore, after some initial hesitations participatory interaction seemed to be appreciated by some of the stakeholders, as well as FTI team members. New methods, such as focus group discussions and visualization of group analysis, found their way as research methods (ibid).

The last day of the workshop was committed to plan the way forward. Here in particular issues of team composition, team meetings, financial and human resources for FTI, the relevance of selected innovations as well as FTI communication and coordination were discussed (van Veldhuizen *et al.*, 2009). The nature and outcomes of the discussed issues is briefly presented here.

Roadmaps: Though the teams started to write their interdisciplinary work plans since June 2008, for three of the four teams (CA, SA and AL) these were still work in progress and the teams were clarifying issues amongst themselves. All of these teams had yet to share their ideas and details of intended joint experimentation with their chosen stakeholders. The decision by participants was that all the four FTI should strive for finalizing their respective plans in collaboration with stakeholders where needed and share their final work plans with the FTI Facilitator, who will provide assistance in terms

of comments and ideas. Once the plans were ready and discussed with the stakeholders and FTI facilitator, agreements of cooperation were to be jointly prepared with stakeholders.

Team Composition: The feedback from the Ph.D. students (Field Note August 2009) indicated that the labeling of the Ph.D. students as support members de-motivated them. In addition, specifically in WUA team, Ph.D. students were instrumental in conducting key activities and trainings with the stakeholders, and thus instrumental to the process. Therefore, the Core and Support Members division was abolished. Two additional researchers, who recently attained their Ph.Ds., were added to AL team to actively pursue the team's progress.

Enhancing knowledge sharing: Particularly the WUA team expressed the need to be aware of activities, processes and outcomes of other teams more regularly. So far, the only forum for a joint exchange was the FTI training events, which were organized too rarely (almost one in six months), which was perceived inadequate. Therefore, it was decided that the FTI facilitator should call for monthly coordination meetings inviting all FTI members. The facilitator was also assigned the responsibility of preparing a summary of discussions and sharing it with FTI participants through a mailing list. The attendance by the FTI team leaders in these coordination meetings was considered mandatory, who were then made responsible for sharing the details with those members who could not attend the meetings.

Geographical concentration: As CA team also decided to undertake some of its activities in the same locality and with the same people where WUA team worked, there were issues related to information about field activities not being discussed amongst the two teams. This sometimes was seen by WUA team as confusing the stakeholders. Both the teams were advised by participants to share all information and documentations of meetings with stakeholders with the group (mailing list prepared, folders on servers structured and regularly updated by FTI facilitator, FTI Facilitator to send a summary and

translation of workshop report to stakeholders); and to coordinate work and invite stakeholder to coordinate in order to avoid too many meetings etc. for stakeholders.

Enhancing Facilitation skills further: As noticed earlier, and as identified during the workshop, some of the FTI participants were lacking skills for facilitation. It was decided that Monthly FTI group meetings organized by FTI facilitator will also serve as training ground for learning facilitation skills. Facilitation of these meetings was to be rotated (Urgench: 1st Monday of Month, 10am; Bonn, 1st Tuesday of Month, 2pm). Additionally specific skills training events would be organized by FTI facilitator.

Logistics and Financial Issues: Since the WUA team had actively engaged with stakeholder and chose capacity-building as route to strengthen the WUA capacity for managing water better, there was a need for professional translation of the training materials from English / and or Russian to Uzbek. It was decided that since the teams comprised of both local and foreigner members, one of the local staff from within the respective team would perform as a translator during the dialogues and discussions of the team with stakeholders. In case written translations of documents were required, a project assistant, who had a formal translation diploma, was assigned for FTI.

The research assistants of the WUA team had made several telephone calls to the stakeholders, and did not know whether or not those costs would be reimbursed. These arrangements were clarified. Besides, there was also need for resources for conducting field experiments. It was then decided that each FTI team would prepare a draft budget as basis for discussion with the project management. The teams were advised to indicate required financial resources in their work plans, which after review from the facilitator, would be approved by the project management. Furthermore, cost sharing arrangements with stakeholders, loan mechanisms, and external fund raising were considered as options that needed to be discussed transparently with the stakeholders. The willingness for stakeholders to invest (finances, time and work to write external proposal together) in the proposed innovation was considered as an important indication of their interest.

Process Documentation: It was realized that the level of detail and the quality of process documentation varied greatly across the four teams. It was mutually agreed that the processes, events, and meetings with stakeholders had to be documented more thoroughly. FTI Facilitator was requested to prepare formats, and share examples with FTI participants to guide these.

Next FTI Workshops: Realizing that the time span between past FTI events was quite long, it was decided that in May 2009, an internal workshop will be organized by the FTI Facilitator to review the progress of each team and offer a platform for discussion on emerging issues and perspectives, and planning the next steps. It was also decided that the fourth FTI training workshop was to be organized in November 2009 to review the implementation steps taken during 2009 and offer inputs on methods of participatory monitoring and evaluation. It was also decided that the final and fifth training workshop would be organized towards the end of the project in order to assess the entire process from a scientific and operational perspective.

By the end of 2008, finally all four FTI teams had prepared their respective work plans and road maps for 2009 for applying, testing and adapting the selected innovations. As outlined above the degrees of actual stakeholder involvement highly varied with one group acting as strong front runner, two groups slowly taking their first steps, and one group still being in the planning phase and hoping that a recently assigned social science Ph.D. student would accelerate the process for the overall team. According to all four roadmaps, the teams planned to use the concepts, methods and tools learned during the three workshops.

4.3.7 Training IV: Taking Stock and Looking for the Impact

Towards the end of 2009, the fourth FTI training workshop was supposed to encourage the team to review the second year of 'following the innovation' and to provide additional insights, methods and tools into impact assessment[35]. The four-day training

[35] The detailed account is documented by van Veldhuizen et al., (2010)

workshop 'Taking Stock and Looking for Impact' took place in Urgench, Uzbekistan from 2nd to 5th of November 2009. It was facilitated by the external consultant and co-facilitated by the project's FTI facilitator as well as the coordinator of the social science part in the project.

It brought together 22 participants, 15 directly associated with the project as senior researchers, Ph.D. students or research assistants and seven stakeholder representatives (two farmers, four staff members of the selected Water User Association and the Director of Forestry Research Institute (FRI)). This was the second FTI workshop in which project stakeholders actively participated. The WUA stakeholders and the head of FRI attended the whole workshop and contributed substantially. Two CA farmers joined only the first day (van Veldhuizen *et al.*, 2010), but then realized that since they did not participate in the earlier workshops, it was too late for them to relate to the content and discussions during the workshop.

The specific objectives of this workshop were to enable participants:

- To critically review FTI implementation to date, identify lessons learnt and inspire planning for continuation of FTI in 2010;
- To obtain insights in participatory impact assessment, methods and tools, and discuss and operationalize their use and relevance for FTI implementation in each of the teams;
- To review once more the organization of the FTI teams and their functioning, also in view of the staff changes in the recent past, and take measures to improve or re-strategize where needed; and
- To decide on inclusion of additional innovation areas in the FTI program.

The four-day program comprised of the following blocks:

- Welcome, introductions, participant expectation, background to the workshop program
- Recap of FTI and FTI trainings I, II, and III

- Analysis of progress in the four FTI teams to date
- Introduction into Impact Assessment
- Designing participatory impact assessment
- Introduction into Most Significant Change approach to Impact Assessment
- Field Study on IA
- Strengthening the FTI teams, communication and coordination

While the workshop was a success in terms of participation, topics covered and the level of engagement of participants, all teams reported from their interaction with stakeholders on the complexity of real life situations. All teams did show a lot of learning on the relevance or not of their innovation. Four types of factors emerged in analyzing why stakeholders showed reluctance to directly accept FTI innovations: the innovation itself, the system and institutions, the people involved, and the way FTI process was implemented. The systems and institutions were found as key bottlenecks in Uzbekistan. Some teams started to incorporate options from the farmers/stakeholder themselves, not just the innovation, which was recognized as an important step in FTI. However, a need for more reflection on the FTI process and interaction with the stakeholders, at least once at the end of the season clearly was identified. It was also learned that the stakeholder involvement and influence in decision making in the FTI process differed across the four teams, but generally could be further increased.

The participants learned how to design, implement and analyze participatory impact assessment exercises. It was noticed that earlier monitoring and evaluation (M&E) activities were largely too scientific and the stakeholders did not have much input apart from data provision. Therefore the FTI teams were asked to design their own participatory impact assessment (PIA) methodology for each innovation.

Overall, the main issues and agreements reached included the following:

- Development of team and innovation specific suggestions to proceed further from where the teams have been;

- The Flexible Water Management was dropped as an FTI innovation because it was still at the level of a scientific idea needing further testing before undertaking FTI with stakeholders in their real life situation. Besides, the capacity in the project on this topic was also not enough anymore. The hydrologist who was to be responsible in the field for conducting research, and the water management specialist, who had to provide supporting inputs, had both left the project. The former left the project because his mother became extremely ill and he had to move his family and himself to Tashkent to take care of her. The latter received a better job offer in Tashkent, where his family was located, and decided to resign. This implied that only the proponent researcher out of the initially identified team members was available at ZEF, but he was too distantly located in Bonn.
- It was agreed that the FTI teams would compile and review their process documentation reflecting the team progress in the light of suggestions and comments made at this workshop and share this for another round of review by the FTI facilitator and social science coordinator by early January 2010.
- It was also decided to hold an interim review workshop in March 2010 coinciding with the project's planned workshop for donors. The team work plans would be jointly reviewed and refined.
- The fifth and the final FTI training workshop was decided to be conducted along a "write-shop" model, in order to assist the teams to come up with their final peer-reviewed outputs for publication.
- Finally the future of FTI promotion and ownership in Uzbekistan after the end of the project was reviewed briefly. It was indicated that the project will have to strategically identify potential organizations that could carry the FTI message forward and involve these in activities in 2010-11.

4.4 Participation

A department-wise analysis of the participation (Table 4.2) reveals that the participation of the senior natural scientists belonging to ZEF remained highly variable throughout the

FTI trainings. It was at its lowest ebb during training I when only two senior natural science researchers participated and was at its maximum during training II, when seven senior natural scientists participated. During the last two training events, it stabilized at five. This variation was largely due to the venue of the workshop. The first training was held in Bonn, while most of the senior natural scientists of the project were based at Urgench, and it was considered financially burdensome to bring them to Bonn for the duration of the workshop. For the other two departments, all the senior researchers, excepting project field coordinator, were already in Bonn due to their other assignments and could participate in the training without any additional financial implication for the project. Though all of the FTI training events were planned ahead, and mostly during the previous FTI training where FTI participants collectively decided the dates, for some of the senior researchers, there were assignments imposed from the project management that clashed with the timing of the FTI training events.

The participation of the junior researchers, largely Ph.D. students, was quite high during the first two training events, but eventually declined during the later stages. One reason for their dropping out was that their initial interest to be associated with an FTI group was access to stakeholders, relevant data, and expertise. They anticipated learning new tools and techniques that could be used by them while they collected data for their own research. As the FTI teams matured from 2008 to 2010, the tendency in at least two of the three FTI groups was that the Ph.D. students waited for senior members to assign them tasks rather than actively offering their assistance and interest. Also, they saw limited opportunities for boundary crossing and venturing into just 'interesting' areas rather than being focussed on their own research needs, as their research plans were content and time bound (Summary of support members interviews compiled in August 2008). The labels of 'core' and 'support' FTI members, whereby Ph.D. students were considered as 'support' members, also acted as demotivating factors in several instances (Ul-Hassan and Hornidge, 2010).

Table 4.2 FTI Training Participation

Training Event	Staff Level	ZEFa	ZEFb	ZEFc	Project Collaborators	Total
I	Senior Researchers	2	1	2	1	6
	Junior Researchers	4	3	2	2	11
	Research Assistants	1	0	0	0	1
Total		7	4	4	3	18
II	Senior Researchers	2	3	7	1	13
	Junior Researchers	3	0	5	2	10
	Research Assistants	0	0	0	0	0
Total		5	3	12	3	23
III	Senior Researchers	2	3	5	0	10
	Junior Researchers	1	0	1	2	4
	Research Assistants	3	0		0	3
Total		6	3	6	2	17
IV	Senior Researchers	1	4	5	0	10
	Junior Researchers	1	0	1	0	2
	Research Assistants	3	0		0	3
Total		5	4	6	0	15

Source: Authors compilation from annexes of (van Veldhuizen, 2008; Wettasinha and Bayer, 2008; van Veldhuizen *et al.*, 2009; van Veldhuizen *et al.*, 2010)

A high turnover amongst participants from one to the next training was observed till training III. For example, only half of the participants of the third training were those who had also attended the second training. Some of the turnover was due to job transition amongst the staff, and some was due to administrative reasons of financial arrangements within the project. The turnover related to job transitions was beyond the control of FTI facilitator or the project management. An attempt to bring newer members aboard was to include a brief introduction to FTI during training II and III.

The high turnover imposed serious challenges in retaining and consolidating learning within FTI groups as the new members had not much knowledge about the previous

group learning. The turnover also impinged upon the quality of participation in discussions, as the new members would tend to remain silent during group discussions.

While stakeholder participation in training III and IV was useful in advancing discussions about and finding solutions to practical and real field challenges, it also imposed additional epistemological challenges as the content and language of the training had to be adapted to make it more inclusive. As a result, the discussions about serious epistemological and ontological issues, such as lessons on the relevance of the selected innovations to the local context, methods and approaches so far used by various team to record the process as well as innovation related outcomes, facing FTI teams had to be postponed for a later opportunity.

4.5 Training Methods and Evaluation by Participants

A variety of training methods were used during the FTI training events (Table 4.3). Most training events were planned in consultation with the trainer, FTI coordinator, social science coordinator, as well as project management. Besides, all the trainings were reviewed on both, a daily basis, as well as in overall at the end of each event. The lessons were documented and used as an input to the next event.

The training delivery methods included lecture-style presentations, facilitated group work and plenary discussions, brain storming, games, visualization, turn-wise note-taking, daily small group evaluations reported in a plenary next day, and field study. As demonstrated during the first training, when presentations were longer or too many in a single day, these tended to attract negative feedback from the daily evaluation groups. Thus, a balanced mix of various methods offers greater opportunities of maintaining the participant's attention and interest in the training.

The participant evaluations (Table 4.4) of various FTI training events indicate that in general, the satisfaction levels of participants gradually increased. For example, the first

training was assessed by trainees as ‘medium’ in all aspects (content, participation, facilitation and relevance to actual FTI implementation). The only exception was organization and logistics that was assessed high. During the subsequent training events, the participants were highly satisfied with almost all of these aspects with a few exceptions only. Their item-wise as well as overall assessments indicate that the choice of new external facilitator as well as bringing aboard the FTI facilitator made the difference. The exceptions to theses general trends were logistics during training II, relevance to FTI implementation during training III and meeting participant expectations during training IV.

During training II, the venue was found inappropriate by some participants as it was the ZEF field guesthouse, where majority of the participants stayed. The training was organized there instead of ZEF office because it was one of the lessons from the previous training that such a training venue should be chosen where the participants can have informal exchange after training hours. However, the guesthouse did not have a proper training room. The training presentations and group work were held in a rather general living space of the guest house where even placing the projection screen was cumbersome. Likewise, the participants of the third training assessed the relevance of training contents to actual FTI implementation as ‘medium’ because more than half of trainees were new to FTI trainings. During the fourth and final training event, the participants expressed that the overall objectives of the workshop were not met as they expected more tools to be taught. This was the final training event in the FTI training series, the FTI facilitators, therefore, intentionally focused more on the substantial aspects of consolidating the learning from actual FTI implementation, rather than teaching more tools.

Table 4.3 Training Methods used for FTI Training Events

Training Workshop	Design and Methods used
I	- designed in consultation between ZEFa senior researcher and external consultant - brief presentations on review of concepts - facilitated plenary discussions for reflection - group work including brainstorming, games, visualizations - turn-wise note taking of sessions - small group daily evaluations reported in a plenary - trainers and organizers joint review of each day
II	-preparatory consultation in Bonn between new external facilitator and ZEF staff - external facilitator and FTI facilitator co-facilitated the training - started with recording of participant expectations - the first session was used as a participant recap of previous training -Focused introductions in lecture-style were used to present new insights, methods and tools followed by facilitated plenary discussions. - A variety of small group assignments was used for more detailed discussions and, particularly, to practice various tools - brainstorming, games, visualization were used to stimulate group work - The participants took turns in documenting the proceedings of the sessions. - Small groups of participants also undertook an evaluation at the end of each day and reported their findings in the plenary - At the end of each day, the trainers also reviewed the day together with the organizers and finalized the program for the next day
III	-A prior email consultation with participants of the first two FTI trainings to inventorize issues, concerns for discussion in the third FTI training. -These notes on the functioning of the FTI teams formed the basis for the discussions during the last day. - Shared facilitation - Daily small group evaluations -facilitators reviewed the progress daily and adjusted / revised schedule and content -due to involvement of stakeholders, the training was slower as they needed to be translated -As before, a variety of small group work techniques were used to ensure active participation and joint understanding -The participants were divided into two groups to conduct actual field study to practice taught tools -As before, participants took turns to take notes daily
IV	- the organizers consulted FTI research staff by email to draft a workshop program - shared facilitation - daily small group evaluations -facilitators reviewed the progress daily and adjusted / revised schedule and content -due to involvement of stakeholders, the FTI assistant was assigned to translate the training proceedings and stakeholders views -As before, a variety of small group work techniques were used to ensure active participation and joint understanding -The participants were divided into two groups to conduct actual field study to practice taught tools -As before, participants took turns to take notes daily

Source: Authors summary based on consultant training report

Table 4.4 Evaluation of FTI training events by participants

Training Workshop	Evaluation (Satisfaction level as indicated by participants)
I	-Content: Medium - Participation: Medium -Organization and Logistics: high -Facilitation: Medium -Relevance : medium
II	Content: high Participation: high Organization and logistics: low to high (low due to the inappropriateness of the workshop venue) Facilitation: very high Relevance to FTI implementation : high Overall expectation met: medium to high
III	Content: High Participation: High Organization and logistics: high Facilitation: high Relevance to FTI implementation: Medium Expectation met: High
IV	Contents =High Participation=High Organization and logistics= high Facilitation= High Relevance to FTI implementation=Not assessed Objectives Met= mixed (more training / tools expected) Overall= High

Source: Author's summary based on van Veldhuizen, 2008: 21; van Veldhuizen, et al., 2009: 76; van Veldhuizen, 2010:76 and Wettasinha and Bayer, 2008: 48

4.6 Conclusions

Since ZEF used project funds to further its strategic goal of carrying out interdisciplinary research, the important role that foundational conditions around the IDR exercise played in framing the experience of nurturing interdisciplinarity within ZEF's Uzbekistan project became clear as soon as the project started taking actions to achieve the ambition. The recruitment experience for the FTI facilitator showed that for ZEF as a research institute relying heavily on externally funded projects, recruiting someone from an unusual job market was particularly cumbersome. The delayed recruitment as a result did not allow ZEF to nurture interdisciplinary in the way it had originally designed and ZEF had to proceed to implement the first FTI training without the staff member that was to carry the process further and thus had to forego critical inputs that the FTI facilitator's presence

from the start could provide. Likewise, the key Urgench-based staff that had to actually carry the implementation process forward could not attend the first training due to complications with financing their travel. The critical role of foundational conditions in nurturing interdisciplinarity was also visible from the overtime participation of staff in FTI training events. In none of the trainings all participants from the previous training could participate, either due to financial reasons, or due to administrative reasons, or due to clashing field activities. During training III and IV, a few natural scientists were hopping in and out because they accorded higher priority to attending to their field activities or visiting collaborators compared to learning about interdisciplinarity. Continuous participation could not be ensured despite the fact that training events were planned and communicated well ahead of time, and with the consent of all participants.

The literature discussion sessions as a follow-up of the critical discussions during the first training, could potentially act as a first bridge in narrowing epistemological gaps prevalent within ZEF's three departments, but these exercises resulted in creating confusion. The literature discussions were thought to create broader understanding on relevant conceptual, methodological and theoretical issues, and need for interdisciplinarity and integration of sources of knowledge. Since many of the Urgench based staff were not exposed to the critical discussions that took place during Training I in Bonn on why interdisciplinarity was needed in the first place, they could not relate to the critical literature on agricultural adoption, system thinking, or hard and soft systems till FTI Training II, and found it burdensome, irrelevant, and unrelated to FTI. Part of these confusions could be due to the presenter's skills and the choice of literature, which largely belonged to critical realism. However, this experience also suggests the complications in understanding due to epistemologies of the participants of these discussions. The social science participants liked it, but for natural scientists the literature was irrelevant or too complex.

The choice of innovations during training II for FTI process proved to be reflection of the past history of power distribution within ZEF, especially between ZEFa and ZEFb, and

was proportionate to the relative degree of research that the two departments had carried out in the project.

I assumed that since the trainees of facilitation skills and communication were largely senior and junior researchers, they would as researchers be keen to gain knowledge about new skills, and find themselves its relevance to their work and look at the ideas contained in these presentations for implementation during their FTI work, only a few of the trainees benefited from this training in reality, as later discovered. The experience following from training on facilitation and communication skills showed that learning soft skills required much more practice by research team members than learning hard skills. This became evident from the continuous desire to learn and practice more facilitation skills by the participants till training III.

The combination of delivery methods (power point presentation, group work, energizers, visualizations and charts, discussions in plenary sessions) used during various trainings was found useful by participants, and the day, on which there would be relatively more concentration on one of these, the evaluating participants criticized it. Thus, mixing and combing the delivery methods appeared to be a successful training strategy.

The participant expectations were generally met in almost all training events, but the last one, where participants expected more tools. As relevant tools were already taught during training I through IV and it was made clear time and again during the training sessions and later in FTI related discussions between the facilitator and the FTI teams, that the teams should work with those tools, adapt tools for their respective stakeholder and innovation, and seek assistance from FTI facilitator, if needed for any issues related to the use of tools. However, the desire to learn more tools or tools that precisely matched an FTI teams needs, suggested that a section of participants, most likely the research assistants[36], desired rather prescriptive style of training. This once more points to the

[36] Since the external consultant, social science coordinator, and the FTI facilitator had co-facilitated training II, III, and IV, they refrained from watching the evaluation process so that the participants would freely evaluate. Therefore, it is impossible to establish a relationship between the satisfaction level and the type of FTI participants.

complexity involved in training staff on participatory and social science research methods of research in organizations where positivist analytical methods generally dominate and a hierarchical organizational culture prevails.

Despite the above-mentioned issues and challenges, the incremental, additive, and longitudinal design of capacity-building appeared to work in general for FTI teams. The gradual learning amongst all FTI teams about the complexity of their respective innovations, system complexity, importance of processes and process variables, and the need to adapt the innovations further to fit the local context did happen. The proponents of innovations, who initially believed that the innovation was "great" were moving forward to understand that it is not the innovation alone that can address the problems Khorezmian agriculture faces, rather each of the innovation has to be tailored to work in a bigger context that is shaped by not only the variables addressed by a single discipline.

Chapter 5: Interdisciplinarity at Work: FTI Implementation in the Uzbekistan Project

5.1 Introduction

In this chapter I discuss how and how much of interdisciplinary research (IDR) actually took place within the Uzbekistan project. Section 5.2 presents the overall IDR process framework through which the IDR teams were perceived to pass for undertaking the research regarding their respective innovations. Section 5.3 discusses the initial step of forming the IDR teams around each of the four selected innovations. Section 5.4 discusses the age and disciplinary profiles of various teams, and in section 5.5 I discuss how various IDR teams used capacity development as an input to their first IDR task of planning their further steps to design and implement their innovation specific IDR. In section 5.6, I examine the teething problems of integrating junior and senior membership within various teams and how members perceived their own epistemologies and team performance. The section 5.7 discusses various phases of interdisciplinary action through which the teams passed and the process and team dynamics while undertaking innovation specific IDR. The final section 5.8 concludes the discussion.

The evidence discussed in this chapter suggests that the teams experienced several difficulties in the beginning due to member's conflicting epistemologies, diverse personalities and cultures, but the longitudinal training design coupled with reflexive internal reviews and team work helped each of the four teams to considerably achieve interdisciplinary outcomes, in terms of both conceptual and procedural interdisciplinarity. The chapter makes two important contributions to theoretical discussions about interdisciplinarity. Firstly, the research team members might have two kinds of epistemologies; fundamental and superficial epistemologies. Secondly, the concept of "instrumental interdisciplinarity" needs further sub-division into "conceptual" and "procedural" interdisciplinarity.

The findings confirm several of the earlier findings in literature about process leadership, and its characteristics, role of power in shaping interdisciplinary research processes and outcomes. I argue that the teams experience higher degrees of interdisciplinarity in the beginning and towards the end of the IDR process, and tend to operate under multi-disciplinary modes during the middle part of the IDR process.

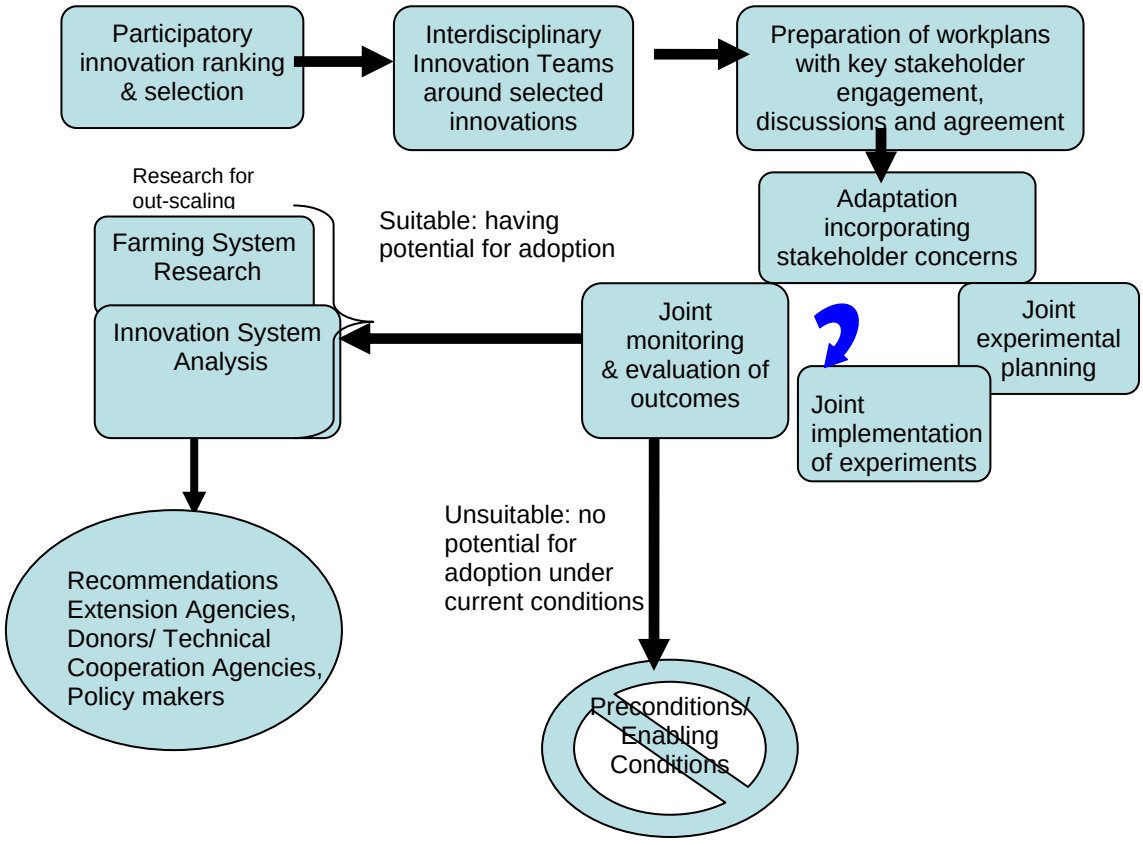
5.2 The IDR Framework for FTI

The "Follow-the- Innovation" (FTI) facilitator conceptualized the IDR research process around the innovations as a part of his first assignment of translating the ideas presented in the work package into an actionable work plan. This framework was presented to the project researchers based at Bonn in the end of April 2008 and later in mid May 2008 to the project researchers based at Urgench, and was eventually considered as an operational framework for carrying out IDR under project's FTI Approach (Figure 5.1), which was once more presented at Training II.

The ultimate aim of these IDR processes was to integrate scientific knowledge with local knowledge through inter and transdisciplinary processes and test the hypothesis of whether or not the innovation was ready to be out-scaled under local conditions. If the innovation was not yet ready, then to identify and assess the alterations needed, and re-assess the plausible promise of the innovation. Once the innovations for IDR process were identified through a participatory process during the FTI training II (as explained in Chapter 4), IDR teams were formed around each of the selected four innovations. The first task the teams had to undertake was to define the purpose of their IDR team, and prepare work plans or road maps for putting their respective innovation into a test under real life conditions of the intended users, or stakeholders. These team plans, as the first interdisciplinary exercise, were to indicate how the members of a specific IDR team had perceived the process of carrying out IDR. The IDR teams had to identify their key stakeholders and mutually agree on the team strategy and preliminary research plans for joint testing, adoption and adaptation of the innovations. Concrete roles and

responsibilities were to be spelled out for IDR team members as well as interested stakeholders. By continuously involving local stakeholders the teams were to ultimately become transdisciplinary, internalizing local and global expert knowledge for validating innovations. It was expected that some of the innovations would be drastically changed and might no more offer the benefits as envisaged at their scientific design stage. The IDR team members were responsible to make necessary amendments to the innovations as identified by the stakeholders and the validation experiments were to be jointly perceived, designed and implemented. The perceived IDR processes (Figure 5.1) involved questions and problems relating to both nature and society that the teams had to resolve, and therefore, had a strong project-based learning orientation (Conrad, 2002).

Figure 5.1 The Perceived IDR Approach for FTI



Source: Ul-Hassan, 2008

The integration of local knowledge was to take place through the validation loop (middle right in Figure 5.1). Through Participatory Monitoring and Evaluation (PM&E) of the implementation cycle it would be verified if the innovation in its revised form still held a plausible promise (Röling, 2009), or needed to be shelved. In the former case, further research would be required to understand the entire innovation system and eventually form recommendations for the extension and technical assistance agencies for further out-scaling. In case the innovation failed to yield the anticipated benefits, enabling conditions that were precondition to the successful adoption of the respective innovation would be identified.

5.3. Forming IDR Teams around Selected Innovations

As indicated in chapter 4, around each of the selected innovations IDR teams comprising senior and junior, or core and support, researchers were formed. Each of the four teams comprised old and young members, highly and relatively less experienced members, as well as members from various nationalities, locations and disciplines. These composition details are briefly elaborated in the following sub-sections.

Table 5.1 presents the team composition and disciplinary mix of IDR teams around the selected four innovations. The senior scientists from disciplines more closely related to the innovation in question formed the core of the team, and those related to supportive research areas as well as the Ph.D. students were considered as an arm of team to support FTI.

A senior scientist from the core discipline, from which the innovation emerged, led the group as the work package write- up proposed. In three of four IDR teams (Afforestation as an Alternative Land Use -AL, Conservation Agriculture -CA, Salinity Assessment using Induction Techniques-SA), the team leaders were those scientists who had earlier defended their Ph.D. dissertations around the technical aspects of the innovation in question. The leader of the Water Users Associations (WUA) team had extensively

worked on an action research project carried out by the International Water Management Institute (IWMI). The IWMI's project aimed at testing the viability of WUAs in the Fergana Valley of Central Asia, spanning over parts of Uzbekistan, Kyrgyzstan and Tajikistan. The WUA team leader was also leading another work package aimed at understanding socio-technical linkages of water management in Khorezm. The choice of leadership from the main discipline of the innovation augured well with the availability of technical expertise within the project, as not many senior scientists, apart from those made responsible for various teams were based at the field location, where the FTI experiments had to be conducted[37]. The potential danger of appointing a leader from the core discipline of innovation directing the activities into the core disciplinary research rather than focusing on integration of insights and knowledge from other disciplines was not realized at that stage.

What was realized later was that the choice of leadership from the core discipline of innovation expressed the project mentality of considering 'technical expertise' superior to 'managing teamwork and collaboration', a broader pattern prevalent within the project as well as ZEF owing to its departmental organization. This also reflects a lack of recognition within ZEF of the differential roles that experts and managers play in a research process.

Reason for the separation between core and support members was the project's presumption that Ph.D. students, and scientists from relatively distant disciplines, due to their high research work load and focus on their own research areas, could not be asked to act as the main carriers of the process, as their "main" research responsibilities did not necessarily align well with FTI type of work. The perceived role for support members was to participate in group deliberations, share their disciplinary knowledge related to the particular innovation and partly be involved in some of the field research activities during the testing of respective innovation.

[37] The other senior scientists, apart from the project's field coordinator and the FTI facilitator, based at Urgench field office were two senior agronomists, a Soil Scientist, a GIS coordinator, a groundwater specialist, and three young economists appointed in 2008 or later as postdoctoral scientists. All of these were members to various FTI teams.

While most of these members volunteered themselves for the membership of various IDR teams, some teams initially lacked members from critical disciplines. The project coordinators addressed these critical disciplinary gaps by nominating additional members to these teams, and the nominees agreed. For example, initially no social scientist was interested in joining the AL team, and the project's field coordinator suggested that a Ph.D. student on agricultural extension was to take part as a team member. Likewise, no economist volunteered to join the WUA team at the beginning, and the project coordinator nominated a senior economist to contribute to this team. Six out of 22 core scientists were members of more than one team. Likewise, out of 16 support researchers, 5 participated in more than one team.

Table 5.1 The IDR Team Composition for FTI

IDR Team (total members)	Disciplinary Origin of the innovation	Disciplines of Core Researchers (No.)	Disciplines of Support Researchers (No.)
Conservation Agriculture – CA (11)	Agronomy/ Natural Science	Agronomy (2) Soil Science (1) Economics (1)	Agronomy (2) Soil Science (1) Social Science (2) Geography (1) Agricultural Extension (1)
Afforestation as a Land use for degraded lands – AL(10)	Forestry/Natural Science	Forestry (2) Economics (3) Soil Science (1) Crop System Modeling (1)	Agricultural Extension (1) Forestry (1) Geography (1)
Water Users Associations-WUA (9)	Water Management/ Social Science	Water Management (1) Hydrology (1) Economics (2)	Social Science (3) Geography (2)
Salinity Assessment – SA (8)	Soil Science/ Natural Science	Soil Science (1) Hydrology (2) Water Management (1) Economics (1) Geography (1) Agronomy (1)	Geography (1)
Total members (members in more than one group) 38 (11)		22 (6)	16 (5)

Source: Author's compilation based on (van Veldhuizen, 2008)

5.4. IDR Team Profiles

5.4.1 Age Profile of IDR Teams

The age composition (Table 5.2) of FTI teams indicates that only WUA team had an overwhelming majority (5 out of 7 below 30 years) of young members and no team member was above 45. CA and AL teams had a mix of younger and older generations and the SA team had no members below the age of 30. The team leaders in WUA, CA and SA teams were in their thirties, while that of AL was in his mid forties, a senior scientist from a collaborating organization.

Table 5.2 The Age Composition of FTI Teams

Age in completed years		FTI-Group				Total
		WUA	CA	AL	SA	
Team Members	20-30	5	1	2	0	8
	31-45	1	3	2	1	7
	46+	0	1	0	1	2
Team Leader		37	35	57	35	4
Total Members		7	6	5	3	21

Source: FTI Member Profile Survey (August 2008)

5.4.2 Experience Profile of IDR Teams

The majority of members in SA, AL, CA teams had more than five years of professional experience (Table 5.3) in their respective fields, whereas majority of the WUA team members had an experience of less than five years. The team leaders of WUA and AL teams were relatively well experienced (above ten years of professional experience) compared to those of CA and SA teams, who had an experience of seven and six years respectively. The SA and WUA team leaders had experience of working at more than one organizations, but the CA and AL team leaders had only worked for the same organizations.

Table 5.3 Experience profile of FTI Teams

Experience of Team Members (years)		FTI-Group & No of Team Members				
		WUA	CA	AL	SA	Total
Experience in years	0-5	5	1	1	0	7
	5-10	1	3	2	0	6
	>10	0	1	1	2	4
Team Leader		11	7	29	6	4
Total Members		7	6	5	3	21

Source: FTI Member Profile Survey (August 2008)

The age and experience composition of FTI team members indicate that the members of each of the above teams, apart from the CA team, had considerable differences in maturity and life experiences. Individual team members in each of these groups, therefore, had different motivations for learning, and required different approaches to learning. Relatively mature members could benefit more from training methods of adult learning, as they draw their learning motivation from inside (Knowles, 1989; Knowles, 1990), compared to younger members who draw their learning motivation from outside, and needed different techniques for induced learning. The junior research team members, Ph.D./ MS students and research assistants, were all Uzbek nationals, except two Ph.D. students engaged in WUA team. The Uzbek nationals generally are respectful to their work and study supervisors, and questioning supervisor's views is considered culturally inappropriate (Hornidge, et. al., 2009). One implication of such age and experience differences within the teams, therefore was, that special efforts were needed from the team leaders to mobilize the local knowledge of younger members within these teams while undertaking IDR. Most team leaders were, however, not much exposed to needed facilitation skills, as was to be discovered later during the process. The leadership and facilitation skills of team leaders and senior management, especially tactfulness in conflict resolution and the ability to encourage cooperation among team members have been found as important assets for successful IDR teams (Stokols, et al., 2008), which were only available with WUA team out of the four teams.

5.4.3. Epistemic Profile

The perceptions of team members regarding the role of science and scientists (Table 5.4), categorized along agreement and disagreement to specific statements, indicated that a vast majority of the team members disagreed with propositions that scientists should only undertake science for publishing, or solving scientific problems of their disciplines alone. This indicates that most of the participants believed that science should address actual societal problems and find practical solutions to those problems. All of the FTI team members agreed that carrying out interdisciplinary research was the way to understand the societal problems and to come up with workable solutions. A small minority who differed comprised research assistants, who were not much exposed to science and the ways in which science is generally conducted. The FTI members strongly believed in science for resolving societal problems, and undertaking IDR as a scientific pathway to address those problems.

Table 5.4 Perceptions about role of science

Statement	Strongly disagree, disagree, disagree more than agree (%)	Strongly agree, agree, agree more than disagree (%)	No. of respondents (%)
The most important role of the scientists is to do research and publish high quality research articles	20 (80%)	4 (20%)	24 (100%)
Scientists should focus on solving scientific problems of their disciplines only	15 (63%)	9 (37%)	24 (100%)
If scientists from all relevant disciplines work together as a team, they will come up with more real situation assessment, and workable realistic solution	0 (0%)	24 (100%)	24 (100%)

Source: FTI Perception Survey, August 2008

The team epistemologies on their specific disciplines and relative importance of natural, economic and social science disciplines in solving problems facing agriculture in Khorezm (Table 5.5) indicated that almost two-thirds of the survey respondents (62%) regarded their own discipline capable of finding the 'best' solutions for resolving agricultural problems. Almost six in ten respondents (58%) disagreed that the lack of availability of technological solutions was the major issue for Khorezmian agriculture. Over two thirds of the respondents agreed that there was no need for newer technologies,

rather the need to work on social and institutional issues. An overwhelming majority (80% and 96% respectively) agreed that technical solutions provided only a part of the solution side of the equation, and that the most important issues were rather those related to social, institutional and political systems.

Table 5.5 Member Perceptions on their disciplines and relative importance of technological and socio-political solutions

Statement	Strongly disagree, disagree, disagree more than agree (%)	Strongly agree, agree, agree more than disagree (%)	No. of respondents (%)
My field of training finds solutions that are the best for resolving agricultural problems	9 (38%)	15 (62%)	24 (100%)
The major problems of rural areas of Khorezm are due to non-availability of technical solutions and technologies	14 (58%)	10 (42%)	24 (100%)
Technical solutions for Khorezm already exist, but social and institutional system needs to be changed to make these solutions work	8 (33%)	16 (67%)	24 (100%)
Technical solutions and technologies are only one part of the solutions to the problems of Khorezmian rural areas	5 (21%)	19 (79%)	24 (100%)
Social, economic, and political issues are the most important issues to improve Khorezm agriculture	1 (4%)	23 (96%)	24 (100%)

Source: FTI Perception Survey, August 2008

Overall, it appears from the above two tables that a vast majority of the respondents was already aware of the limitations of disciplinary research in resolving real societal problems. This could be partly attributed to the learning from FTI training I, which was further enriched by discussions at training II (Chapter 4). However, not all respondents of the survey had attended the first two training events, where concepts of interdisciplinary research and its potentials were discussed comparing it to those of disciplinary research. One possible explanation could be that some of the respondents gave socially desirable answers, as they were engaged in FTI related interdisciplinary research themselves. This appears to be a plausible explanation considering that almost two-thirds of the survey respondents (62%) at the same time regarded their own discipline capable of finding the 'best' solutions for resolving agricultural problems in Khorezm (Table 5.5).

This has important implications for methodology deployed in studying interdisciplinary research during its action phases. Since the self-reporting survey included separate sections on respondent's perceptions on role of science for society and their views on their own disciplines, it could reveal conflicts in what the participants expected from science in general, and how their own discipline was embedded in the overall context of science. Therefore, separation of questions about respondent's views on desirability of IDR and on the validity of their own disciplinary specialization need to be separated and spaced apart in the survey instruments deployed to understand participant epistemologies.

5.5 Utilizing the Initial Capacity-Building for IDR Planning: The First interdisciplinary task of preparing Work Plans

During training II, one of the initial tasks assigned to the teams was to prepare a road map for FTI process around their innovation. After training II, the FTI teams held internal meetings to plan their activities, identify, and involve stakeholders. The teams used only one of the several taught tools - Venn Diagrams - to discern relevant stakeholders for the FTI process from other important stakeholders for the innovations in question (Hornidge *et al.*, 2009).

Thereafter, the team leaders of WUA, AL, and CA teams organized structured consultative meetings with members available at Urgench to identify the purpose of their respective IDR exercise and outline a road map of activities to involve the identified stakeholders and jointly plan and implement experiments aimed at validating their respective innovations. The SA team opted for an unstructured approach of work. The team leader prepared an outline and sought inputs through email. Once a preliminary draft work plan was available, the team leaders circulated these drafts to their respective members through emails. The team members that were not based at Urgench provided their inputs in the form of comments and suggestions on the initial drafts, which were copied to all team members of the respective group as well as to the FTI facilitator and the two project coordinators, who also commented on these versions.

The internal activity planning of each FTI team proved to be rather time consuming, however, as there had been tendencies amongst some of the teams to plan for the entire experiment as scientists and experts rather than planning the process of stakeholder engagement and joint experimentation. For example, the CA team at the first stage came up with a detailed but phased plan of activities indicating the timing of field selection, land preparation, sowing, irrigation, fertilization, agronomic field practices during the growth of the crop, and harvesting. The plan included text book scientific research methods, such as soil sampling, measuring use of inputs and estimating harvest index by scientists (Egamberdiev *et al.*, 2008). The plan was completely silent on how farmers' experiences and suggestions were to be incorporated into the design of the experiment, implementation of activities and the measurements of data. The plan looked as if it was a controlled scientific experiment of an MS student intending to compare the CA practices with those of conventional farmer practices, and establish the superiority of CA practices based on statistical analysis of comparing input use and yields. This team decided to call its work plan as a 'road and maneuver map'. This title indicated the group epistemology of considering scientific knowledge superior to local knowledge and using tactics to maneuver the actions of the stakeholder, though the intention behind FTI was to integrate scientific as well as local knowledge in such a way that the innovation is checked under real conditions and not under controlled scientific conditions.

The CA team that was largely manned by natural scientists and one economist thought of "convincing" and "sensitizing" their selected stakeholders, especially the farmers about the benefits of conservation agriculture and then carrying out joint experiments with those farmers who got convinced. The SA team decided to explore the interests of a range of organizations whose mandate was to map and assess salinity over large areas. The AL team decided to select farmers with degraded farmlands who were interested to plant trees as an alternate land use through carrying out a survey in the two most environmentally degraded districts of the province. The WUA team identified a poorly performing WUA whose newly appointed chairperson was interested to make that WUA able to perform its functions and be financially and socially viable.

The teams proposed various stakeholder engaging strategies, which varied between the teams. They ranged from individual meetings (CA, SA, AL) with key stakeholders and possible partners to participatory situation analyses (WUA). A tendency for individual and face to face discussions related to "technology oriented" innovations (SA, CA and AL teams) could be observed. In contrast, for the innovation that originated from social science discipline (WUA team) the tendency was to carry out more complex but participatory processes, like problem and situation analysis, right from the start.

The teams gradually progressed towards completing their first "ready-to-implement" plans during a period of almost six months (June – November 2008). The six team members, who were not based at Urgench, were involved through email communication. Empirical literature about interdisciplinary research (e.g. Conrad, 2002; Kostoff, 2002) has identified availability of sufficient time, which is usually lacking, as a facilitating condition to acquire and to utilize a common conceptual (theoretical) framework in problem oriented research….*because a project team's substantial (i.e. emotional) internalization, and the subsequent implementation/ utilization of such a newly developed conceptual framework is undoubtedly a time consuming process which requires repeated feedback loops of social learning* (Conrad, 2002:13). Time is also *required to learn techniques, cultures and traditions of other disciplines* (Kostoff, 2002:939).

These Electronic team (E-team) members proved to be both an asset as well as a problem in the FTI experience. On one hand, while not being part of live face-to-face discussions, they provided more objective comments and criticism reflecting upon their understanding of team objectives, and proposed actions as decided at the second FTI training. On the other hand, the team members who were actually investing time and energy in debating issues and devising strategies considering local realities for making FTI work in the field, perceived the criticism from E-members as divorced from reality, too theoretical, and obstructing rather than helping (Hornidge *et al.*, 2009). One of the Urgench-based FTI scientists differentiated between the Urgench based and Bonn based FTI members as the *'workers'* and *'criticizers'* respectively (Field note, July 2008), indicating a lack of appreciation for the comments and suggestions from E-members of the teams by those

who were on-site. Urgench – Bonn interaction amongst scientists was clearly not easy. Such problems are not uncommon in dispersed teams attempting to undertake team research (Stokols, et al., 2008).

The FTI facilitator held individual and group discussions with team leaders and FTI teams to clarify issues ranging from what was the purpose of FTI, why innovations had to be tested under real life, what value a participatory planning process would bring to the whole exercise, as well as team specific issues. Some of these discussions were held with respective FTI teams, while many others were in the form of informal chats over a cup of coffee or at the lunch table. The content of these discussions varied from progress on plans, on-going activities, and difficulties experienced during the process, personal issues and aspirations, tips for addressing specific challenges.

5.6 From Enthusiastic Start to Team Realities

Though FTI teams started enthusiastically, several epistemological, personal, and logistical factors played a role that led to some members becoming more active and others taking a back seat in the FTI process. The Ph.D. students in general had a tendency to gradually be less and less involved in FTI activities. To investigate this further, five Ph.D. students were interviewed in October 2008 to find out about their experience of being members of FTI Teams.

5.6.1 Integrating Junior and Senior Members

Most of the discussions within the groups usually took place either at structured meetings chaired by the team leaders or through one-to-one meetings between the group members. The team members tended to record the minutes of the structured meetings, but felt that these took much more time than they initially thought it would require. While some groups (WUA, SA) had made the team leaders responsible for documenting the essential

details of the meetings, and generally had an agenda circulated prior to the meeting, the other two groups took it more informally. These tendencies led to confusion and frustration, especially amongst the Ph.D. students. While two of the Ph.D. students kept on taking active part in their respective teams, the general tendency amongst the others was that they were gradually divorcing themselves from their teams (Field Notes November 2008). The reasons for their gradual withdrawal included lack of clarity about their team roles, dissatisfaction with the way teams were undertaking their team work, de-motivating or unfair comments from senior members about their capabilities, and work pressure due to their own research that did not necessarily benefit from their participation in the team. Loss of interest and motivation, especially amongst younger scientists, during an IDR process, if not facilitated well by project's senior management has also been reported by Rhoten (2004), who argues that the high labor intensity of collaborative research is specially challenging for younger scientists who are particularly concerned about establishing strong scientific identities within their chosen fields. A few examples are cited below from the interviews conducted with Ph. D. students (Field Notes from November 2008).

> Interviewer: *What was your interest that you decided to be a member of one or more FTI teams?*
>
> Ph.D. Student1: *In my [*Ph.D.] *research, I am interested to understand why farmers conserve or not conserve water in agriculture in Khorezm. I joined WUA group because it is trying to improve user's water management organization so that it can improve water management. The second group tests the applicability of conservation agriculture for Khorezmian settings, which includes water.*
>
> Ph.D. Student2: *In my previous job, I had worked for six years on improving WUAs in the Fergana Valley, and thought that I could contribute a lot based on my experience there. Also, the WUA that the team has chosen is at the same village where I do research, so I can get some data and share what I collect.*
>
> Ph.D. Student3,4,5: *I am carrying out field trials on a few aspects of CA. The filed sites for my research are the same where some of the CA experiments are carried out. The project management asked me to join this group.*
>
> Interviewer: *What role do you perform in the CA FTI team?*

Ph.D. Student1: *I try to help team on WUA with conceptual insights, as well as use some of research skills [*e.g. PRA exercises, group facilitation, note taking]. *This way, I help the team, but also gather data for myself. As far as CA group is concerned, so far I provided comments on the team plan.*

Ph.D. Student2: *I was requested to facilitate one group discussion within the problem analysis workshop. The team leader once asked my help about finding out performance indicators for WUAs. I gave suggestions.*

Ph.D. Student3: *I do not know. I sit through the meetings, and listen what is being discussed. If I have anything to say, I say, but nobody explained to me what I should contribute to this team. It would be better if our team would have first discussed what everybody was supposed to do.*

Ph.D. Student4: *I have a lot of experience in participatory agronomic research from my previous job. I usually share my insights about how to bring CA to farmers in Khorezm.*

Interviewer: *How untrue I will be if I say that you are not as active in the team as you were at the start of FTI?*

Ph.D. Student1: *Absolutely untrue for WUA team. I am happy to be a part and I am a very active member. We discuss, plan and carry out activities together. We distribute roles for each activity based on which member is good at what. But you will be true for CA team. I lost a track of what is happening. The team does not meet or discuss much. They are not clear what they are doing….. I stopped following this team, feeling that they don't need me.*

Ph.D. Student2: *Due to my own research, I have a very busy schedule. Also, I do not know how to contribute? Sitting in the team meetings, I often wonder what does he* [Team Leader] *want from me?*

Based on these statements reflecting upon the difficulties the Ph.D. students faced in getting integrated into their respective teams, one could argue that the choice of team leadership for IDR research, that is strictly based on "expertise" and does not consider skills in "managing team work" might lead to ineffective use of expertise available within the teams. Team leaders perform a number of tasks, such as cognitive tasks and process tasks, which require a different set of skills than mere disciplinary expertise (Gray, 2008). Process skills, for example decision making, problem solving, conflict resolution, information exchange, coordination, and boundary management, are crucial determinants to IDR collaborations (Gray 2008:S125). The absence of such skills leads to conflicts

regarding legitimacy, power differences, and heterogeneity of aims of collaboration (Gray 2008:S125). Leaders with skills to manage collaboratively may make the difference between success and failure in IDR. A plausible explanation for retaining a disciplinary leadership model for FTI, which otherwise would require a democratic choice of team leadership based on skills and abilities to manage the process, lies in ZEF's departmental organization that also trickles down to its research projects. Separating team leadership from disciplinary expertise would have implied allowing non-disciplinary venturing into disciplinary turfs, and thus the fear of loss of control over interdisciplinary outcomes.

As a mitigation strategy, the CA, WUA and AL teams had counted more and more on the research assistants, for organizing and conducting meetings, taking care of logistical requirements for stakeholder interactions, and carrying out data collection activities. This was an easy choice by the team leaders as those assistants were generally associated to team leader's work packages, and thus were easy to train and monitor. The Ph.D. students did not see much benefit for themselves from their participation in FTI, and gradually withdrew, as Rhoten (2004) and Stokols, et al. (2008) indicated, due to lack of motivation. Besides, one of the senior economist associated with CA team and based at Bonn, accepted an employment in the United Kingdom and left ZEF and the project. As a result, towards the end of 2008, the team memberships stabilized to a total of about 24, including 12 senior researchers, 5 Ph.D. students, and 7 research assistants.

These FTI team members were surveyed using a structured questionnaire about their perceptions about their respective team performance using Clark's Team Survey (Clark, 2009). The results of these surveys are discussed below.

5.6.2 Performing Teams: The Team Assessment of their IDR Teamwork

Clark's methodology (Clark, 2009), is a structured way of assessing team formation processes along Tuckman's model of sequential stages of Forming, Storming, Norming, and Performing teams (Tuckman, 1965 and Tuckman and Jensen, 1973). The results of such team surveys indicate the stage at which a team generally operates. Through a structured questionnaire, that contains 32 statements about teamwork, the team members are requested to score (ranging from 1 for never to 5 for almost always) each of the statement indicating how often in their perception their team demonstrates those teamwork behaviors. There are eight statements related to each of the stage. To ensure that there are no systematic biases, the statements reflecting a particular stage are not asked in a single sequence. The respondent's scores are then summed up for each of the group of statements relating to various stages. An aggregate score below 16 for a stage indicates that the team almost never operates at that stage, while a score higher than 32 indicates that the team operates at that stage almost always. A score between these two values indicates that the team transitions through that stage. If scores are close to the same in two or more stages, it implies that the team is going through a transition phase, except when:

The score is high in both the Forming and Storming Stages then the team is in the Storming Stage; and

If the team scores are high in both the Norming and Performing Stages then the team is in the Performing Stage.

Only a small difference between three or four scores indicates that the team members have no clear perception of the way their team operates, the team's performance might be highly variable, or that the team might be in the storming phase, as this phase can be extremely volatile with high and low points.

The results of the teamwork survey, that was carried out in early May 2009, almost fifteen months after the first FTI training, are summarized in Table 5.6. The results indicate that by the time of the survey almost all teams perceived that their respective teams were at the performing stage. It can be noted that the difference between team scores between Norming and Performing stages were relatively low, indicating that the teams often tended to transition between these two stages.

Table 5.6 Team Stages for various FTI Teams in May 2009

FTI Team (No.)	Mean Scores (min-max)			
	Forming	Storming	Norming	Performing
WUA (6)	24.3 (22-26)	23 (17-26)	29.7 (28-31)	33.4 (27-38)
CA (6)	24.6 (22-27)	21.5 (16-29)	28.8 (23-31)	32 (25-35)
AL (5)	23.6 (20-26)	18.2 (16-21)	30(26-32)	35.6 (31-40)
SA (3)	23.0 (21-25)	18.3 (13-23)	31 (28-36)	32.7 (28-35)
Overall (20)	24.5 (20-27)	20.7 (13-29)	29.9 (23-36)	33.4 (25-40)

Source: Teamwork Survey, May 2009

As the team scores were relatively higher for the performing stage than other stages for all the teams, these can be attributed to the outcomes of capacity building events, such as the second FTI training in June 2008, literature discussions, training on effective communication and team facilitation, and the first internal review workshop. These capacity and team building events had provided a number of building blocks for the team members to work together. Besides, the teams while preparing their work plans and road maps, carrying out stakeholder engagement activities, and actually engaging with stakeholders and fine-tuning their IDR plans had already gained considerable experience of working together.

What can also be noted in the table 5.6 are the relatively close average team scores for sets of stages. The differences in average scores between forming and storming stages as well as those between Norming and Performing stages are relatively low. In case of the first two stages, the minimum difference (WUA and CA) ranged between 1 and 3 respectively, and maximum difference (AL, SA) ranged between 5 and 4 respectively. Likewise, the range of the lowest score differences between norming and performing stages was observed to be around 3 in case of SA, CA and WUA teams, whereas the maximum difference was observed in case of AL team (around 6). These narrow

differences imply that there were occasions when the team members viewed their teams to be in a continuous transition- sometimes moving forward, sometimes falling backwards. This hints on a gradual but non-linear progression of teams from forming to performing stages. This non-linear progression of teams, that the Tuckman's model has not much elaborated, has attracted some criticism by others, for example by Gersick (1988), who argues that groups' progress can rather be triggered more by a few members' awareness of time and deadlines than by completion of an absolute amount of work in a specific developmental stage. This appears to be the case for the FTI teams, as the teams were required to prepare and follow their road maps, indicating major activities and timelines for the identified activities. The senior team members pushed by those deadlines pursued delivering on time. The quality of work, for example, adequate levels of discussions within the teams or with the stakeholders, appeared to be compromised (Field Note May 2009) in pursuit of the deadlines.

One implication of the discussion above is that building and nurturing IDR in teams should be carried out as an organic process, and not as an engineering input-output process. Imposing stricter deadlines for achievement of outcomes could compromise on quality of the process as well as on the IDR research. However, within the Uzbekistan project, the IDR was already delayed due to contextual and foundational conditions that delayed the start of the process, and the project management, the process facilitators and coordinators, as well as the IDR teams did not have much time left for giving the process adequate time that it needed to develop organically.

5.7 Phases of IDR in FTI

The FTI Framework (Figure 5.1) can be divided into four distinct phases of IDR action, through which various team members passed while carrying out their FTI work. Each of the four FTI teams passed through a preparatory phase, a planning phase, an implementation phase and the final consolidation phase. During each of these phases, the teams carried out activities that differed in terms of mode, degree and depth of interdisciplinarity across teams as well as across team members. These phases with respect to interdisciplinarity are elaborated further in this section.

5.7.1 Preparatory phase

The preparatory phase included activities related to understanding of interdisciplinarity for individual team members whereby the team members differentiated for themselves between the concepts of discipline, multi-, inter- and transdisciplinary research, and as members of teams consolidated these concepts in terms of interdisciplinarity research for their team.

During these processes, team members were exposed through capacity building activities to these concepts, were given group work to consolidate and elaborate these concepts as these related to FTI in their perspective. The interaction tools (Karen *et al.*, 2010) which were used comprised brainstorming, group discussions, and facilitated group work followed by the presentation of group work results in the plenary session. The activities where the team members had to consolidate their discussion, for example generating a single definition of their innovation, or team definition of interdisciplinarity, can qualify for interdisciplinarity. In contrast, the activities which did not require a consolidation, such as literature discussion, can be categorized as multidisciplinary as the team members discussed the content of the literature and shared their reflection from their disciplinary perspective, but the outcome of the discussion was the discussion itself and did not

necessarily need a consolidation, rather a summary by either the presenter, or the facilitator. These literature discussions could potentially qualify for interdisciplinarity if, for example, the participants would reflect on how the contents of the literature related to their FTI exercises, which concepts were relevant to which FTI team, or how the FTI teams could refine their experimental methods based on what was presented. However, these discussions were mostly undertaken as avenues of information sharing rather than reflection and consolidation, and therefore, did not contribute much to enhancing theoretical or analytical skill levels of the participants.

It appeared to be important during these IDR exercise to break down what Klein calls instrumental IDR into two sub- typologies, the procedural and conceptual IDR. The difference between the two types of interdisciplinarity is a subtle one. Within FTI teams, when a team borrowed a concept from another field of specialization, it often focused on the term itself, without much deeper reflection on the details of the concept. For example, all the teams readily borrowed the concept of stakeholders from social science, and frequently referred to it during their team discussions, progress reporting or analysis. At the initial stages, the teams also identified the stakeholders that could be negatively affected by the innovation (rural administrative structures for CA, central government for AL and structures of ministry of water resources for WUA), but when it came to the details of planning and strategic interdisciplinary actions, none of the teams engaged with the potentially opposing stakeholders beyond invitations to joint activities, or awareness building seminars (Field Note July 2009). Thus, the concept of key stakeholder was operationalized as referring to those groups of stakeholders only for whom the innovation offered potential benefits, and not the ones who could oppose the wide scale use of the innovation.

The procedural IDR in the case of FTI was limited to borrowing analytical tools and methods, for example stakeholder identification tools of ranking and scoring, or using Venn diagrams. The initial tendency amongst the FTI teams with natural science innovations was not to use a tool for undertaking a systematic analysis of stakeholders, or to visualize the discussions. Such teams rather tended to rely on traditional paragraphed

descriptions. The FTI facilitator had to insist upon the use of Venn diagrams, and other similar tools taught to the participants for undertaking a systematic analysis. Only upon insistence, the teams used these tools during their preparatory stages as well as during the consolidation stages. There was a tendency to use the tools as these were taught, with little modification. Thus, conceptual ID readily took place in all the four teams, but when it came to procedural part of ID, the teams with natural science innovation were found a bit reluctant to borrow tools from other disciplines than the main one. Therefore, it is important that the procedural and conceptual aspects of Klein's (1990) instrumental ID are discussed separately in understanding an ID exercise.

Table 5.7 Activities during preparatory phase of FTI

Activities	Mode (level of interdisciplinarity)	Interaction tools	FTI Team
-Discerning D, MD, ID and TD modes of research	ID (Conceptual)	-Facilitated group work;	Available members of all FTI teams
- Defining Innovation	ID (Conceptual and Procedural)	-Facilitated group work	
-Identifying stakeholders and key stakeholders relevant to team specific innovation	ID (Conceptual and Procedural)	- Venn Diagrams	
Literature discussions	MD	-Brainstorming - Discussions on relevance to FTI	All four FTI teams

D= Disciplinary, MD= Multidisciplinary, ID=Interdisciplinary, TD = Transdisciplinary
Source: Author's field notes (May 2008 through July 2008)

5.7.2 Planning Phase

During the planning phase the FTI teams underwent series of planning discussions through meetings, exchange of drafts, as well as informal unstructured one-to-one discussions whereby the team members shared disciplinary insights, data, approaches, methods, and theories to come up with their respective team plans to implement innovation testing and refinement experiments (Table 5.8).

These planning discussions included presentation of the respective innovation by the team leader to the team, sharing knowledge about potential stakeholders and experimental sites, discussing advantages and disadvantages of engaging with various stakeholders and finally selecting an appropriate stakeholder or group of stakeholders to engage with. The teams also devised their respective stakeholder engagement strategies, and identified perceived implementation activities, time and financial resource requirements. While WUA and AL teams explicitly discussed the role and responsibilities of team members in their pursuit, the CA and SA teams tended in the beginning to vest their respective team leaders with every activity apart from field data collection or process documentation that was assigned to the research assistants and students available to the team leaders. All the four teams prepared their respective financial and time plans.

The SA, AL and CA teams spelled out the details of their data gathering exercises (soil and yield samples, input use, perception surveys, surveys to monitor soil salinity, etc), whereas the WUA team focused more on training the staff of WUA and leaving data collection to the WUA. Data analysis was foreseen as the responsibility of the FTI teams, who were then to discuss the results with the stakeholders.

These details formed what the teams called their road maps or work plans. The details were more precise for the first year and a bit vague for the following years. The teams intended to refine all of these based on their first year experiences.

A striking deficiency in the plans of all the teams was an absence of an agreed analytical framework. None of the teams addressed the question of how the teams would declare by the end of year one, whether or not the innovation in question was verified or not or what further elements of the innovation would need to be studied in detail. One could assume that the team leaders as the key scientists for their respective innovations would know from their previous work experience how to evaluate the effectiveness of their innovation. There were some details of what data will be collected, from whom, who will collect it, but they were not explicit in their plans about the methodology of analysis of

the data, neither these methodologies were explicitly discussed within their teams. One possible explanation could be the assumption by the team leaders that everyone else in the team knew how to assess the innovation in question regarding its social, environmental, agronomic, and economic impacts. Another possible explanation could be that since the monitoring and evaluation frameworks were yet not presented to the trainees by the time they had to write their plans, they did not think that it was important. They could have also assumed that it was the job of the FTI facilitator to assess whether or not the innovation was validated through those experiments.

Whatever the reason this absence of an analytical framework could be attributed to, the lesson one could draw is that in any capacity-building program, like that used by FTI, the monitoring and evaluation needs to be discussed early enough in the exercise.

Overall, preparation of team plans was not always a pleasant experience for the team members, and especially the team leaders. As stated above, the team member's feedback, especially from those not located at Urgench, was not always appreciated, and sometimes triggered negative feelings in some teams about those comments and suggestions provided from Bonn. One simple explanation for comments by Bonn-based team members triggering negative feelings amongst team members based at Urgench could be the style of commenting. Urgench based researchers were largely Uzbek nationals, where saying something negative about someone else, even though true, is viewed as extremely rude. When extremely essential, suggestions for improvement and negative remarks can only be conveyed in symbolic language, using stories, gestures, and jokes. In contrast, most of the researchers based at Bonn were European or western nationals or those who spent long years working in European countries, and tended to be direct, when it is related to business, as they do not see direct criticism as humiliating or aimed at putting someone down.

Table 5.8 Activities during planning phase of FTI

Activities	Participating Disciplines	Time Span	Exchange	FTI Team
Planning Meetings	Water Management, Hydrology Economics, Sociology, Geography	June - November 2008	Insights, local knowledge about the stakeholders and chosen sites, experience from previous job, synthesis of literature rationalizing activities	WUA
	Agronomy, Soil Science, Economics, Agricultural Extension, Geography	June 2008-April 2009	Insights, local knowledge about chosen sites and stakeholders, legislative issues, experience from previous trails, sharing knowledge from literature	CA
	Forestry, Economics, Soil Science, Agricultural Extension	June 2008-February 2009	Results of previous survey, Insights, experience, legislative challenges	AL
	Soil Science, Hydrology, Water Management	June 2008-April 2009	Insights, knowledge about mandate of proposed stakeholders, literature	SA
Documentation of discussions into draft and revised plans	Team Leaders of respective FTI teams	June 2008–April 2009	Incorporation of comments and suggestions	All four FTI teams

Source: Authors' compilation based on Field notes from June 2008 through April 2009

The teams which included E-members, some of the members located in Bonn and contributing to discussions through emails, especially faced challenges during communications:

> Team Leader of an FTI team: "*For* [names one activity of the innovation that belonged to commentator's field of specialization] *he* [names a Bonn-based member who provided comments] *is responsible for making the plan, and has lots of ideas, but for* [names the other activity that was not specialization of the commentator] *only agrees to everything I write– no suggestion on how to proceed further…"* (Field Note October 2008).

> Team Leader of an FTI team: "…*the comments we got on our draft team plan from Bonn are very demotivating* […] *we* [those based in Urgench] *work and they* [those based in Bonn] *criticize our work* […]. *The realities in the field are very different* […]. *If they think they can do better than us in the field, why don't they come here and do it themselves"* (Field Note August 2008).

What these statements indicate is not only the level of dissatisfaction with the contributions made by Bonn-based team mates by Urgench-based team members and vice versa. The first statement also points to existence of what Barbra Gray calls *Challenger disaster* (Gray, 2008: S125). Challenger disaster refers to *a team phenomenon whereby the team members having different views do not share their differential views due to power distortions within the team* (Gray 2008:S125). These statements also reflect contestations between epistemologies, localities, and hierarchy. The Bonn-based team members, when they commented on the draft plans, they tried to display their superiority in knowledge and expertise in their respective field of specialization, which was valid and universal under all conditions, including Urgench, as they usually read much more of the relevant literature, and participate in seminars and other forums where scientific knowledge is discussed compared to those based in Urgench, who did not have much access to literature. The seminars and presentations that took place in Urgench were usually related to the project work by researchers associated with the project. On the contrary, the comments from Urgench-based team leaders showed that the disciplinary Western knowledge had no clue what the reality in the field was, or did not understand the "real" side of things. The Bonn-based members triggered negative feelings amongst field based members especially when they tried to venture into the disciplinary or experience territory of their Urgench-based counterparts.

The fact that departmental coordinators, as well as leaders of most work packages, apart from the project's field coordinator, were all based at Bonn, the Bonn-based staff were generally perceived by Urgench-based staff as coming from "the Headquarters" in the sense of having higher levels of authority in decision-making and influence within the project, but having less practical knowledge of how to make things happen in the field.

When such exchanges happened through electronic communications (emails, commented electronic drafts) these posed special challenges and appeared to be not a good way of providing critical feedback in this case on several accounts. Firstly, when researchers from different disciplines communicated, they did not completely understand the terms, concepts, or the choice of phrases used by the sender (Field Note August 2008). If the

communication was face to face, they could directly ask the meaning of a specific term that was not understood. In an electronic communication, such clarifications were only possible through several rounds of exchanges, which could potentially clarify one term and create confusions about the terms chosen to explain. Secondly, in face to face communication, the specific tone of the speaker can change the meaning and the speaker has the possibility of using an appropriate tone. In electronic exchanges, it is up to the recipient of the electronic communication to assume and interpret the tone. For example if a scientist reading comments from another scientist is already irritated by some of the earlier comments, or simply has bad mood due to work pressure, or a conflict with the boss, there is a greater likelihood that a well meant comment could be interpreted negatively by the recipient of an email. Given that several of the researchers engaged in FTI had multiple responsibilities (more discussed in the following section) and very busy schedule of activities, such communication problems were not un-expected.

Another dimension was that since the team leaders were relatively older and more experienced than the younger researchers associated with those teams (Table 5.1 and 5.2 above), it was not always easy to get the perspectives and insights from the younger members into the discussions, unless specifically invited for an input or feedback, and therefore the phenomenon of *groupthink* (Gray, 2008:S125), whereby members tend to suppress their differences due to power distortions within the team and face *Challenger disaster*. Trained and experienced facilitators realized this challenge (for example the WUA team leader), and made special efforts to ensure the participation of silent members. Therefore, it is quite likely that the younger members in other three teams might not have adequately contributed their knowledge, experience and insights to their fullest potentials. These dimensions of barriers and challenges to IDR as experienced by FTI teams are further discussed and elaborated in Chapter 7

5.7.3 Implementation Phase

The teams carried out a number of activities during the implementation of FTI with the stakeholders. At the start of this phase, each of the four teams presented the research idea to the key stakeholders. Each of the four teams decided a stakeholder approach that differed depending upon, both the type of the stakeholders they addressed, as well as the skills that were available within their teams. The WUA team for example, had a number of members who were trained in using participatory tools. This team decided to carry out a problem analysis workshop together with the WUA, and using this opportunity, to relate their innovation as a solution to address some of the problems WUA faced. Likewise, the CA team had results from the past agronomic trails that showed that CA practices saved inputs without reducing yields. This team decided to invite potential farmers to a presentation and equipment demonstration at the project's field office and then, through a second event, bring interested farmers to its research sites, where farmers could see the impacts visually. The SA team's innovation was a novel method to map salinity using commercially available equipment. Since this team targeted heads and specialists of salinity-mapping research organizations, it decided to prepare a research brief and hold individual meetings with potential stakeholders to raise interest. The AL team could only target farmers having saline lands where selected tree species could be planted as an alternative and profitable land use. This team therefore decided to first design a survey instrument, and while implementing this instrument, to use the opportunity to explore the interest of the farmers in growing trees of recommended species as an experiment.

These processes of stakeholder engagement and implementation of activities required a high intensity of interactions amongst team members to discuss, re-discuss, and adjust their team plans in the light of new information from the field. As FTI was not the only assignment for most of the FTI team members, the teams had to adjust their schedules and activities either for the FTI or for their main research. Some members decided in favor of FTI and proactively participated in these exchanges (most members of WUA and

AL teams) while others, especially Ph.D. students and researchers having too much and too diverse work gradually withdrew themselves from activities (CA and SA teams).

The team leader of WUA team, also a lead researcher for another work package, made special efforts that all members were either involved in key activities, or at least were kept informed through sharing field notes and write ups, and visit reports. A key strategy the WUA team leader used was that he brought FTI work closer to his main research area of socio-technical analysis of water management in Khorezm. The field site and the partner WUA for FTI was also a sample site for data collection of activities related to the work package under his main responsibility, and several of the field assistants and students that were contributing to socio-technical analysis were also part of FTI.

> *The discussions* (largely through email as two key members were out of Urgench for most of the time) *in June 2009 led to an agreement that a workshop would be organized with WUA to understand the current water distribution principles and practices within the WUA, and to present several alternatives for water distribution for WUA. The principles and pros-and cons of the alternatives would also be presented to WUA and it would be requested to decide through its council if it would like to adopt any of the proposed methods. Once the WUA takes its decision, the FTI team would assist the WUA in operationalizing it.*
>
> *…another development during the process of elaborating the workshop details through email exchange was that one of the emails written by the team leader of … was seen by a key member of the … as humiliating, where the former commented on the capabilities of the latter. Though the former apologized, the latter became emotionally upset and decided to step out of the process.* (Process Notes, July 2009)

What this instance signifies is the failure of two key researchers from the same demographic background and similar specializations having different epistemologies due to differential experience and age, to arrive at a negotiated IDR outcome (Miller et al., 2008). Therefore, it can be argued that the hypothesis of stronger network ties being developed during IDR interactions amongst members sharing demographic and

educational backgrounds (Stokols, et al., 2008) was not valid in this specific case. What also becomes clear is that member's epistemologies in an IDR team do not necessarily emerge from same specialization alone, rather age and past experience do contribute to member's epistemologies, which keep on changing over time.

During 2009, all activities that were to be carried out by FTI team as training and support activities for equipping WUA for getting organized better were undertaken. For the rest of the period of 2009 and 2010, the team's role was largely to assist in assessing perceptions of water users towards WUA and assessing WUA's performance. The FTI WUA team leader suddenly left the project in November 2009 on account of finding an attractive job in Tashkent, the hometown of the researcher. The WUA team carried out its balance FTI activities throughout 2009 and 2010 with partial support and guidance from the FTI facilitator, who shared the responsibilities of leading the team together with an economist member of the team. Also, three of the Ph.D. students completed their field work by end of 2009 and were no more involved in FTI activities. The effective team size of the WUA team by early 2010 was reduced to two senior staff (FTI facilitator, senior economist), and three research assistants.

The team leader of CA team had several responsibilities as well. He was responsible for carrying out several field trails of agronomic aspects at project's research station, was lead researcher for project's collaboration with international centers conducting research on CA, as well as was preparing for his professorship at one of the Uzbek universities. His style of work over the period developed into a 'solo-flight' style. While he would perform field visits to his other work, he tended to visit selected CA farmers as well, but did not share his findings or exchanges with his other team members formally. He would rather pass on this information casually to whosoever would ask. The team members from his team would often complain about lack of information sharing. The FTI facilitator, upon becoming aware, several times tried to explain that it was important for the entire team to know the outcomes of his field activities related to FTI. He would agree and promise to share the information through meetings or writing it up for others, but would rarely live up to his promises. Multiplicity of tasks and the resultant lack of

time, and competing institutional demands, as was the case for the team leader of CA, have been found to impede IDR team performance elsewhere too (Stokols, 2008).

The SA team was lost in the beginning. The interdisciplinary research idea this group attempted to address appeared to be simple. The team was confident that the methodology the team used to assess and map salinity was relatively simple and straightforward, and would readily be accepted by salinity mapping organizations, as the used methodology made salinity mapping over large areas a relatively rapid and easy job with reasonable accuracy. The team's innovation required only one person to operate the equipment for surveying, recording, analyzing, and interpreting data. The only envisaged constraints the team saw was availability of equipment, and training of staff. Eight members signed up for this team at the start, only four of them were based at Urgench. The entire input this team received at the initial stages from almost half of the team which was based at Bonn was input for identification of stakeholders. When the work plan was drafted, most of the inputs were just statements of agreement to what team leader had drafted. As the identified stakeholders were high level civil servants, with whom the team felt it could not use participatory tools, rather could only exchange ideas through formal discussions and exchange of scientific outputs. The team's stakeholder engagement strategy hinged around two Urgench-based researchers, the team leader and a hydrologist, who knew salinity mapping agencies in and around Khorezm well. The visits to stakeholders in Urgench city were well received, and the stakeholders initially showed interest in the innovation, and they promised to contact the team leader for further discussion on the innovation. Likewise, the chosen stakeholders in Tashkent also showed interest to work together further. For several months, however, none of the stakeholders followed up on their promises. The team leader, frustrated by lack of progress, asked advice from the project coordinator and FTI facilitator, who held a meeting with the team leader and the hydrologist to revisit and re-discuss team strategy. The team leader was advised to contact the stakeholders through telephone and explore their interest further. Upon contact, the team leader found out that the stakeholder in Urgench had undergone internal changes in the leadership and therefore needed to be

contacted again. The stakeholder in Tashkent delegated the matter further down the chain to a salinity specialist and advised to liaise with the specialist.

These developments frustrated the SA team leader, who reported that he felt like being seen by the stakeholder as a *salesman of the manufacturers interested to promote the product* (Field Note, June 2009), and argued that since stakeholders did not see that the innovation served their interests, the innovation should be withdrawn from the FTI process. Lack of progress has been found to be an important negative factor affecting member's motivation to be involved in collaborative research (Stokols, 2008). Another reason for the de-motivation was that the effective team membership reduced to one member- the team leader. During FTI training III, this situation was discussed and the FTI facilitator was requested to join the SA team. The team leader, the FTI facilitator and the hydrologist carried out an analysis of the road map, chosen stakeholders, and the engagement strategy, and came up with the idea that the interest of more stakeholders should be explored, including agricultural development projects, universities, and irrigation research institute, partly mandated with training of governmental staff for salinity assessment. This re-visiting the strategy did not help much in case of salinity measuring organizations, but helped for irrigation research institute, who got interested in testing the innovation by itself, and if found promising, would include it in its teaching curriculum. This institute then tested the equipment at its own research sites, shared the data and analysis with the project, and recommended the innovation as a useful tool for rapid assessment of salinity with reasonable accuracy, and included the methodology in its curricula for training of salinity specialists.

The AL team relied heavily on one stakeholder, the head of forestry institute, to lead the interdisciplinary team activities as the project had previously been collaborating with that institute. However, the selected collaborator was based in Tashkent and could not be frequently available in Urgench, where the field activities were to take place. The team leader, therefore, delegated the task of field work to project's Ph.D. student on agricultural extension, who had previously carried out a perception survey of farmers regarding agro-forestry. The only occasions when the team work would gain high

momentum would be the time when the team leader would visit Urgench. The field activities, otherwise, would be carried out by the Ph.D. student on agricultural extension, not much familiar with science of trees, but more familiar with tools and methods to collect information from farmers about their practices, needs and constraints.

Table 5.9 presents the activities that were carried out by various FTI teams during the implementation phase of IDR, mode of activity (disciplinary, multi-disciplinary, and interdisciplinary) and nature (conceptual, procedural and critical) in terms of interdisciplinarity, and the interaction tools that were deployed to accomplish that activity. It becomes clear that during the implementation phase, several disciplinary, multi and inter-disciplinary activities were carried out. It was the nature of the performed activity that led to the choice related to how much of interdisciplinarity was feasible. For example, if data were required regarding the salinity level in the field as a result of conservation practices, actual data recording had to be done by a disciplinary scientist on salinity.

What becomes clear from Table 5.9 is that most activities were undertaken in an interdisciplinary mode either at the earlier stage, when the teams revised their work plans integrating comments from other team members or stakeholders, or later stages, when teams processed, analyzed, and interpreted their results. Actual implementation activities during the FTI experiments were largely disciplinary or multi-disciplinary. Most of the interdisciplinary activities were of procedural nature (borrowing and adapting tools and methods) during the implementation stage. Critical interdisciplinarity took place in the beginning, in the middle as well as in the end (for example, linking FTI to other water research, preparation of training materials, devising M&E indicators, and interpreting data) of implementation phase.

The table also shows that the integration was multi-layered. What was integrated in terms of disciplinary knowledge by the teams from various participating disciplines was information, data, tools, and explanations (Figure 3.1 chapter 3). At the earlier stages,

information and concepts were integrated; then tools, methods, and procedures; and towards the conclusion of the interdisciplinary action, explanations were integrated.

Breaking down instrumental ID (Klein, 1990) into conceptual and procedural parts (see Section 5. 7.1) was helpful in associating it with the relative beginning, middle and end of ID action during implementation stage. As is evident from table 5.9, most ID activities of conceptual nature took place at the earlier stages of implementation, whereas the procedural part dominated the rest. Therefore, it can be concluded that the use of conceptual ID only took place at the beginning of ID implementation, whereas the procedural ID dominated the rest of the implementation stage.

The implementation phase carried out during 2009 and 2010 generated qualitative and quantitative data in terms of both the IDR processes, as well as data related to innovation's relative validity for out-scaling under prevailing conditions in Khorezm. In terms of the FTI framework used (Figure 5.1), the general feedback was that there was not enough evidence proving that any of the experimented innovations was as such ready for large scale out scaling (van Veldhuizen *et al.*, 2010). All the four FTI teams came up with identification of further research questions that yet needed answers before the innovations could be further out-scaled and many preconditions were necessary for the innovations to be actually used by the stakeholders (Table 5.10).

The identification of additional research questions and the enabling conditions for the selected innovations to be adopted in Khorezmian context was a process that entailed critical reflection considering not only disciplinary variables, but the reality from multiple perspectives, multi-faceted assessment of reality, argumentation challenging single-sided perspectives, and finally consolidation of this critical reflection into a team epistemology. Therefore, it can qualify for critical interdisciplinarity within the FTI context.

Table 5.9 IDR Implementation Activities

Activities	Mode in terms of interdisciplinarity	Interaction tools	FTI Team
Presentation of the research idea to the key stakeholders by key researchers	D/ MD (Conceptual, Procedural)	Expert Meetings with stakeholder	CA, SA, AL
Situation Analysis workshop with stakeholders	ID (Conceptual, Procedural)	Group Meetings and discussions Visualization, Water Distribution Games, Infrastructure Mapping	WUA
Revising the work plan in the light of situation analysis	ID (Critical)	Discussion, Exchange of drafts, Exchange of comments and arguments	WUA
Design and pretest of survey instrument for stakeholders identification	ID (Conceptual, Procedural)	Discussion & Visualization	AL
Distribution of Team Roles	ID (Procedural)	-Note taking, reporting minutes and collecting comments/ suggestions	WUA WUA
Linking FTI with other project water related research	ID (Procedural, Critical)	Power point presentation, schematic flow charts, discussion	WUA
Signing agreements with selected stakeholders	MD (Procedural)	-Exchange of drafts, revision based on comments and final agreements	CA, AL WUA, SA
Organize meetings with other WUAs	MD (Conceptual, Procedural)	Note taking, distribution of minutes, integrating comments	WUA
Preparation of Training materials for stakeholders	ID (Conceptual, Procedural, Critical)	-Literature review, synthesis, discussion on areas of expertise - Visualizations, case studies, exchange of papers	WUA, CA, AL
Conceiving and devising monitoring and evaluation approach, indicators and instruments	ID (Conceptual, Procedural, Critical)	Literature review, discussion on member's areas of expertise - Visualizations, case studies, exchange of papers	AL, CA, SA, WUA
-Recording Discipline specific Field Data	D (Procedural)	-Notebooks, questionnaires, water measuring equipment, soil samples, induction meter	AL, CA, SA, WUA
- Data Processing and interpretation	D/MD/ID (Procedural, Critical)	-Charts, Graphs, Narrative Summary -Annual process and outcome reports	AL,CA, SA, WUA

Source: Author's compilation based on Ul-Hassan, et al., 2010

Table 5.10 Findings of IDR Teams with respect to their innovations

IDR Team	Results confirmed	Key questions that yet needed answers	Preconditions for successful adoption
WUA	-Higher awareness levels of WUA members - WUA staff became pro-active in managing WUA affairs -Installation of water metering infrastructure -Canal cleaning by farmers - more regular WUA meetings	- Will the WUA sustain after withdrawal of project inputs? - Farmer's willingness to pay for WUA services - Will WUA act as a service provider rather than a state agent? - Can the experience be replicated in other WUAs with same methodology?	- Support by local administration and higher level water administrations - Partial removal of state order, or permission to grow rice for increasing farmers capacity to pay - Availability of knowledgeable mobilizing and capacity building team (project-like)
SA	The new method was found good enough to work for salinity mapping by the engaged stakeholder, who included it in its training curriculum for salinity experts	-Will the organizations trained deploy the method in their routine work? -Will the knowledge be lost if not practiced after training?	- Availability of equipment (US$ 3 Million investment in purchasing the equipment for entire Uzbekistan) - Willingness of user organizations to give up old methods in which they are experienced - Acceptability of maps generated by newer methods to the ministry which uses these for decision making
CA	- Confirmed improved productivity and cost saving for wheat crop	- How to make CA attractive for farmers for the second crop (rice, cotton)? - How to influence state policy that dictates resource intensive agronomic practices	- At least partial elimination of state order - Change from resource intensive mentality to resource saving mentality amongst agricultural planning organizations - Support from local administrations
AL	-Planted trees grew in Khorezmian lands - The forestry research institute open to further experimentation - Theoretical economic benefits confirmed	-Tree benefits in the medium to long terms, but immediate costs or additional efforts for potential farmers - How to define marginal lands? - Social perceptions of nurturing trees of "no-use" if not fruit or shelter belts -Confirming economic benefits in reality and not on paper (through simulations)	-State permission -Elimination of state order for marginal lands - Initial availability of water for trees - Incentives for farmers to grow non-fruit trees as contiguous plantations

Source: Authors compilation based on team progress reports of 2009-2010

As the project's timeframe did not allow for further testing and adaptation to the innovations in question beyond 2010, a decision was taken during training IV that required all the four teams to complete, summarize and consolidate their respective process documentation and reflect upon these in terms of lessons learnt for the innovation as well as for the process of IDR.

One member from each of the four teams volunteered and took responsibility to lead this process. The reasons for organizing the final event at Bonn were that the process of reflection needed the full time attention of the scientists, which was not easy to achieve at Urgench, where most of the researchers had to multi-task owing to their main disciplinary assignments. Besides, three of the four volunteering researchers were mostly confined to Urgench since completion of their Ph.D.s and had not visited Bonn, which they aspired to do. They wanted to again see some of their previous colleagues, and to visit the city in which the spent several years during their Ph.D. studies. It was seen as an incentive for the participating researchers.

The four volunteering researchers agreed to collect all necessary process details before they were to depart for Bonn, prepare and share an outline of their respective research article, and identify co-authors for their analytical work. These volunteering members were then invited to Bonn for analyzing their respective team processes, and consolidating their analysis and findings into interdisciplinary research papers. These experiences are briefly elaborated in the following sub-section

5.7.4 Consolidation Phase

The consolidation phase aimed at addressing the analysis of the processes of each team as well as identifying ways and means of sustaining the interdisciplinary process outcomes after the project phase ends. Towards this end, the final FTI workshop, planned along a "write-shop" model was arranged at Bonn in January 2011. As most FTI participants were scientists, who had strong professional urge to publish articles to beef up their curriculum vitae, the write shop model provided a perfect opportunity to write articles.

The challenge for most of the participating scientists was however, to write an article in a non-comfort zone of science- an area of research that did not necessarily emanate from their respective discipline, rather reflecting and analyzing a process. As two of the four participants put it, "…*I never thought that writing about FTI experience could qualify as a publishable scientific article…*", or, "*…reporting on an experience is like a story telling…it is difficult to imagine that any scientific journal will publish a story*" (Field Note, May 2010).

These statements signify the epistemological foundations of positivist science prevalent within the Uzbekistan project on one hand, whereby the "true or real" science implied finding appropriate research questions, devising hypotheses to answer the research question, collecting quantitative data using positivist instruments, and then deploying statistical tests to verify the framed hypotheses. The statements also reflect a complete negation of the non-positivist ways of inquiry, where qualitative data is used to explain a phenomenon. The non-positivist science appeared to be perceived nothing more than journalism, or historical accounts. On the other hand, these statements also indicate that though the team members underwent an intensive capacity-building and learning by doing, the actual understanding of interdisciplinarity, its need, and validity of non-positivist sciences remained superficial, at least amongst the scientists who made these statements.

The FTI facilitator, together with the social science coordinator and the FTI consultant explained that such reflexive analyses were quite common in many social science fields, and were considered as valid science by those disciplines. They also pinpointed a few journals that published such reflexive analysis based on practice. They also then provided guiding formats for kick starting the processes of reflexive analysis (van Veldhuizen, 2011). These guiding notes required the authors, with inputs from their team members, to think in advance of an appropriate title for the paper, to prepare a brief main argument of the paper, and to briefly mention sections and subsection, and for each of the sections and subsections, briefly mention key points and arguments. They were also advised to distinguish between conceptual framework, and how this was related to the empirical and

conceptual argument of the paper, empirical section detailing out which data sets were used and why, and include the titles of tables and graphs they intended to use and how these contributed to the main argument. The third part was the key conclusions / sub messages supporting the main message, finding and arguments, as well as briefly pinpointing implications for innovation research or development. The researchers were also requested to mention open questions that the authors would like to discuss during the write shop to get clarity about (Field Note January 2011).

The actual write-shop was organized into four main sessions (van Veldhuizen, 2011). The first session was aimed at presentation of draft papers by authors about the main arguments and structure of the paper, which was followed by brainstorm generating comments and suggestion from peers using meta plan cards. This was then followed by a plenary review and discussion of comments of each of the paper. In the final session, the lead authors carried out individual work on their papers to address comments and suggestions. The last session formed the core of the write shop, during which, brief rounds were organized to give updates on progress in writing and to discuss possible dilemmas. Pair-wise or small group discussions were also organized as needed to help elaborate specific sections of papers or provide other detailed inputs.

Parallel to this process individual interviews were held with the four researchers attending the write shop, who had been part of the FTI teams on the ground. Three of them also attended the first training. This was to assess the extent of learning at their level on FTI since their involvement in the FTI activities and to generate feedback on how they saw the FTI capacity building process organized by the project over the last 3 years and its strengths and weakness. The outcome of these interviews is discussed in Chapter VI as a part of participant learning. Here, those parts of the interview are discussed which are related to participant's views on the strength and weaknesses of FTI training events.

Generally all the four interviewees expressed considerable personal growth in terms of learning on FTI, stakeholder interaction and trans-disciplinary research ((van Veldhuizen,

2011). The main issues noted on the strength and weaknesses of FTI capacity building are spelled out in Table 5.10. The participant feedback indicates that all of them valued the new knowledge and insights that was not part of their original discipline, for example tools and methods to identify and rank stakeholders, designing, implementing and evaluating monitoring and evaluation. The group work during the training sessions to practice those tools was also appreciated. What also participants found useful was the alternating sequence of capacity-building events followed by implementation, followed by reflection sessions and then the next training event.

What was also clear from their feedback was the lack of actual practice with the tools while the participants were undertaking their research within their FTI teams. Though the participants complained about lack of opportunities for practicing those tools, what they did not realize was that it was actually them who had to adapt those tools while working with their teams and stakeholders. This shows that they required much more instructions, push, and facilitation from the FTI facilitator during the implementation, or a prescriptive model together with tools, whereby steps, methods and content of work is already spelled out by someone else, for example the FTI facilitator. However, given the participatory and collaborative nature of the intended IDR, it would be useful, for example, that the FTI facilitator would work together with individual teams to adapt the taught tools and methods to their team specific needs.

Also, three of the four evaluating participants indicated the need for making the content of the training more relevant to actual FTI practice and introducing tools and topics closer in terms of timing of actual need during the implementation. This implies that if a training theme is introduced too early in the process, it might remain too abstract for the participant, and if too late, it would not be useful as some actual work would have already taken place within the teams without adequate tools. This was clearly indicated by one of the participants who commented about the literature discussions, which to his/her perception did not add to clarity about FTI, rather proved to be confusing. Since the literature discussions were organized early in the process, some of the participants at that stage did not realize the adaptive and process nature of interdisciplinarity.

Table 5.11 SWOT analysis of FTI Capacity-Building by Selected FTI Participants

Strengths	Weaknesses/ Suggestions for improvement
Participant I - The games used in the first FTI workshop were very instructive (for example Puzzle game) - Many of the tools and concrete formats were useful (ranking, stakeholder selection, criteria analysis for PME. Good opportunity to practice them during the training	Participant I - More opportunities for practicing tools were needed. - In Uzbekistan it would have been an incentive if at the end of each training a sort of test, assignment (or a game) was done that would show participants how much they had learned
Participant II - Good informative and relevant content - Sharing between the FTI teams during the workshops on what they experienced helped a lot - The overall design, rhythm, of the capacity building alternating training with trying this out and practice followed again by reflection/discussion on this in next workshop - Concrete forms/formats for use of tools, planning and PME were useful (could have been given more? E.g. on process documentation)	Participant II - Not enough opportunity for practicing most of the tools during training - It would have been useful to have more concrete case studies and illustrative (video) examples (of e.g., joint experimentation) from other countries, see how it worked there - The FTI workshops often had a considerable number of participants that a) had not followed previous FTI training b) had only sideways something to do with FTI and c) remained often passive. Reduce workshop participants to active FTI participants
Participant III - Generally good quality of training workshops - Materials, tools and techniques used were relevant	Participant III - There was not always enough opportunity to internalize topics from the training; it could have been easier if topics given were more immediately linked to the actual FTI process on the ground at the time - Process documentation and its role were not fully clear to all and many felt it to be too much work (maybe done to help others with data collection?) - Further localization of facilitation and its skills is still needed to fit the Uzbek context. - Involvement of farmer stakeholders in the FTI workshops was it always useful? AF farmers were never bothered with concepts such as FTI but knew about the interest of the project to collaborate.
Participant IV - Generally good and solid methodology	Participant IV -Introduction of tools and methods more closely linked to the actual FTI process as it was developing. Case in point is the PME training part when a framework was suggested and used during the training but used much later. Fortunately notes from the training could be retrieved. - Generally there was a need to follow-up the training with assistance to the FTI teams to put what they learned into practice; the training alone was not always enough for the teams to implement and use all on their own. - During FTI 2 it could have been useful to have the innovations selected and teams formed earlier in the workshop so that there would be more time in the rest of the training to practice various tools within the newly formed teams. - Literature discussions confused more than clarified.

Source: Authors compilation based on (van Veldhuizen, 2011)

5.7.5 Evaluation of the Write-Shop

A final plenary discussion looked back at the write-shop process as implemented and reviewed its strengths and weaknesses. Generally all felt that the write-shop went well and that the methodology proved to be effective, as a) it created a good atmosphere by working closely together for four consecutive days in a concentrated timeframe; b) it helped that the group was relatively small. There was thus strong involvement of all in the process. It also allowed open and critical discussion on FTI practice to feed into the papers; c) the time was effectively and efficiently used. There were no or few distractions. The participants felt a strong push to write, something that generally lacks in the regular work situation. One could thus call this a '*push-shop*[38]'

By the end of the write-shop, the papers were yet not ready for submission, as was anticipated during the design stage, and required substantial work. Two of the four authors did not follow the guidance provided for preparations, and hence came with preliminary material in the shape of process reports. In the case of both AL and CA, the process documentations were yet not complete, and needed further work. Besides, the volunteering researchers showed a lack of confidence in leading the write up, and asked for the social science coordinator to be the main author, while they would contribute.

In the other two cases (WUA, SA), the draft papers only needed a few specific improvements either in terms of conceptual elaboration or theoretical embedding. The co- and lead authors agreed on their respective inputs based on their strengths. They agreed to finalize the drafts for submission within four weeks. These two papers were finalized and submitted according to the plan. One of these papers has already been published (Djanibekov *et al*., 2012) and the other one is still under the review process of the journal (Akramhanov *et al*., under review). The CA and AL lead authors did not do enough, despite reminders and promises to do so till the time of this writing.

[38] A term coined by one of the participants of the write shop

Another part of consolidation was to collaboratively write a guide book for researchers and practitioners on "how to test and adapt innovations in similar contexts". The four volunteering researchers agreed to contribute to and be co-authors of this guide. The FTI facilitator with significant inputs from the social science coordinator, and the external consultant, mainly prepared this draft. The co-authors from various FTI teams, did not contribute substantially, but provided comments and limited inputs on the process details. This has already been published and circulated widely (Ul-Hassan, *et al*., 2011).

The consolidation phase experience in FTI and its outcome in two of the four teams who managed to publish analytical journal articles about the experience challenge Conrad's (2008:14) arguments in two ways. Firstly, the generalization that problem oriented and interdisciplinary research do not usually go well appeared to be a tentative one, as two of the four teams managed to produce peer reviewed interdisciplinary analysis of the problem. Secondly, in contrast to what Conrad (2008) asserts about the level of explanation in problem oriented research, that the main level of scientific explanation is description and assessment, but this was not the case. The two peer reviewed articles produced explained inter and transdisciplinary interactions attempted and tended to generalize the conditions under which such initiatives would make a meaningful difference in the Khorezmian context.

5.8 Conclusions

The disciplinary composition of various IDR teams of the Uzbekistan project indicates that at the initial stages, there were considerable differences across the four teams in terms of senior-junior mix, a condition that had the potential to create misunderstanding due to status differences (Stokols, et al., 2008). Also, as the project was largely populated by natural scientists and economists, availability of social science inputs posed a challenge. The project management attempted to resolve this challenge by inducting missing disciplinary expertise through nominating senior and junior researchers to fill disciplinary gaps. In such cases, therefore, the motivation to learn was induced from outside. Andragogists (for example Knowles, 1990; Smith and Pourchot, 1998) argue that

the adult learner's learning is effective when the motivation to learn comes from inside and not from outside. One could argue that for those researchers who were nominated to various teams by project management, the interest in interdisciplinary learning was relatively low. The challenges of integrating junior members into the teams at the beginning stages of team formation can partially be attributed to the lack of internal motivation by some of those members, but also in some instances as a display of what Barbra Gray calls *Challenger Disaster* (Gray, 2008: S125), whereby team members having different views do not share their differential due to power distortions within the team. This was especially the case when the CA and AL team meetings were facilitated by the project's field coordinator. Most of the Ph.D. researchers ultimately dropped out of all the four teams partially on account of lack of motivation and availability of time. Factors like lack of time, scarce resources, insufficient appreciation or recognition, competing institutional demands, loss of autonomy in decision making, frustration due to lack of progress, and inter-professional conflicts have been found to impede IDR and TDR collaborations (Rhoten, 2004, Stokols, 2008:S105). Stokols and colleagues argue that member's incentives to remain involved in IDR should exceed personal costs they incur through their participation. The incentives can be financial compensation, training and educational opportunities, and peer recognition. The project could not offer financial incentives due to restrictions imposed by Bonn University and project donors. The training opportunities available in case of FTI appeared to be not enough for the Ph.D. researchers who decided to drop out. Also, there were issues with recognition by senior peers, as interdisciplinary research spanned over a period of three years, and those who managed to publish articles could only publish one publication. Number of peer reviewed publications remains an important evaluation criterion for ZEF's research staff, who are recognized based on their publications.

The innovation teams started enthusiastically debated various options and developed some rough edges due to epistemic and personal boundaries in the beginning. While Stokols et al. (2008) recognize the value of participatory goal setting, which they believe enhances team performance by encouraging feeling of inclusiveness among team members and providing them structure, connection, and shared beliefs as well as

enhancing collective efficacy (Stokols, 2008: S101), it also prolonged the initial planning stages in case of three of the four teams. The preparatory and planning phases took disproportionately longer time than envisaged, leaving much less time for actual implementation and reflexive learning. Though these delays in the beginning were expected, making changes to the overall duration of the project phase was not in project management hands.

All the teams adopted key concepts from participatory science and taught procedures and tools to select their stakeholders and field areas. When teams moved from planning to action, they faced several disturbing tendencies: tendency of solo flights in team having majority of natural scientists, 'don't know how to proceed' behavior in another team largely populated by natural scientists, and absolute scientific planning in another team largely manned by natural scientists. Disciplinary integration between natural and social scientists was particularly challenging for the team with social science innovation, as an epistemic conflict over an activity turned into a personal conflict leading to the resignation threats by both the scientists involved. The interventions from Project's senior management resolved such conflicts. The conflict resolution role by the senior management and process facilitators has been recognized in literature (e.g. Stokols, et al., 2008). Frustrated by lack of progress, natural scientist in one team tended to abandon the exercise, but recharged after being provided with assurances by senior management for appointment of a social scientist to the team for support.

The complexity of IDR (Klein, 2004: 2-10), in terms of conceiving, discussing and communicating research and implementation ideas (Kostoff, 2002: 937-941), role specification and actual implementation of activities (Winowiecki *et al.*, 2011: 20) became quite visible as the road maps, the first IDR exercise of each of the four teams, which got revised several times in terms of content and methodology to proceed. In terms of interdisciplinarity, the teams after an initial period of two years adjusting to each other, and various team and leadership styles prevalent within each of the four teams, frequently and comfortably used terms and concepts of the participatory science, and to a large extent internalized these. All the teams used some of the taught tools and procedures as

well. Tools that were disregarded, the teams forwarded logical reasons for not using these. However, in effect, only SA team was able to achieve its intended outcome of validating the innovation under real life setting, and WUA and SA teams were able to achieve critical interdisciplinarity, through cross-disciplinary analysis of the experiences.

Overall, all the teams had common interdisciplinary learning, both in terms of means and forms of collaboration (Pohl and Hirsch 2008:115) in several ways. For example, the team members gradually started to use more and more same language reflecting various aspects of innovation testing and FTI team processes, though none of the teams prepared a glossary of terms suggested by Pohl and Hirsch. Team members also referred to and used key theoretical concepts adapted to team specific requirements. All the teams attempted PM&E analytical model, though with varying levels of details and with mixed successes in doing so. WUA and SA teams generated integrated analysis of their respective innovation, and published it as analytical account of key aspects of their team process of innovation validation and testing. These forms of collaboration (use of language, theoretical concepts, analytical model and output) as well as means of integration in terms of team deliberations and integration by sub-groups or individuals reflect considerable advance in terms of interdisciplinarity (Table 5.12), if assessed by the methods of Pohl and Hirsch (2008).

What also became clear during the implementation and consolidation phases of IDR was the fact that since the effective implementation activities were largely undertaken by the Urgench-based research and support staff, the team's effective membership shrank considerably. Those based in Bonn, as well as Ph.D. students who completed their field work gradually withdrew themselves from the IDR. Those based in Urgench aspired for an IDR capacity-development and implementation model that was more "prescriptive" in terms of the use of taught concepts, tools, and implementation procedures. This is another dimension that needs to be addressed while discussing disadvantages of dispersed teams. Literature discussing problems faced by dispersed teams, such as Stokols et al. (2008), does not refer to aspirations for prescriptive style by dispersed teams.

Table 5.12 Forms of collaboration and means of integration for FTI

Means of Integration	Forms of Collaboration		
	Common Group Learning	Deliberation amongst experts	Integration by a subgroup or individual
Mutual understanding reflected by team language	All teams	All teams	All teams
Theoretical Concepts (transfer of concepts, mutual adaptation of concepts, bridge concepts	All teams	All teams	All teams
Analytical Model (PM&E Methodology)	All teams	All teams	WUA, SA, CA
Output	WUA, SA	WUA, SA	WUA, SA

Source: Author's adaptation from Table 5.1 of Pohl and Hirsch (2008)

The analysis of team stages after fifteen months of team working showed that the team members perceived their teams to frequently transition between norming and performing stages. This was partly due to the contestation amongst member's fundamental and superficial epistemologies that were identified during the survey of FTI member epistemic profiles. On one hand, the respondents were aware of Project's desire and advocacy during the FTI training about the desirability of interdisciplinary research as a means to adapt innovations to resolve problems in Khorezmian agriculture. Each of the respondents was part of an interdisciplinary research team. They tended to respond to questions on the desirability and potential of IDR in a socially desirable manner, and therefore, tended to agree to project's desirable propositions that IDR was the way in which science could help resolve societal problems. On the other hand, and more fundamentally, the team members belonged to the tribes of their own disciplines (Becher and Trowler, 2001:239) and believed that their own discipline alone was largely adequate in offering credible solutions to the prevalent problems in Khorezmian agriculture. Apart from the recognition that a research team members demonstrated both fundamental and superficial epistemologies; this finding has an important methodological implications for study of IDR. The research instruments deployed to understand an individual's epistemology in an IDR team should contain questions that are capable of identifying whether or not these differences between fundamental and superficial epistemology exist. In this particular case, for example, since the self-reporting survey included separate

sections on respondent's perceptions on role of science for society and their views on their own disciplines, it could reveal contradiction in what the participants expected from science in general, and how their own discipline was embedded in the overall context of science.

Methodologically, two aspects need special mention. Firstly, the design of self reported survey instrument that placed questions, relating to views on desirability of IDR and views about researcher's own discipline's power to provide solutions, at considerably distant locations within the instrument helped to identify epistemological contradictions amongst participants. Secondly, this strategy acted as a triangulation method that identified biases in the survey due to tendencies amongst some participants to provide socially desirable answers. While researchers themselves might expect from their respondents to provide unbiased answers to the questions posed by scientists, they themselves replicated the behaviors of survey respondents without noticing it.

The instrumental IDR in the case of FTI was limited to borrowing analytical procedures, tools and methods, for example stakeholder identification tools of ranking and scoring, or using Venn diagrams. The initial tendency amongst the FTI teams with natural science innovations was not to use a social science tool for undertaking a systematic analysis of stakeholders, or to visualize the discussions. Such teams rather tended to rely on traditional paragraphed descriptions. The FTI facilitator had to insist upon the use of Venn diagrams, and other similar tools taught to the participants for undertaking a systematic analysis. Only upon insistence, the teams used these tools and procedures during their preparatory stages as well as during the consolidation stages. There was a tendency to use the tools as these were taught, with little modification. Thus, conceptual ID readily took place in all the four teams, but when it came to procedural part of ID, the teams with natural science innovation were found a bit reluctant to borrow tools and procedures from other disciplines than their own. Therefore, it is important that the procedural and conceptual aspects of Klein's instrumental ID are discussed separately in understanding an ID exercise.

Chapter 6: Facilitation, Reflection and Learning

6.1 Introduction

This chapter illustrates the role that facilitation and facilitated reflection played in enhancing team and individual learning amongst the FTI interdisciplinary teams. It sets out to answer the following question: what were the types, roles, and characteristics of facilitating interdisciplinary research in ZEF's Uzbekistan project and how the facilitation assisted in enhancing participant learning at team and individual levels. It mobilizes theories about process facilitation (e.g., Schwarz, 2002; Brockbank and McGill, 1998), and learning (Peschl, 2006; Mezirow, 1991). I argue that facilitating an interdisciplinary research process does not only include facilitating, mentoring and coaching, but also supervision, coordination, and criticism. I show evidence that individual members of interdisciplinary teams do experience triple-loop-learning and transformative learning, but at a team level, to induce such learning, the reflection needs to be induced and facilitated.

The main findings are that IDR facilitation is a multi-faceted role, which in the current case was performed by several members of project's senior management. Many of advices about facilitation ideal types were only found practical when facilitating an event within FTI, and had to be violated when facilitating the entire FTI process as a whole. When an IDR process is facilitated by several individuals, there is a risk of confusing research participants, and the process may proceed to a direction that might not be intended. Facilitation by project managers needs to be exercised with caution as the danger of personal and epistemological biases getting induced into IDR process increases with the hierarchical level of the seniority of the leadership involved.

The team initially showed a lack of will for internal criticism and adequate self-reflection, which was then induced through facilitation and cross team peer review. This facilitated reflection under one roof and at the same time appeared to be more effective than internal

team reflection, or team specific advice from the facilitator or coordinators. The resultant learning through facilitated reflection was about three types of complexities: a) complexity of innovation itself and the need for additional disciplinary inputs to innovation research to make these more relevant for stakeholder needs; b) the contextual complexity of Uzbek socio-political system; and c) the complexity of embedding technically developed innovations. At an individual level, the interviewed researchers reported considerable learning in several dimensions- from concepts, tools, theories, and complexity to their content based, and emancipatory learning, which had been transformative in nature. All in all, facilitating the IDR process proved to be much more complex social process of interaction compared to what was assumed during the design stages of the project phase.

The chapter is structured as follows. Section 6.2 presents the types and roles of facilitation inputs, and is followed by section 6.3 which discusses the processes and outcomes of various internal review and facilitated reflection events and team learning. In section 6.4, based on participant interviews, I examine the individual learning that the participant researchers involved in FTI experienced. The sources of information for section 6.2 are largely author's observations and field notes, and the reflections on these observations. Section 6.3 draws heavily from the session reports of the two review workshops that were conducted in 2009 and 2010, and section 6.4 draws on semi-structured, open ended interviews with seven FTI researchers and four of them re-interviewed during the final capacity-building event. Section 6.5 concludes the chapter and draws major lessons and relates these to the findings in literature.

6.2 Facilitation

The project's social science coordinator and the FTI facilitator discussed the concerns that after the FTI training III in November 2008, there had been too many demands on facilitator, and not exclusively for facilitation, but also as an advisor, as a manager, and sometimes as a team member. It was becoming evident that there were tendencies

amongst some of the FTI participants to blame the facilitator for everything that did not go well in their teamwork (Field Note December 2008, van Veldhuizen, 2008). During the review workshop in May 2009, one session was therefore exclusively reserved for discussing the role of facilitation with the FTI participants and the project management. The FTI team members during the above-mentioned session defined a facilitator as a person who:

"[o]bjectively, clearly and carefully summarizes, encourages shy participants, has knowledge about the subject, keeps an eye on the road map, sees the big picture and helps the group see the big picture, and … is neutral and liberal (Ul-Hassan, 2009: 9). In addition, the facilitator, "[g]ives directions/advice, carefully approaches people, coordinates, translates science, makes things happen, makes sure objectives are achieved, and is sensitive to culture and diversity. [He/ she] [g]uides, but does not drive or dominate, clearly conveys message, maintains life in the group (ibid: 9).

The participants also delineated what facilitator is not. According to them, the facilitator is not:

"in charge of the content, not a team leader, not part of the process, does not make decisions on behalf of the group, does not dictate, or favor a few", and that, "[a]n ideal facilitator is neither too authoritative nor too weak but adjusts his/her facilitation to the needs of the group he/she is working with" (ibid: 9).

The participants also realized that there were risks associated with facilitation as: a) the risk of creating dependence if the facilitation was too strong; b) the risk of losing direction if the facilitation was too weak; and c) the risk of favoritism and loss of neutrality.

The participants also agreed that a facilitator is not needed, when:

- team members have established a work routine and are happy with it
- the roles within the team are clear

- the team members know how to approach the stakeholders
- might be always needed but the role diminishes as the teams progress
- (s)he becomes a dictator
- the task is achieved
- team dynamics are achieved
- facilitator fails/succeeds his / her job
- the team comprises one person (ibid)

The statements above, recorded on charts as an output of the group discussion during the review workshop clearly indicate what the participants expected from the facilitator, and where the facilitator had to draw his/her boundaries. From participant views, one-man teams were thought to work without a facilitator, and the facilitation could be withdrawn or considerably reduced once the teams were able to define team roles and establish work routines.

Though there was an exclusive facilitator recruited and assigned for the task of FTI process facilitation and coordination, several other individuals also played a role in facilitating the process. These included a) the external facilitator; b) the project's science coordinator based at Bonn; c) the project's social science coordinator based at Bonn; and d) the project's field coordinator based at Urgench.

6.2.1 The External Facilitator

The role of the external facilitator was well articulated- that of a resource person for carrying out and reporting the FTI formal training events. The selection process was undertaken through open bidding, and an appropriate consulting firm was chosen almost immediately after the financing for the phase was released. The original design was that the company would provide two consultants, which worked only for the first FTI training. Based on evaluation of the first training by participants and organizers, one of the consultants was not considered suitable for the rest of the four trainings, and was replaced by a more qualified and suitable consultant. However, for the second training, the firm could not send both consultants due to sudden illness of the second consultant, and the project management and the consulting firm agreed that they will try the training

with a single consultant. The project administration related to FTI (science coordinator, field coordinator, social science coordinator, and FTI facilitator) based on their own observations and feedback from the participants concluded that the quality of inputs from the newly proposed consultant was excellent, and decided that the same consultant should continue. During the second training, where the external facilitator facilitated all the sessions alone, it was also realized that a four to five days continuing facilitation put a lot of strain on the consultant. It was mutually agreed that the FTI facilitator and the social science coordinator would co-facilitate some of the sessions in the future (van Veldhuizen, 2008). This design worked for FTI and was maintained for all future training events.

There were additional roles the external facilitator played. These included: a) inputs to the design of the future training events; b) feedback and suggestions on process summaries compiled by various teams; c) a summary analysis of various FTI processes; d) inputs to the guiding documents for paper presentations; and e) inputs as a co-author to the FTI guidebook. The inputs on process summaries and the summary analysis served the purposes of providing objective criticism to teams as an outsider, which were well received by the teams compared to those provided by the FTI facilitator or the social science coordinator. FTI teams saw the internal criticism, as opposed to the external criticism, as having disciplinary bias due to commentator's association with ZEF's department on political and cultural change (Ul-Hassan and Hornidge, 2010), as compared to the criticism from the external facilitator as he had no departmental biases for ZEF staff.

6.2.2 Project's Science Coordinator

The project's science coordinator, the overall responsible person for ensuring that all ZEF departments undertook research in line with the project's overall framework, participated in three of the five training events and both of the review workshops. When needed, he would motivate and push research staff as well as assertively explain his understanding of

FTI. Due to his central position in the project, his in-depth knowledge of the project research and of agricultural sciences in general, he claimed a respect and authority amongst scientists associated with FTI. My own observations show that the Urgench-based staff members would rarely argue with him, even if sometimes the points he would raise would be contestable. This does not imply that he was always right, however. It does imply/did imply that the subtle balance between facilitation and pushing could be lost at times. The facilitation roles he played in FTI in the beginning were related to the proposals for structure of teams and membership in those teams. For example, upon his assertion, two innovations were placed in one team – that of salinity mapping and planning field level irrigation based on field observations rather than irrigation norms. The inspiration for putting these two innovations under one team's responsibility came from the fact that irrigation practices cause as well as mitigate salinity, though both are subjects of different disciplines. The former is the specialization of irrigation experts and hydrologists, while the latter is the subject of interest for soil scientists. The coordinator believed that a single team could best address thematic links between the two innovations. In practice, however, what dawned to the team members during the process was that the salinity mapping was a rather mature innovation for FTI process, which could already be tested together with the stakeholders, whereas the irrigation planning was just a research idea, yet to be tested for its potential benefits. The stakeholders for the former were salinity mapping agencies, whereas the potential stakeholders for the latter were farmers. The former was a rather straightforward innovation in use by its intended users, whereas the latter required sophisticated calculations for every irrigation event, which its intended users would not be able to undertake. Because of these differences between the two innovations bringing them under the responsibility of a single team did not work in practice. The FTI team was thus stuck in the beginning, often confused in deciding process steps, as both required a different approach to testing. Once a decision was taken during the reflection and review meeting in May 2009 to separate the two, the SA team made quick progress in undertaking its IDR.

For the overall process of FTI, the positive administrative role the science coordinator performed was critically important. There were several administrative challenges and

issues that could not be resolved without the necessary approval and his agreement. These included, for example, support in recruiting the external consultant, support in recruiting the FTI facilitator, finding ways of adjusting budgets to accommodate FTI related unforeseen costs, for example related to publication of the FTI guide, including an extension to the contract of the facilitator for three more months than originally planned that was required to finish up the work.

6.2.3 Project's Social Science Coordinator

The project's social science coordinator performed another important facilitation role. The senior staff member of ZEFa, who owing to his academic interests decided to opt for a half-time position at ZEF, withdrew from coordination of social science research of the project and FTI. Though he originally wrote the FTI work package based on the consultations within the writing team, he decided to limit his role to supervision of Ph. D. students after the project phase became operational, A sociologist took over the responsibilities for overall coordination of ZEFa inputs to the project and research activities, who also was the main facilitator of the process till the recruitment of FTI facilitator. The FTI facilitator, once recruited, was placed under her overall supervision and responsibility. She participated in four of the five FTI training events and attended all of the review meetings. She had co-facilitated some of the sessions during the FTI training events, and the review meetings. Her strengths were critical thinking and attention to process details. She would readily fill in staff gaps if requested, offer her assistance towards conceptual discussions within the teams, provide her critical, but constructive comments to process documentation undertaken by FTI teams, as well as by the FTI facilitator. Also, whenever the FTI process faced administrative challenges, she would attend to those and try her best to garner management support for resolving such issues.

She also participated in co-authoring all papers documenting various FTI processes, as well as FTI guidebook. She eagerly offered her help to CA and AL teams to contribute as a lead author, if they decided to analyze the FTI experience of their team, which however did not materialize, as discussed earlier in Chapter 5.

6.2.4 Project's Field Coordinator

The role of the project's field coordinator was also critically important. While conceptual discussions and theoretical planning are important, unless steps are practically undertaken in the field, these remain paper preparations. Though the original FTI event plan was that the trainings would alternatively be organized in Bonn and Urgench, the field coordinator insisted, argued and pushed for organizing those training events in the field, where most of the FTI related researchers were based. One anticipated benefit was cost reduction as majority of Urgench-based researchers would not need to travel and be accommodated at a rather expensive place like Bonn. A more important motivation for carrying out all training events in the field was that this would provide an opportunity for immediate field practice of some of the knowledge and tools that were delivered to the trainees, an opportunity they would not have at Bonn. It was due to his persistent push that apart from the first and last FTI workshops, all events took place at Urgench.

Other facilitative roles the field coordinator performed included motivating researchers to join various teams, and even nominating members, especially economists, to various teams where disciplinary gaps were present. Another role was as a team facilitator to especially CA and AL teams, which had weak facilitation skills in the beginning, during initial planning phase. The field coordinator was always available for discussions, and was helpful in addressing administrative issues as immediately as those were brought to his attention. One example was that though there was no formal provision for a research assistant for FTI, once it was realized that FTI teams needed assistance to undertake and organize their process documentation, he found ways of making sure that the facilitator had a research assistant.

He also provided disciplinary inputs to CA and AF teams as an experienced economist and coordinator, well aware of the socio-political situation in and around Khorezm.
Almost all of the members associated with AF and CA teams were either project graduates, or collaborators, or students or research assistants, who had worked during the past two phases closely with the field coordinator as a mentor, coach, or supervisor. I

observed, however, that the team members were often too respectful of the field coordinator, and would rarely challenge his knowledge and arguments (Field Notes 2008, 2009, 2010). Though the field coordinator himself did encourage team members to provide most of the inputs, I observed at several occasions, that during his presence in the team, the team members adapted would prefer to act as respectful listeners. Therefore, the facilitation contributions and insights on FTI did not always generate a positive outcome. For example, since he volunteered in the beginning to facilitate the discussions in AL and CA teams as these teams were found stuck in their progress, these teams did not learn how to facilitate their own internal meetings, were always looking for assistance from outside, and even demanded that they should be provided with a facilitator (Field Note August 2009). The CA team leader especially, as a result, took a passive role expecting that he and other team members had to contribute and not drive the process. Likewise, the members of AL team were most of the time found waiting for a push by the field coordinator (Field Note September 2009). Both of these teams did not undertake process documentation well either (Field Note August 2009). On the epistemic side, both of these teams initially believed that they had to create wide-scale awareness about the innovation to popularize the innovation rather than validating the innovation through experimentation under real life conditions of intended users (Field Note August 2008). Since both the teams remained confused about the purpose of their respective FTI process, they did not report or analyze their processes or results well and received criticism at both review workshops. Both of these teams never managed to complete their promised inputs. Throughout the FTI processes, the FTI facilitator had to summarize their processes and share these with the teams for checking and improving (Ul-Hassan, 2009).

6.2.5 FTI Facilitator

The overall role of the FTI facilitator was to translate the work package into an actionable FTI process, facilitate the processes, and to research and consolidate this learning. This role had several key dimensions as spelled out by (Mollinga, 2006). These dimensions included: a) designing an approach appropriate to the Khorezm context; b) arranging the

training of the project staff in the relevant methodologies; c) coordination of FTI activities amongst teams; d) managing the process documentation; e) undertaking team building activities and need based short trainings; f) documenting that process and researching it.

I, as the selected facilitator, translated the work package into a stepwise approach (Figure 5.1) through which the FTI teams could undertake IDR and test their innovations. I also organized, coordinated and partially delivered FTI relevant training events. During the process, I oversaw and coordinated team work on FTI by various teams. Realizing the difficulties some of the teams experienced in the beginning, I designed process documentation formats and shared these with teams. I also designed processes, procedures and systems in the form of an open access shared folder on project's intranet server, so that it was available to all those who were interested. I created an FTI group email account so that the individual members did not have to search and add email addresses to anything they wanted to share via email. I acted as a 'hub' of information in several instances. For example, all teams were requested to share their meeting minutes, field notes, survey databases, analytical documents, and other data formats with me and upon receipt of each of those, I would post it in an appropriate subfolder on the intranet and notify all FTI members through the group email. Whether or not to read or consult that information was, however, left to individual team members. At the end of each cropping season, I summarized the processes of each of the four teams, and wrote my brief reflections on these summaries and circulated these summaries to all FTI participants. The process documentation was then compiled annually into a ZEF working paper publication (Hornidge *et al.*, 2009; Ul-Hassan and Hornidge, 2010), which were then analyzed further and published as research articles (Hornidge and Ul-Hassan, 2010; Hornidge *et al.*, 2011; Ul-Hassan *et al.*, 2011; Ul-Hassan and Hornidge, (accepted as a ZEF Book Chapter); Ul-Hassan and Hornidge, (under review); Ul-Hassan and Hornidge, forthcoming).

A structured half-day capacity building event on facilitation skills and effective communication was organized in 2008 (Chapter 4) and a team building training,

comprising several games followed by reflections on team and leadership styles was also organized to kick start team building processes.

As far as the coordination role was concerned, I not only coordinated the capacity-building events, but also the team work by different teams. I effectively acted as a bridge between team members of each of the teams, if problems arose, as a bridge between teams, as well as a bridge between FTI research teams and the project management. I had to take on membership roles in two teams, as the teams faced staff shortages due to staff departures, or lack of competence in one or more aspects of the team processes. During May 2009 internal review workshop, the participants of the workshop decided for me to hold regular coordination meeting formally from May 2009 onwards. These meetings aimed at discussing progress, plans and issues that might need to be addressed. I also documented these meetings and shared the minutes with all FTI members.

Besides, these documented and rather formal roles, individual FTI staff members would also approach me occasionally over a cup of tea, during the lunch break, or at smoking place and consult me about FTI related issues ranging from intellectual and team issues around FTI to personal advice on career growth or further capacity building. Many times during such encounters, I realized that the FTI team members, especially from CA and AL teams, had misunderstood FTI as an extension exercise - that of proving and demonstrating the innovation's potential that the innovation was valid, rather than its nature as a joint experiment to adapt and evaluate under real life conditions. This suggested a rather more emphasis on coaching and mentoring side of the facilitation role, which I enjoyed greatly.

A typical example of an event, out of many documented during the course of FTI, where I used the techniques of appreciative inquiry, as suggested by Stokols, et al. (2008), while coaching and mentoring the team leader of CA is presented below:

> Facilitator: *I think your team is progressing. What is happening in FTI on CA now-a-days?*

Researcher: *We* [CA team members] *were thinking to go to Agroprom* [agricultural extension agency embedded within provincial administrative system of Uzbekistan] *and show them results from previous trials* [on conservation agriculture] *we conducted at cotton research institute so that they know that CA does not reduce yields but requires less inputs…they* [staff of Agroprom] *force farmers to undertake intensive agriculture….we are also planning to hold demonstration for farmers…*

Facilitator: *But are you sure that CA practices work in farmers' conditions? Only then it will make sense to carry out demonstrations or to go to Agroprom.*

Researcher: *For wheat yes, for cotton and rice, there are still issues to be resolved.*

Facilitator: *It might be good to convince Agroprom in general about CA, but it is not related to FTI at this stage. We need to test first under farmers real conditions, and if farmers and we together find that CA works for both crops, then going to Agroprom would be the next step…One indicator for success I would use is that whether the farmer with whom you work himself decides to put more area under CA next season based on the results he gets from CA with FTI in this season.*

Researcher: *That is difficult…farmers do not have equipment needed for CA, there is pressure from state to use intensive inputs. If we do demonstrations of CA and convince Agroprom and farmers, may be CA will become popular in the region.*

Facilitator: *Exactly, but that is then agricultural extension work, which is not FTI as we planned. Under FTI, we need to be first sure that the stakeholder assess the innovation positively under their conditions, including state pressure and lack of equipment.* (Field Note based on informal conversation with a CA team leader after lunch at project cafeteria in November 2009).

This dialogue typifies the dilemma that at least two of the four FTI teams faced- the dilemma of delineating boundaries between interdisciplinary experimentation for innovation validation vis-à-vis project's senior management's aspirations for demonstration, popularization and out scaling of innovations.

Reflecting on the whole facilitation experience, my role as an informal coach, mentor, friend, and colleague augured well and further deepened the influence of my formal role, which I performed through team meetings, email exchanges, written comments and views and sharing my views during more formal capacity building events. Since I stayed for a few weeks at the project guesthouse at Urgench each year, where at least six FTI senior researchers also stayed, this helped in building personal friendly relations with those team members. Besides, I attended, together with many of the FTI researchers, marriages, birthday parties, Uzbek national events, and seminars and workshops, that all helped in overcoming formalities and becoming friends with researchers. To my own experience, I believe that most of the FTI researchers, especially those based at Urgench were in the beginning too formal and somewhat covert in sharing the true feelings and thoughts with the FTI facilitator till these relationships turned into non-formal arena. The performance of my role in the informal arena was, however, not possible without my formal role, which provided me legitimacy. The implication of this formal and non-formal sides of the role are that if I would have limited myself within my formal role alone, I would not be able to exert influence and understand the "inside" of the process as much as I did while maintaining both of these sides together.

In the beginning, there was tendency amongst all of the FTI teams to include my name as an author to their work plan, or activity reports, the tendency I tended to discourage. Because I was participating in FTI team activities as an observer or as a resource person, or provided comments and suggestions for improvements, the team members felt I had contributed to the substance. My own fear was that if each of the FTI teams kept on including me as a co-author, then the ownership of the process would be lost, for example the teams sometimes saw their process documentation as data for my research as reported

by a team member (Table 5.10). As there were several departures and new memberships to FTI teams, I had made one-to-one presentations to new members for informing them about the rationale and design of FTI and the status of various FTI teams and their expected role in the process.

The project management posed a few interesting challenges to my role as a facilitator. Apart from the field coordinator, none was aware of my 15 years long international research management career of which about half was in Uzbekistan, after which I joined ZEF. At times I felt that ZEF being an academic institute was highly biased towards staff having a formal Ph.D. and did not value experience much. My own thinking was that FTI, being an interdisciplinary action research by teams with stakeholders required a subtle balance between academic science and local knowledge of practical reality out there. Seeing the reactions of FTI members to FTI-related literature discussions, at one point I proposed to reduce the emphasis on such discussions, which was over-ruled by the social science coordinator, who was my departmental supervisor. Likewise, during the third FTI training, when it was found out that some of the teams had not progressed well, the responsibility for lack of action by teams was blamed to my lack of interest in and ownership of the process (Field Note November 2008). At times, therefore, I felt undervalued and overruled by colleagues who were higher in project hierarchy, had more academic and theoretical knowledge and carried doctoral titles, but had spent less time in the field and therefore had less pragmatic and field knowledge about Uzbekistan.

I interpreted the task of facilitation as generating understanding, building capacity, building bridges, enhancing communication across disciplines, and setting up systems that helped FTI teams to do interdisciplinary research. To my own understanding, the task of carrying out actual interdisciplinary research to test and adapt innovations was vested with the teams, whom I had to support intellectually and logistically. The researcher side of me found it more interesting to understand why some team members were more active than others and some teams more performing than others, but not actually doing the job of the teams if they did not undertake it due to any reason. However, to project management's understanding, they expected the facilitator to 'get the

job done at any cost', even if the facilitator had to practically do it himself/herself (Ul-Hassan, 2009). Based on the decisions of the internal review workshops in May 2009 (Ul-Hassan, 2009), I ultimately had to participate as team member to two of the four FTI teams.

What becomes clear in the above discussion is that the interdisciplinary research process facilitation is a multi-faceted task, which requires skills not only in facilitation and coordination, but also in mentoring, coaching, supervision and management. When some of these facilitation roles are shared between several individuals, as was the case with FTI, those who hold administrative positions within the organization need to cautiously consider their way of facilitation. They might deprive others of learning an important skill, or unknowingly push the team in a direction that is not actually intended. The process facilitator needs to be aware that facilitation is not possible through a formal style of job performance alone, but also the facilitator needs to facilitate the process in a non-formal manner whenever s/he is approached in whatever situation and under whatever conditions.

What is evident in the above is that the facilitation role performance by several individuals had both positive and negative influences on the process. The advantages were that each of the facilitators, depending upon the hierarchical position within the project, carried different weight for the team members. The suggestions from the project coordinators, for example, were considered more seriously than those by the process facilitator. At times when the members needed to be steered in a specific direction, for example attending to the process documentation, it would have been useful to mobilize the influence from the project coordinators. The negative side was that the coordinator did instill their own biases into the process, as was the case in AL and CA teams regarding their understanding of the objectives of the FTI, which were inspired by the project's field coordinator, and the process was understood as an extension effort rather than experimentation with the stakeholders for testing and further adaptation of the innovations. Another example of negative influence was initial clubbing together of two completely different innovation under the responsibility of SA team, that kept the team confused for several months.

These influences were only later understood by the teams through facilitated reflection, which is discussed in the following session.

6.3 Team Reflection and Team Learning

In a project-based interdisciplinary research, experimental implementation has been found to enable learning through providing means for reflection (Morse, 2007; Pohl and Hirsch, 2008). Reflection enables individuals and groups to "learn from the experience"(Boud *et al.*, 2005:13) and is a key in the transformation process of individuals and groups (Mezirow, 1991) in terms of learning. Peschl argues, however, that individuals do not consciously experience premises, and assumptions on which their thinking and constructing is implicitly based (Peschl, 2006). It has to be rather made explicit by active exploration of one's own assumptions, premises, ideological attitudes, etc. This active exploration can be through the process of reflection, which implies ability to step out of one's normal way of thinking. He labels the ability to actively reflect and transform one's own knowledge into wisdom as "triple-loop-learning" (Peschl, 2006:138), which is achieved when an individual starts to question premises at the level of his/ her own being.

Mezirow discerns three kinds of reflection. The first of these is content reflection, where an individual may reflect on the content or description of a problem. The second one is process reflection which involves thinking about the strategies used to solve the problem rather than the content of the problem itself. And the final and third one is the premise reflection, which leads individuals and groups to question the relevance of the problem itself and the individual or group starts questioning the assumptions, beliefs, or values underlying the problem. The process of premise reflection is distinct from problem-solving and can lead to transformative learning. Mezirow (1991:13) argues that if the process of reflection leads to an enhanced awareness of an individual, challenges or distorts the meaning scheme or perspective of the individual, and if the individual then revises the perspectives, the individual then has experienced transformation through learning. This is similar to Peschl's third loop of learning (Peschl, 2006).

While the FTI teams were assumed to reflect on their processes in "learning while doing" style of implementation of activities, during the third FTI training, the participants expressed their concerns that the gap of one year between the FTI training III and IV might cause loss of learning as well as loss of track of progress, and thus a need for more structured and facilitated team reflection. However, the FTI teams faced considerable difficulty in reflecting on the process and their experiments of their own. Such tendencies of getting too much caught up in action and poorly reflecting on the processes and outcomes in project based learning efforts are not uncommon (Barron, et al., 1998).

Therefore, two structured internal review workshops were organized for facilitated reflection amongst FTI teams (Ul-Hassan, 2009:5). The review workshops were organized in April 2009 and 2010, and were reported in detail (Ul-Hassan, 2009; Ul-Hassan, 2010). The design was that most of the scientists, students and research assistants engaged in FTI process would participate in the review and share their progress and review and discuss substantial as well as logistical issues that the teams faced and collectively take decisions on their resolution. This was particularly needed for generating more ownership of the process by the participants, as well as enhancing effectiveness of the FTI processes through team learning.

The workshop programs of both these events were designed to critically review the progress of various teams and identify issues that fostered or inhibited the progress as opposed to plans made earlier and identify and address the constraining issues.

The first review workshop spanned over 14 working hours and was conducted in seven sessions. Eleven senior and seven junior researchers and research assistants participated. Session 1 focused on clarifying the objectives and organization of the workshop which was then followed by a set of group presentations by the four FTI teams critically reviewing the performance of their teams since the last FTI training as well as the group dynamics, communication, cooperation between the different FTI teams and within the overall project FTI team. The teams were particularly requested to focus on two positive

examples of good performance and two not-so-good performances. In the second session, as some new staff members joined the some of the FTI teams, the participants were once more exposed to FTI research briefly. During this session, a group exercise on the role and function of a facilitator was carried out. Here the question of which types of facilitation exist and have to be chosen, depending on context and group needs, were also discussed. During the session 3 stakeholders from the most advanced FTI teams shared their views on the progress and participants had dinner together. The fourth session focused on the introduction of value based monitoring, which was then followed by an exercise on identifying group values by different teams. In the fifth session, the teams worked together to refine their plans for 2009, which were discussed in a plenary. This was followed by summarizing and discussing the issues during the sixth session that were identified during the course of FTI implementation. The participants in consultation with the project management identified strategies to resolve those issues. In the concluding session, the participants briefly expressed their personal views on the relevance and success of the workshop.

Likewise, the second review workshop spanned over 17 working hours and was conducted in seven sessions. The participation was very low, however, as only seven senior scientists and five research assistants participated. Most of the senior researchers that were based at Bonn could not participate. All the Ph.D. students had either completed their field work or were too busy to participate. Session 1 focused on clarifying the objectives and organization of the workshop which was followed by a set of group presentations by the four FTI teams critically reviewing the experience of their respective FTI teams since November 2008 in the session 2. The teams were particularly requested to focus on critical reflection of the past two years. The presentations were discussed in the plenary by all participants. In the third session, the FTI teams discussed the comments on the process documentation provided earlier by the internal and external reviewers followed by discussions in the plenary. The fourth session reviewed the previous day, which was followed by the fifth session on innovation-specific out scaling strategies by FTI teams, which were discussed in the following plenary session. The sixth session provided an opportunity for FTI teams to discuss their future plans in teams and

then share these plans in a plenary, where other teams commented on these plans. During the seventh and final session the teams discussed issues for the final interdisciplinary outputs of their teams. These included identification of the main argument for the article based on team experiences, choosing a lead author, nominating a co-authoring team, task division for the team members, and rough time lines and possibly the journal where such articles would be sent for publication. In the concluding session, the participants briefly evaluated the workshop.

A brief account of each team's reflection is presented in the following sub-sections.

6.3.1 Team Reflections and learning during the first review workshop (May 2009)

All the four teams summarized examples of good and bad cases of their performance and presented in the plenary to all FTI participants, which were discussed by all participants of the workshop. These discussions and the group reflections and learning are reported below.

The WUA Team

The main message from the WUA team's presentation (Ul-Hassan, 2009: 6) was that for the team members it had been a good learning experience on how to work together and with their selected stakeholders. However, in the team's assessment, the young members, especially the research assistants, were unable to see the big picture till April 2009, as they did not know what other teams were doing. The younger members were particularly reported to be frustrated by the fact that *other FTI teams did not share information on their activities* (Ul-Hassan, 2009: 6). They wondered about the relationship between the actual job and FTI, particularly on the benefits of participating in FTI to the Ph.D. students and research assistants. This team also questioned the level of practical support they received from the facilitator. In the team's view, the team itself took all initiatives of working, and experienced coordination problems with other teams as well as with other

ZEF researchers, some of whom started to work with their stakeholder or within the same area, but did not inform or consult the FTI team members. There had been visit requests to WUA directly from non-FTI staff that had confused the WUA in team's opinion, and the team had then to spend considerable time on explaining to the chosen partners. The research assistants of the team had made telephone calls from their private telephones, but did not know whether or not those calls were reimbursed or not.

The feedback during the plenary to the WUA team was that the team had undertaken process documentation well and it kept on sharing it with FTI group leaders. However, the team had not seriously considered how it was going to measure the impacts of designed activities on WUA. The WUA team responded that they had designed a survey of the user's perceptions about the WUA, the benchmark survey had already been undertaken and the survey was to be repeated to assess the changes in users' perceptions about WUA approval rates. Whether or not the survey of approval rates of WUA was enough to measure the effects of changes within WUA was, however, not discussed.

The CA Team

The team informed during the first review workshop that considering the team had limited availability of equipment and staff, it decided to continue with the farmers on whose fields earlier research on parts of CA package was undertaken by various researchers during Phase I and II, as well as add one more farmer based on a set of selection criteria developed by the team. During initial discussions with the chosen farmers, the innovation was modified. The basic tenets of CA prohibit any tillage of land, whereas the farmers experienced soil compaction without tillage. Thus, the tenet was modified from Zero-tillage to minimum tillage. Likewise, the literature-recommended seed and fertilizer application rates had to be increased. These modifications were aimed at avoiding the initial yield dip that is usually experienced during the earlier years of conservation agriculture. The team seemed to be on track in terms of milestones set by the team. The team faced issues on time allocation for FTI activities as each of the team members primarily had other research activities, for which they were accountable.

The group reflection in the plenary identified that the monitoring indicators this team used were relatively too scientific, which required detailed scientific data collection, processing and analysis, and therefore were not cost effective for participatory agronomic trials. The plenary participants suggested that the team further refined its monitoring approach to fit the needs of the experiment as well as to integrate the local knowledge possessed by the farmers. The participants learned, compared to the WUA team, that if FTI activities were related to regular research of the key researchers in the team, these worked, as these would not be seen as additional activities by FTI team members.

The SA Team

The team reported that it had undertaken stakeholder analysis and identified a few promising stakeholders. The team also reported that it spent more time on planning and revising planning, and managed to approach only one stakeholder. The approached stake holder's representative found the innovation interesting but not attractive enough to enthuse. Meanwhile, new potential stakeholders were identified as the team leader participated in a few conferences. Interactions with one of those stakeholders showed that they had interest as well as money to buy the equipment. The team shared its confusion on the concept of "process documentation", and reported that it had not done any process documentation, as the team members did not understand what it meant.

The limited progress by this team was seen due to lack of motivation and staff constraints. Most of the discussion in the plenary was then around commitment to the FTI process by the team members, and need for regular coordination with the FTI facilitator and other teams for seeking guidance from FTI facilitator on issues where the team was confused. There were suggestions that if the SA team did not attract enough team members, then the teams should either merge with another team, or re-discuss its motivation for being part of FTI.

The AL Team

The AL reported that it had finalized its road map, and as a part of its plan had already planted a nursery of saplings for distribution amongst farmers interested in working with the team. The team followed a three stage stakeholder selection process. In the first round some 14 farmers showed interest, but ultimately three were chosen using a list of criteria. These farmers already had rapport with the project. The team then had planted saplings on their plots. The team faced several challenges, which provided significant learning in terms of a locally grounded innovation process:

a) As farmers in Uzbekistan did not own the land they worked on, they needed permission from state administration to plant trees as they were supposed to grow state ordered crops. This permission was refused to many farmers with whom the team would have liked to work.
b) Marginal/ degraded land, though considered part of the farm, was deducted as arable land for the production planning purposes, and thus remained without a water allocation. The water availability in the beginning was critical to tree plantation. The team therefore needed to come up with a good definition of marginal land.
c) Farmers had a rather simple classification of trees, i.e. “trees of use” and “trees of no use”. Trees of use were those with fruit, timber, or border trees in the field. They did not want to plant “trees of no use”. For fruit and timber trees, the arable farmers were not eligible. Thus, no arable land farmers, for whom the only permissible trees were poplar trees as border trees, wanted to plant any other tree species but poplar trees. But poplar trees were unsuitable for marginal and degraded lands.
d) One of the species recommended by the project’s research as tree for marginal land was Russian Olives, which grew by itself as a wild tree in the area. Farmers felt that they would “look stupid” amongst their peers if they planted wild species and irrigated those and took care of those trees. Besides, the fruit from this species were rather small compared to other species of the same tree, and therefore the

farmers did not like the recommended species, which could grow on marginal lands.

e) Farmers' preferred species were those recommended by the state, even though many farmers did not know those trees (mulberry, poplar).
f) Farmers looked for tree species that provided quick tangible products, whereas the minimum time required for reaping the first benefit from recommended trees was four to five years.

The team learnt the following lessons: a) the team leader, a high level scientist of Uzbekistan, got exposure to interdisciplinarity and found it interesting; b) the team needed to be flexible with innovation. There was scope for agro forestry (poplar as a border crop, or fruit trees as field border trees), but not for contiguous plantation of project recommended species under the prevailing state order system prevalent in Khorezm. c) Farmer's preference for agro forestry within arable land rather than contiguous afforestation of marginal lands with recommended species was too radical for Khorezmian system on account of state order system.

Each of the four teams brought their progress and team learning together during the first review workshop. Structured and facilitated discussions of these issues in plenary sessions provided significant learning to the team members about the innovation, innovation processes and about their own team organization and role distribution. This review also assisted in identifying several key constraints, such as inadequate staffing, and multiplicity of assignments, that thwarted the interdisciplinary research processes and outcomes.

6.3.2 Team Reflection and learning during the second review workshop (May 2010)

Experimental implementation, such as what was undertaken through the FTI exercise, enables team learning processes through providing means for reflection (Pohl and Hirsch, 2008). Continued reflection on the process has been found to ease some of the challenges and barriers IDR teams face (Morse *et al.*, 2007). Mutual learning is the core challenge of

IDR (Pohl and Hirsch, 2008). Acknowledging diversity of perspectives and to explore and clarify differences has been identified as the first step towards team learning (MacMynowski, 2007).

During the second review workshop, apart from the progress reporting, the plenary discussions were more substantial in terms of interdisciplinarity. The plenary discussion after the WUA team presentation focused on the ways how the team experience could meaningfully be analyzed, for example not only by comparing WUA approval rates in different points of time as suggested by the IDR team working on WUA, but also analyzing WUA general assembly participation rates by various categories of stakeholders, by analyzing hydrological data of the WUA and by comparing WUA's fee collection records for the base and subsequent years. Besides, it was found out that the skill building materials and the trainings that were delivered to the selected WUA were generic enough for Uzbekistan and could be used by anyone else to empower and re-invigorate a WUA anywhere within Uzbekistan.

For the SA team, as the salinity mapping approach was validated by the stakeholder, the main discussion points revolved around how best to out-scale the innovation, what kinds of materials would need to be prepared and who could use those materials for training the salinity experts within Uzbekistan.

For the CA team, the main discussion points revolved around the nature of the innovation considered by the CA team- that the CA practices actually comprised 'several' innovations bundled together (for example an initial precision land leveling, minimum tillage, maintenance of crop residue, and appropriate crop rotations). If unbundled, many of those innovations could attract farmers in their original form, but CA as an innovation bundle added to the complexity as the Uzbek farmers were not always able to take cropping decisions without approval from the state. Therefore, a complex innovation that was already in wide scale adoption in many similar agro-ecological zones (for example, Pakistan, India, Egypt) made agriculture more complex for farmers intending to use it within Uzbekistan due to the complexities and restrictions imposed by the state order

system of Uzbekistan. Thus, CA as a bundle of innovation lumped together created more problems for farmers than it resolved. The farmers had to justify and explain to the state agricultural inspectors why they used less than recommended intensity of agricultural operations, while following CA practices than those recommended by the state apparatus.

On the process side, the CA team had carried out several implementation, data collection and analysis activities but had not reported on these because the team was led by a scientist expert in CA, but not familiar with team facilitation skills, process documentation or socio-economics of the innovation. The role of the "expert" in the team and the recognition for someone else, apart from the expert, to lead the process part and the process documentation part was highlighted. The team considered field demonstrations as the only awareness/out scaling strategy, which was attributed to heavy dominance by the agronomists and extension experts in the team.

For the AL team, the discussions were around learning from experiments, choice of criteria for including farmers and the usefulness of developing extension material before the actual results from joint experiments with farmers were available.

What becomes evident is that the assumption of the process design that the teams would themselves reflect on the process as they proceeded through various implementation steps, and learn from their process along the course and refine their strategies, did not hold true. This was not only due to lack of knowledge about the importance of reflection, but also due to time pressure to achieve results within FTI teams, but also in involved researcher's main areas of research, which did not necessarily align well with activities undertaken within FTI, and thus left much less time to adequately discuss the progress, problems, and effectiveness of approaches chosen by the FTI teams. The experience showed that none of the teams attempted self team reflection, though the teams recognized the need for team reflection vis-à-vis with other teams. Therefore, the reflection and review sessions needed to be induced and facilitated from outside.

The discussions during the facilitated reflection sessions were rich in content regarding both the innovations as well as the process of testing and adaptation. The teams learned that technically developed innovations by the project scientists under controlled conditions, as well as recommendations generated through project research regarding socio-political dimensions of land and water management were yet not fit for out-scaling under the prevalent socio-political system of Uzbekistan's agriculture, and several dimensions of each of the tested innovations needed further research to adapt and improve those innovations, especially related to the constraints imposed by the state order system of agricultural management.

Regarding the innovation processes, the learning was that through a well structured capacity-building and IDR facilitation process, an interdisciplinary research process could be induced. It was found that the process nature of this type of team work needed much more time than planned, and much more human resources than available with the project. The ambitious team designs of assembling teams containing bio-physical, social and economic expertise simultaneously from within the project researchers, whose main areas of responsibility were their own disciplinary research, did not work well. At times, several FTI members expressed their frustration owing to lack of time due to overwhelming disciplinary research workloads. Likewise, the Ph.D. students, the supporting arms of IDR teams divorced themselves from the IDR in two of the four teams at quite early stages. All in all, IDR process proved to be much more complex social process of interaction compared to what was assumed during the design stages of the project phase.

After having discussed the learning at a team level, I discuss individual learning which selected FTI participants experienced, in the following section

6.4 Individual Learning

The earlier sections have focused on discussing the team learning based on researcher's FTI experience. In this section, I explore the individual learning through this experience.

To capture the degree and nature of learning by FTI participants semi-structured interviews were conducted with seven of the FTI participants during June to August 2010, after the participants had undergone four of the five FTI training sessions, two internal review workshops, as well as completed almost all field activities aimed at implementing FTI related experiments in the field. In addition, after the final consolidation write shop mentioned in Chapter 5, the four members of the authoring team were re-interviewed.

As a theoretical background of learning by adults, Cranton (1996) offers a useful typology of learning by adults as: a) Subject-Oriented Learning, where the learner's goal is to acquire content (e.g. facts, problem solving strategies, practical or technical skills); it is instrumentalist in nature and most often meets the expectations of the learner and is, therefore, comfortable for the learner; b) Consumer-Oriented Learning takes place when an individual expresses a need to learn, looks to the educator for fulfillment of those needs, and then proceeds to learn under the guidance of the educator. This kind of learning is constructivist in nature as the individual aiming to learn has a goal in mind that s/he wants to achieve through learning interventions; and c) Emancipatory Learning is the process of freeing the learner from forces that limit his/her options and control over his/her life. This kind of learning is constructivist in nature and can be transformative. Unlike the other two kinds of learning, *emancipatory learning is often a difficult and painful process* (Cranton, 1996:10).

Since the design of the FTI was imposed on the researchers, one could argue that the consumer oriented learning was not aimed at. The focus of the design was to induce subject oriented learning in that the participants learn for themselves the types and relevance of knowledge beyond their own disciplines as well as the local and system knowledge. The interviews showed that both the subject oriented learning as well as emancipatory learning took place in terms of science itself, local knowledge, as well as system knowledge.

In terms of subject oriented learning (Box 6.1), almost all of the interviewed researchers expressed learning beyond their own respective disciplines. Some researchers reported a greater understanding of the importance of other disciplines, as well as the value of local knowledge. Others reported learning new tools and skills. Others reported acquiring more system knowledge. Many of the interviewees reported acquisition of local knowledge as well as knowledge about its validity and importance. For these researchers, the understanding that their own respective discipline offered a limited understanding of the complexity of reality, which could be enriched by understanding the perspectives and approaches of other disciplines was an important learning that assisted them to overcome many of their epistemological barriers. These statements about learning indicate that the FTI participants acquired, both, the content based learning as well as emancipatory learning while passing through various capacity-building events and while implementing that learning in the field. The researchers also reported learning from the stakeholders, and therefore, becoming aware of the importance and potential of the local knowledge in addressing real life problems, and thus changing their scientific perspective and meaning scheme. Therefore, it can be concluded that transformative learning did happen in almost each of the interviewed cases.

The subject oriented learning also contributed to the emancipatory learning (Box 6.2). The examples of emancipatory learning were: a) benefits of interdisciplinary team science compared to disciplinary teams or individual scholarships (Researcher 1, 2, 6 and 7); b) acknowledging the validity of methods of other disciplines (Researcher 1, 2, 3, 6, 7); and c) consolidating reflexive learning how not to do things (Researcher 3, 5, 6). Many interviewed researchers expressed the need for more frequent learning activities to sustain the learning. Some even suggested improvements in the formats of training events.

Box 6.1 Example of subject oriented learning by FTI Researchers:

Researcher 1: …*helped to understand the perspectives of other disciplines, saw beyond what I knew before…*

Researcher 2: *I knew the technical side of the innovation we worked with from my education and experience. For guiding others, I had no skills. During FTI I learned a lot…. From different articles, I read about CA, that zero tillage works perfect, it was common practice in India, when started doing it in Khorezm, the soils got compacted and crop yields reduced. Then we had to find something else…..Colleagues said we need to understand the reasons why farmers don't want zero tillage. We learned from farmers, we found a solution in changing to minimum tillage. One farmer wanted to skip multiple plowing – we did – farmer got good yield. I learned that not being strict to innovation as reported in research, but being able to listen to farmers and being flexible to local conditions helps. At other farmer's field, we first applied 120kg of seed rate, a scientists from India said 60 kg is maximum, in research articles it is maximum 120 kg, we applied 120kg, and the yield reduced. Next year the farmer asked to sow cross line and apply 200 kg, then yields did not reduce. We learned by doing, never repeated the same approaches from which we got bad results.,….Experience in FTI gave many things, helped in opening to other's perspective, tools, training, bunch of literature, read and learn from theory, get skills out of practice….. Not only my discipline, economist, soil scientist, irrigation specialist, engineer, sociologist …., 5-6 people. After LL we found one thing, if field difference is 5cm then 5m³ of soil will be moved. To know what kind of tractor capacity, I need an economist. Sometimes it is helpful to have an irrigation specialist to calculate water, would help me to reduce time. Need engineer, sometimes we have a small tractor bucket which consumes more time, farmers in Khorezm do not have big tractors. Thought of scrapped blade to cut soil, found out that it cuts rough. Need sociologist to understand what farmer means, and to help us understand each other as well…to help in writing. Finally note keeper and corrections to be done together….*"

Researcher 3: …*everybody faces the same problem, what to do afterwards with scientific outputs … I learnt how to take it beyond*

Researcher 4: *I already knew that economic logic only works partly. I did not change my perception, this experience [of being part of FTI Team] added to my awareness.*

Researcher 5: [F]*or me was too far* [abstract] *unless started to implement in field. I could not imagine the complications.*

Researcher 6: *CA consists of more elements, needs more time, you cannot just train and go. FTI is good when more time is there, time* [required] *depends on the complexity of the innovation. With CA it is a good approach but CA is not an easy innovation, we will still need more time. Difficult is the analytical part. Innovation requires lot of field activities, not one activity per year, logistics consume a lot of time and effort. Original idea was to have two fields, one control and one CA, originally it was, but not many indicators could be measured. Soil samples were collected, but I am sure not from all fields…. using of PME* [Participatory Monitoring and Evaluation], *PIA* [Participatory Impact Assessment] *was good. It was explained in a simple*

Source: FTI Researcher Interviews (June-August 2010)

Box 6.2 Examples of Emancipatory Learning

Researcher 1: *I learned how ideas should be adopted. Learned team building, and about the overall approach. Important to get updated, lessons learned of other teams, update other teams what we have done, to see difference with other teams. But if you do not do it regularly it is not effective.* …

Researcher 2: *Natural science is always from natural things- data, numbers. Learned that social scientists can convert qualitative data to quantitative. Learned many social science oriented things. The only thing is gap between trainings, should be more frequent. Higher frequency helps to understand and remember…. we have learned on innovation, monitoring, documentation. For me the most important learning was about the team work. Everyone has their own role in a team, team is like a rope, if some load come to me when I am only one, I will fall, if we tie with the rope* [of team] *no one will fall, group should build a team together.*

Researcher 3: …[interdisciplinarity] *is useful, need to know in a structured way how system operates. It informs us better how to implement an innovation into the national system, and at least we discover how not to do it. Remember literature discussions?…it was disaster – did not understand what is expected, new literature, no proper introduction, could not relate it at all.*

Researcher 5…. *The gap between trainings, too much theory, learned but had not enough opportunity to practice… I am sure others feel like this too. Literature – huge load of literature. At the beginning it contributed to higher understanding, but later no. We could have more background of having under control* [class room type] *reading* [when it comes to literature discussions].

Researcher6*: Cotton guys from Agroprom* [state body responsible for training farmers on crop practices] *are resisting guys, don't believe* [that same production can be achieved by conservation agriculture]. *May be we need a Joint Experimentation with them too, may be we should do some research with them. The analytical part was at the beginning, when we had to make choice of stakeholders, fields, experimental design, decide about input levels and timing. In Joint Experimentation we wanted to compare. In PME we can take economical data from the bookkeeper, but for water data we did not have anyone, the water specialist was not available. The design was there, but we did not have enough capacities to bring it to the end. We have a social scientist, an economist, but no water specialist. Sometimes, when we were devising PME indicators, the team leader wanted to use his indicators on soil, it needed several years to show the difference. Another agronomist wanted to use biological indicators, which we could only do in 2-3 years. I thought to show rough economical indicators of more help for M&E, and they thought their indicators were better, in the end we found a compromise.*

Researcher 7: *In terms of substance of my own discipline, I did not learn much new. We fine-tuned the research idea together with colleagues from other disciplines and farmers. Refining is only in the beginning. We followed all steps, found out the opinion of stakeholders, without their feedback it would be not possible. What we realized is that CA needs approval and push by the ministry. Interdisciplinary work, such as FTI is important for CA because it allows to jointly experiment with farmers. We were collaborating before but it helped to focus on one direction of FTI using the same tools, developing idea, to be more systematic in research collaboration. We need not just an assistant but to have also more time, pressure of other tasks to be reduced. If we had less other tasks, we would have more time to go to farmers.*[Name] *is always in field and we are busy with FTI if we are asked for by you or Name?, it's because of time constraint.*

Source: FTI Researcher Interviews (June-August 2010)

The painful process of emancipatory learning was depicted by, for example, Researcher 7's initial denial that he had not learned anything new in terms of his own discipline.

The process of emancipatory learning was not easy for the researchers involved in FTI, however. They had to acknowledge their own discipline's weaknesses, had to be open and critical enough in order to be able to understand that the science beyond their own discipline could be as valid and as authentic as they considered their own. The evidence presented in Boxes 6.1, and 6.2 demonstrates that the longitudinal and incremental capacity-building design coupled with 'learning while doing' during the implementation phases of the FTI resulted into both subject-oriented and emancipatory learning for the participants regarding interdisciplinary research.

6.5 Conclusions

The project's dilemma about the role of the FTI facilitator becomes apparent by the nomenclature used in the FTI work package text, where the FTI facilitator is labeled at least in three different ways- facilitator, coordinator, and manager. Besides, an additional task that was vested with the process facilitator was that of research and analysis of the process. The later appeared to carry higher weight compared to the other three titles, at least formally, as the chosen title for the facilitator was that of a senior researcher, a common designation for research staff at ZEF due to its nature of being a research institute and affiliation with the Bonn University as a research center. This dilemma continued in practice when implementing FTI IDR activities by teams.

Literature specifies four fundamental characteristics of a team facilitator: a) acceptability by the team; b) neutrality; c) without decision-making authority regarding team work; and d) advocacy of the process. Schwarz (2002:5) for example defines the role of team facilitation as *a process in which a person whose selection is acceptable to all members of the group, who is substantively neutral, and who has no substantive decision-making authority diagnoses and intervenes to help a group improve how it identifies and solves problems and makes decisions, to increase the group's effectiveness*. The characteristics and roles identified by the FTI team during the first review workshop (May 2009) were also along the similar lines.

Retrospectively, it appears that most of these "academic advices" were only practical when an event, such as a training or a team meeting, was to be facilitated. For example, the external facilitator who facilitated most of the sessions during various FTI training events was able to observe neutrality and as a result was seen as a "third-party" by FTI participants. Many of the academic advices were not found practical during the course of facilitating the FTI process. For example Roger Schwarz's (2002:42) advice that *the facilitators have to be seen as a third party by the teams they facilitate and that ideally facilitators should not be members of the groups or their leaders as this can cause confusion around the role being played* had to be ignored all along the process as the facilitator was tasked to become a team member, and at times led two of the four teams which lacked members or team leaders capable of facilitating their teams. The root cause of this problem, however, again can be traced to ZEF's conditioning issues, as ZEF did not opt for renegotiating terms and conditions with the staff members who decided to leave the organization on account of its inability to negotiate beyond contractual terms set out by the parent university.

The condition of neutrality was in practice not possible to maintain, as the FTI facilitation involved making suggestions and offering insights to various teams when they needed. Such intervention might have been seen by some team members as favoring one side or perspective over another. Facilitators are not supposed to be *decision-makers, nor mediators* as indicated by literature e.g.(Brockbank and McGill, 1998; Schwarz, 2002) as well as agreed by the FTI participants. However, in practice, the project management and the participants vested the tasks of scrutinizing (and somewhat judging) the team plans, process documentation, and various outputs partly with the FTI facilitator.

One of the key characteristics of facilitation of the interdisciplinary research process in case of Uzbekistan project's FTI was its multi-faceted facilitation. The facilitation role, though originally vested in one person, was in practice performed by several individuals across the project hierarchy. The sharing of roles on one hand made the interdisciplinary research experience more effective, as it pooled together the knowledge, skills, capacities, and authorities of more than one person with diverse research and experience backgrounds. On the other hand, two of the four teams where the project's field

coordinator provided inputs, got initially confused about the nature of interdisciplinary research they were to undertake. When IDR is facilitated by several individuals, there is a risk of confusing research participants, and the process may proceed to a direction that might not be intended. When senior management attempts to facilitate IDR teams of relatively junior scientists, it can influence the nature and outcomes of IDR much more than a facilitator at the same hierarchical level that of the team members. However, such facilitation needs to be exercised with caution as the danger of personal and epistemological biases getting induced into IDR process increases with the hierarchical level of the seniority of the leadership involved.

The facilitation appeared to be a complex task compared to what is theoretically perceived. Some scholars have identified mentoring and coaching as part of facilitation (for example Brockbank and McGill, 1998). There were additional dimensions of facilitation, which included supervision, coordination, and criticism apart from mere facilitation, coaching and mentoring.

The team presentations on internal review events, as indicated in section 6.2, showed a lack of will for internal criticism and adequate self reflection across all the four teams. Not leaving the participants alone for self reflection and learning, the strategy that evolved in response to lack of self reflection by teams, was to induce structured and facilitated reflection, which was not initially planned in the design of the FTI work package, added value to the entire experience as it provided a platform for pooling collective knowledge and wisdom, as well as bringing forth any substantive or practical challenges that constrained the team work. For example, the WUA team blamed other FTI teams for intrusion in their field area without their consent or lack of information sharing as a reason for lack of motivation or understanding of the junior staff. The senior staff members of the WUA team could have themselves taken initiative to bring the un-informed intrusion and its implication for their work, to the notice of other teams, FTI facilitator or the project management earlier and thus prevented such tendencies at earlier stage. However, the way chosen by the WUA team to bring a relatively trivial issue that it

could address itself, appears to be a strategic choice of getting it addressed from the highest level, as the project's field and science coordinators were present at that event.

The facilitated reflection across all teams under one roof and at the same time appears to be of more value than internal team reflection, or team specific advice from the facilitator or coordinators. While the teams did not attempt much to reflect themselves on their processes and innovations, the facilitated reflection by all teams together was reported to enhancing the understanding of several of the FTI members (Box 6.1, 6.2), cross-team learning, as well as a platform to identify and address practical challenges. What this implies is the lack of team ability under given circumstances of multiple tasks assigned to team members and interdisciplinarity not being a primary research responsibility appears to be a well thought response to cope with the given circumstances rather than a mere coincidence or negligence. Once opportunities for team reflection were provided through structured internal reviews, all the four teams demonstrated considerable learning. The learning about suitability of chosen concepts, tools, methods, and steps came through external peer review by other teams. All the four teams received thought provoking comments from their non-team members, who were part of FTI but in another team. These reflexive sessions generated comments on both the characteristics of chosen innovations as well as on suitability of the innovation processes adopted by the teams. The resultant team learning through facilitated reflection was about the realization of need for additional disciplinary inputs to innovation research to make these more relevant for stakeholder needs, and about the contextual complexity of socio-political system that was beyond the understanding of the proponent discipline of the innovation.

As far as FTI as the individual learning experience was concerned, the interviewed researchers reported considerable learning in several dimensions- from concepts, tools, theories, and complexity to their content based, and emancipatory learning, which had been transformative in nature. It can be argued that the researchers themselves were more aware of their own learning compared to learning as teams. Therefore, the process related learning can be induced and further enriched through peer review during

exclusive reflexive sessions organized for this purpose only. Thus, identifying and facilitating team reflection should be another task for IDR process facilitators.

Chapter 7: Challenges for Interdisciplinary Research

7.1 Introduction

In this chapter, I empirically examine the challenges and barriers that the interdisciplinary research (IDR) teams faced and how these challenges can be explained. In this attempt, I follow Mollinga's classification of hurdles faced in interdisciplinary research (Mollinga, 2008). Following Paul Carlile's typology from information processing science (Carlile, 2002), Mollinga classifies the hurdles for interdisciplinary research into syntactic, semantic, and pragmatic ones. In his view, the syntactic problems refer to the use and understanding of the language while communicating during an IDR exercise. Semantic problems are problems of interpretation—attributing different meanings to the same word, sentence, text or concept. *Such problems are about the epistemological and ontological premises of disciplines and schools of thoughts on which they base their approaches* (ibid, 19). IDR teams being cocktails of disciplines of various proportions might, therefore, tend to create heterogeneous epistemological and ontological constellations and contestations. The pragmatic problems refer to the institutional incentives and disincentives that exist for interdisciplinary research work.

> *The organizational structure, the funding mechanisms, the career structure, the publication and peer review structure, and other institutional elements of academia are largely organized along disciplinary lines, and while doing IDR, different disciplinary tribes and cultures challenge each other's space in order to make more space for themselves* (ibid, 19).

The syntactic challenges that the teams faced are described in section 7.2, and the semantic challenges are addressed in section 7.3. Section 7.4 sheds light on the pragmatic challenges and in section 7.5, I present challenges that the IDR teams faced due to the way Center for Development Research (ZEF) is related to its parent university and the

donors. In my view, this distinction was necessary as these challenges trickled down from ZEF to its research teams and remained beyond the capacity of ZEF or its IDR teams Therefore, I further subdivided what Mollinga (2008) and Carlile (2008) call pragmatic challenges into pragmatic and foundational ones. By the use of the term "foundational" I do not imply foundational in the broader sense of fundamental, but to the specific way in which ZEF's foundations are laid down- the parent university and donors, and their rules and conditionality that dictate how ZEF should discharge its research and academic responsibilities. This subdivision is not only a syntactic one, but deemed necessary because in view of the evidence, the former caused the latter. For understanding which issues are the cause and which ones are the effects, I expand the earlier typology of challenges based on experiences gained during the interdisciplinary research experiments conducted by research teams in the concluding section 7.6 that shows that the foundational challenges are the "mother" challenges that shape the environment in which IDR is nurtured, implemented, modified, sustained, or rejected. Pragmatic challenges that the teams faced are the result of the foundational conditions under which IDR is undertaken. The semantic and syntactic challenges are the disciplinary and personality responses to the pragmatic issues that arise. The facilitated capacity and team building activities can ease some of the semantic and syntactic challenges, and also some of pragmatic challenges, but the foundational challenges need to be addressed structurally, systematically and separately. In case of ZEF, most of the foundational challenges are the direct outcome of its lack of academic and financial autonomy that leads to its acute dependence on funding agencies for research funds.

7.2 Syntactic Challenges

7.2.1 Natural and Social Science Languages

FTI as a work package (Mollinga, 2006) was largely based on a synthesis of experiences from social science theories around innovation adoption and diffusion, as well as on the literature related to sociology of science. Therefore, the work package borrowed many concepts and terms from social science, as discussed in Chapter 2. An epistemic

challenge many natural scientists faced was that of understanding the terminology and concepts used by the social scientists. The statement of a bio-physical scientist involved in FTI exemplifies linguistic challenges FTI teams faced:

"…it is very difficult to understand what he means by his comments…the words and sentences are so heavy at least for me…." (On comments received from a social scientist on the work plan, July 2008).

This statement exemplifies that even if there was a plain simple talk by a social scientist, for example during the literature discussions, or during the review workshops, without much scientific terminology involved, the natural scientists would find it difficult to absorb due to the choice of words and specific social science phrasing used by social scientists.

The term water distribution within WUA, for example, was interpreted differently by hydrologists and management specialist engaged in FTI. To the former, it implied a scientific model that calculated the amount of water a farmer would need considering soil, water, atmospheric and plant characteristics at a specific time, whereas for the latter, it implied the principles upon which the WUA staff provided water to farmers. This differentiated interpretation led to a noticeable conflict that spanned over a period of two months amongst these two kinds of specializations. The conflict finally had to be resolved by an intervention from project's highest authority, the project director, as described in Chapter 5. Therefore, it can be argued that the syntactic challenges, if not addressed in time, have the potential to lead to conflicts within teams. Stokols, et al. (2008) also recognized the role of linguistic differences in creating misunderstanding amongst the team members.

Syntactic challenges made the communication somewhat long and painful at the initial stages, as some members were based at Bonn and others at Urgench. Those who were based at Urgench were responsible for preparing IDR plans and sharing these with members based at Bonn and then integrating their perspectives and suggestions into the

plans. The communications were largely through written drafts exchanged as email attachments. Therefore, most of the lingual and communication challenges were experienced during the early to mid phases of FTI. From the later part of 2009 onwards, as the team members became more stable and well embedded within their respective teams, they found languages to communicate to each other as well as got used to differential styles of communication and expression of their peers in their respective teams.

7.2.2 The Cultural Challenge

As discussed in chapter 6, almost all of the teams initially comprised members from Uzbekistan and European countries. Uzbek members were based at field location of the project at Urgench, and the European members were based at Bonn, who would visit field locations in and around Urgench once or twice a year. Non-Uzbek Ph.D. students would stay for six to eighteen months in field in slots of six to seven months a year.

The Uzbek style of providing critique is implicit and indirect using symbolism as the main tool, whereas that of western and European researchers is rather specific, explicit, direct and to the point. At the initial planning stages of IDR, the comments from Bonn-based members on team plans, who were non-Uzbek citizens, were largely perceived as non-constructive criticism for the sake of criticism by those who "talked" to those who "worked" (Chapter 5, Chapter 6). Stokols et al. (2008) refer to the origin of such challenges due to differential "status conventions of cultures" (p. S 101).

The cultural challenges within the FTI teams gradually reduced as the teams progressed into actual implementation of FTI, partly because the active involvement of Bonn-based researchers and foreign national Ph.D. students reduced considerably towards the maturity of the IDR processes, as most Ph.D. students completed their field work, and almost all Bonn-based senior researchers gradually withdrew from the teams, or became relatively inactive due to lack of time, or emergence of other important assignments.

Also, those foreign members who were still active within FTI, got sensitized to local styles of communication and culture, and thus more integrated into the teams.

7.3 Semantic Challenges

7.3.1 Epistemological Challenges

Two overarching epistemologies involved in FTI teams became clear as the bio-physical, economic, and social science members worked together within each of the four teams: quantitative empiricism (Rogers, 1987) and critical naturalism (Bhaskar, 1998). The former implies that verifiable quantitative data derived from sensory experience, and logical and mathematical treatments of such data, are together the exclusive source of all authoritative knowledge. The latter as an extension of critical realism, describes an interface between the natural and social worlds in a critical realist perspective. Critical realism highlights a mind-dependent aspect of the world, which reaches to understand (and comes to understanding of) the mind independent world.

Most of the natural scientists and economics members in the FTI teams were quantitative empiricists who believed that the validity of their innovation could only be determined by measuring the changes as a result of the use of innovations. Within CA and AF teams, the state-of-the-art scientific methods to collect and analyze quantitative data regarding bio-physical and economic aspects of the innovation were, therefore, stressed very strongly, and those related to understanding and incorporating the concerns of their stakeholders into the innovation design or the changes in the attitudes of stakeholders remained under emphasized (Field Note August 2008). In contrast, the sociologists, anthropologists and management science members, who dominated the WUA team were more inclined to apply anthropological and participatory tools to understand the problem together with the intended stakeholders and demonstrated a critical realism epistemology (Field Note August 2008). They deployed perception surveys; techniques of participatory impact assessment, member's field notes and documentation generated by WUA during their meetings to assess and understand the changes in the WUA. Though they had initially planned analysis of hydrological data to assess equity in water distribution before and

after the experimental interventions within WUA, finally, they contended with assessing it through perception surveys of farmers and households located within the territorial jurisdiction of WUA.

These epistemologies were also visible in ways in which the natural scientists, for examples experts of conservation agriculture or salinity, would convey their main messages during their planning, progress reporting, and reflexive sessions. This would, for example, include graphs, charts, numbers, trend lines, and maps (Field Note July 2009). In contrast, the social scientists, for example the members of the WUA team, would use pictures of infrastructure and people, narratives from WUA members, flow diagrams, and descriptive statements to convey the main message (Field Note July 2009). I observed contrasting communication tendencies amongst social and natural scientists, for example in compiling their process documentation. The WUA team, largely considered as a social science team by other FTI teams as well as by the project management, would tend to produce lengthy and exhaustive reports, whereas the remaining natural science teams would produce slim and number-rich progress reports (Field Notes August 2009). The impressions the entire FTI team would get from these reports during the FTI reviews would be that the WUA team had undertaken a lot of work, whereas other teams were seen as either in dormancy, or unwilling to share their experiences fully, as discussed in Chapter 6.

What also became apparent was that critical realists tended to focus on analytics too much in the initial parts of the process and too less in assessing the impacts, as opposed to empiricists who focused too less on the process and too much on scientifically analyzing the innovation related impacts and outcomes using state of the art methods at the end of the process, whether it would or not make any sense to the stakeholders engaged with the team.

These contesting epistemologies resulted into substantial confusion amongst almost all teams on the actual objectives of their respective IDR. The WUA team interpreted the purpose of their FTI process as “an interdisciplinary approach aimed at improving WUAs

in Uzbekistan", and therefore devised indicators for evaluating the success of their team by combining quantitative and qualitative indicators, some of whom had problems of attribution (Field Note August 2010). The CA and AF teams understood their FTI processes as attempts of disseminating and even out scaling, the innovations, and the SA team understood it as an awareness building campaign for the rapid salinity mapping approach through use of induction meters. The initial work plans of all teams (Abdullaev, et al., 2008; Akramkhanov, et al., 2008; Ergamberdiev, et al., 2008; Kan, et al., 2008) little emphasized the testing, learning from this testing and improving of the innovations, while strongly emphasizing to make things happen in the sense of implementation, diffusion and out scaling. The interpretations of IDR by the four FTI teams matched more the characteristics of what various scholars have labeled as "problem –solving science" (e.g. Conrad, 2002) in the sense that the teams intended to solve a practical problem facing Uzbek agriculture through their collaborative research and action exercise. Despite having devoted substantial time, numerous meetings and two four-day training workshops on this question (Hornidge *et al.*, 2009; Hornidge and Ul-Hassan, 2010), it nevertheless became clear that the invested time and held discussions were not sufficient in clarifying the actual objectives and clear aims of the overall exercise till the end of 2009.

Although the teams were initially exposed to stakeholder identification and engagement tools during training II, the use of these tools did not go beyond stakeholder identification in most cases. Only the WUA and CA teams used participatory stakeholder interaction tools for engagement and to some extent for trial evaluation by farmers to engage with. When discussed within the FTI team, it was repeatedly suggested that this could be explained with the disciplinary backgrounds and expertise of the team members. The WUA team was headed by a staff member who had been exposed to the use of these tools in his previous job, was part of ZEF's department on socio-politics, and was further driven by three social science Ph.D.-students who worked in the same WUA as part of their Ph.D.s. Therefore, use of participatory tools was found helpful and the capacity to use the tools was available within the team. The initial activities of both the CA and AL teams were largely influenced by the project's field coordinator, who had extensive prior

experience in agricultural extension. In addition, the only social scientist who effectively joined these two teams was a Ph.D. student working again on the extension services with previous educational background in linguistics, and had much less exposure to anthropological research that was required to understand the stakeholders' reality. Therefore, both of these teams, despite several attempts of clarification regarding testing and learning objectives of FTI, kept on falling back on demonstration and extension of innovations.

For many of the natural scientists using positivists methods involved in the FTI, making sense out of quantitative data was much easier than reflecting on the statements and behaviors of their team members or stakeholders and understanding the meaning of it. One of the salinity experts, for example, expressed, "…reflecting on the research process itself and its facilitation is not something usual for natural scientists. It takes time to learn" (van Veldhuizen *et al.*, 2009: Annex 6).

Several sources in literature (e.g. Brewer, 1999; Golde, 1999; Younglove-Webb, 1999, Lélé and Norgaard, 2005; Eignebrode, 2007; Morse, 2007) identify such barriers due to disciplinary norms, turfism, and egos. Pohl and Hirsch (2008) and MacMynowski et al. (2008) acknowledge problems due to semantic challenges and regard acknowledgment of diverse perspectives as the first step to mutual learning and integration.

The epistemic challenges as described above led to a longer than expected planning process, as three of the four FTI teams took more than a year merely for planning, and thus, the implementation and consolidation phases became considerably shorter as compared to original plans. The need for investing adequate time at the planning stages has been advised in the literature (Conrad, 2002; Kostoff, 2002; Stokols et al., 2008;), who argue that collaborative IDR requires substantial preparedness, practice and sustained effort. Due to lack of time available of incorporating the lessons learnt about the innovation into refined design of the innovation and repeating the experiments with refined designs, only the SA team was able to conclude its IDR exercise, whereas for the other three teams, the work remained half completed till the end of the project phase. The

major constraint was the project phase duration set by the donors, and their refusal to extend those timelines.

7.3.2 Process Documentation Challenge

The main objectives of the FTI work package were to develop a locally-embedded approach to test, adapt, and finalize innovations (Hornidge *et al.*, 2011), the focus clearly was on developing a concept for out scaling and finalizing the 'plausible promises' according to the local context. The work package did not entail the actual out-scaling and diffusion of the innovations. For developing a conceptual, locally embedded approach to innovation diffusion nevertheless, the four FTI team experiences had to form the empirical basis. Detailed and comprehensive process documentations therefore were crucial for the further analysis and conceptualizing. Process documentation is comparable to field notes of a social scientist, a method common in the social sciences, while most FTI team members, especially the team leaders were natural scientists. For the majority of the FTI members the purpose, structure, content and level of detail of process documentation was not clear (Chapter 4). An exclusive session during training III (Chapter 4) on process documentation was organized to train participants on what to document, how to document, and how to share it with others. In addition, the facilitator prepared and shared specific formats for documenting various types of activities FTI teams undertook, such as discussions, meetings, events with stakeholders, and observations. These were considered helpful but only taken up selectively. Tendencies to not document due to lack of interest, skills, and time also prevailed, which resulted in the team members reconstructing the processes, from their own and other group members' memories, when pressured by deadlines and reminders (Ul-Hassan and Hornidge, 2010).

Achieving systematic process documentation remained a key challenge for three of the four teams that focused on bio-physical innovations. The two teams, that did not do process documentation well particularly struggled with the overarching questions of what process documentation actually was and how it was to be done and what was its use (Field Note August 2009). Detailed guidelines provided during year 2 also included elements highlighting the importance of reflection on the documentation. Yet, two teams,

CA and AF, nevertheless remained rather passive in documenting the processes. Following the interim review in May 2009, an assistant was recruited to assist the FTI teams in recording the proceedings of important meetings and discussions, and preparing field notes. The only condition was to inform the assistant and coordinate the schedules with him. However, many interactions between the stakeholders and FTI members in the CA and AF teams remained undocumented, because the assistant was not informed beforehand in order to participate and document. This lack of regular process documentation resulted in incomplete and sketchy annual reports by these teams. To assist the teams in closing those knowledge gaps, the mitigation strategy was to get the process reports reviewed by three reviewers, the FTI facilitator, the social science coordinator as well as the external reviewer familiar with the FTI process with the task to ask detailed enough questions to capture the missing points. The reviewers provided in-depth comments and suggestions that the WUA and SA teams addressed, but the CA and AF teams never went beyond agreeing to it in principle. Common reasons forwarded for not being able to undertake process documentation were lack of time, and relatively higher importance of other assignments (Ul-Hassan and Hornidge, 2010).

Process documentation was data about the process, that were not only needed to compile a chronological account of processes, but also to understand how and why questions about the IDR processes. The team that comprised social scientists (WUA, SA) understood this and documented as much as was possible about the process. But for natural science teams, a chronological account or the story of going about something was just a piece of, sometimes unnecessary additional information, and not data. It appears in the retrospect that the process documentation challenge described above was a reflection of various major epistemological and ontological differences about data within each of FTI teams. Three of the four teams were led by natural scientists, and majority members in two of those teams were natural scientists or economists, who largely conducted positivist science using quantitative data, and the members of WUA FTI team were largely sociologists and management specialists, who collected qualitative data about processes, decision making and power and authority. The induction of the FTI facilitator,

also a social scientists and process researcher, assisted in clarifying to SA team that process details were as equally relevant data as were the numbers about salinity levels.

Process documentation challenges as outlined above, appear to have roots in disciplinary training and epistemic affiliation of the leading researchers in the teams. While many natural scientists also prepare and maintain detailed log books of activities, these notes are capable of generating quantitative data about chronology of actions only. The notes and field diaries of social scientists are generally more detailed than the natural scientists, as social scientists focus their observations more towards human behaviors, whereas natural scientists tend to focus more on the natural system. Therefore, it was found easier for WUA team to document their process as a process, and the natural scientists just considered chronological accounts as enough. In this particular case, poor process documentation by natural science teams led to relatively less detailed information as well as loss of important empirical details in some respects, as these had to be later reconstructed from the memories of the teams.

7.3.3 Team Reflection Challenge

A vast amount of literature (Pohl and Hirsch, 2005; Lélé and Norgaard, 2005; Gray, 2008; to mention a few) highlight the importance of and the need for self and team reflection. Literature on project based learning, cautions against the danger of team members of 'action based learning' getting caught up in action without adequate reflection, and thus neither making full use of the learning opportunity for themselves nor for the process in which they are involved in (Markham *et al.*, 2003). The FTI experience outlined here can be regarded as an empirical example for such tendencies in IDR teams. Initially, the team members debated, from various perspectives, on how to go about their innovation specific processes, what elements should be included or dropped, how the teams should implement and evaluate their experiments together with their stakeholders. However, as the process proceeded towards greater interaction with the stakeholders and field level implementation activities gained momentum, the tendencies to look back critically and identify gaps and loopholes reduced (Ul-Hassan and Hornidge, 2010). Within the WUA team, initially some of the team members present regularly encouraged

and demanded the rest of the team to critically reflect and re-assess their actions, intended and actually achieved effects. Yet, towards the second half of 2009, these team members left the team, and partly also the project, and the regularity and level of assessment and reflection reduced.

The series of FTI trainings and internal review workshops were designed to address this issue as the preparatory guidelines circulated before hand clearly highlighted the need to critical reflection while summarizing the teams' experiences (Ul-Hassan, 2009). The reports and team presentations indicated that self-criticism was not always easy for the teams, and the discussions remained less reflexive than expected (van Veldhuizen *et al.*, 2010). To encourage teams to reflect often and critically, all of the process documentation formats as designed by the FTI facilitators contained separate section on team reflection for each of the events. However, the tendencies amongst the teams were either to not critically examine their process, or whenever a critical reflection was specifically demanded, to indulge into blame games. For example, during the first review workshop, the WUA team blamed the process facilitator for lack of support for the tasks that team had to perform, and blamed other FTI teams for intrusion into WUA territory without informing or discussing with the WUA team and getting this intrusion "approved" by the WUA (Chapter 6).

In teams focussing on bio-physical innovations, the difficulties of teams to self reflect became evident and needed to be addressed. To address this challenge, the social science coordinator and the FTI facilitator decided to encourage critical self-reflection again and again. Reflexive thinking had to be induced in this specific case through critical comments provided by the FTI facilitator and the social science coordinator on the process documentation, peer review and criticism by other FTI teams during FTI progress reporting sessions, as well as by inviting the external FTI consultant to provide a written review of the process documentations prepared by all four teams (Chapter 6).

These encouragements, pressures, and inputs by various individuals were not always helpful, however. The ultimate strategy to achieve and consolidate critical and analytical

IDR was through team-specific peer reviewed papers to be produced by each of the four teams. However, as the process concluded during the write shop in 2011, only two of the four teams, where the FTI facilitator and social science coordinator co-worked with the authoring team, produced any analytical output. Failure to achieve this reflexive thinking in teams however, does not imply that individual team members did not gain insights into reflexive thinking. The researcher interviews reported in chapter 6 suggest that a lot of individual learning based on their continuous reflection was reported by those interviewed.

The above discussion implies that when teams comprising various disciplines engage in IDR, critical team reflection might need to be induced and facilitated externally, and therefore, should be identified as an explicit task assigned to the process facilitators.

7.4 Pragmatic Challenges

7.4.1 Motivational Challenge

While the teams in early 2008 had formally and/or informally agreed on the roles and responsibilities of various members, it remained rather unclear for the support members to what degree their contributions were valued and what type of benefits they could expect from participating. An earlier survey amongst the Ph.D. students (Chapter 5) indicated that some members did not understand why they were asked to join a certain team. The comparatively high contribution of some Ph.D. students in the WUA team could partly be explained by the student's own interest in broadening their understanding of the WUA, in which their research was located. The inclusion of research assistants in the FTI teams helped in moving activities further, but had to be closely supervised and coordinated by the senior researchers of the respective teams.

Likewise, sustaining the senior researcher's motivation throughout the duration of FTI also remained a challenge, as several of the staff members involved in FTI teams experienced pouring of additional assignments by the project management, re-allocation of responsibilities and shifting career priorities, which are further explained in details in

the following sub-sections. Within each of the FTI teams, the levels of motivation for IDR remained variable throughout the exercise.

7.4.2 Task Plurality Challenges

Most FTI members had to multi-task owing to their involvement in several research, capacity development and implementing activities. Holding regular meetings and discussions to plan, carry out, sum up, and reflect upon FTI related activities proved to be difficult and the tendencies for task-specific specializations within teams, often without co-informing the rest of the team, and the resultant tendencies of solo-flights increased. This also impinged upon adequate team reflections, for which the team members rarely made available the time. Due to the multiplicity of ongoing and additionally popping-up tasks to be taken care of, priority setting clearly became an issue. Resultantly, most of the FTI teams, despite formulating annual roadmaps and revising them in FTI workshops, had been performing on a 'live by the day' principle. This was further compounded by the 'hop in - hop out' situation due to the high turnover rate in staff by some key FTI team members.

7.4.3 Spreading human resources too thinly

Apart from the FTI facilitator, for all other researchers involved in the FTI-process, 'following the innovation' was only one amongst many other job assignments, which was regularly overshadowed by the 'main' responsibilities of the respective researchers. Most of the researchers generally spent one hour pet week and that too not regularly.

Interviewer:
How many hours on average you spend during a week on FTI related tasks?

Researcher 1:

I tried to estimate, it is fair to say that on average it is 1 hour per week. My time on FTI is very irregular, for example, for preparation of extension aid material I spent one week being busy only with this, I spend time for observing the field sites, distribution of materials.

Researcher 2: *Out of 6 days I spend 3 days for research* [analysis and write up]. *Rest days are field observations, walking, and preparation. I keep notes of what I did and need to do. For FTI, after planting I spend 1 day in a week. For FTI, I do not really go to the field, reading, articles, and ideas for phase 4.*
Researcher3: *About one hour per week*
Researcher4: *Don't know; sometimes not at all, sometimes do spend. Can't say, it depends, in a year it is nothing. Roughly an hour a week may be.*
Researcher5: *If to divide in 2 periods before and now, before I spent a whole week only on FTI, on one side that was a mistake, now I am behind in other work, everyone saw FTI as my major topic. In intensive days, during tree plantation, I spent beyond office time. Now it is about 2 days per week.*
Researcher6: *Cannot tell. For the last 2 weeks a lot, preparing documentation, report. Occasionally we have meetings, 1-2 times per month.* [Team Leader] *knows more what's going on, we don't. If something happens in the field he can go spontaneously, we ask to update us. So per week it is about 1hour, for the whole month: 4 hours.*
Researcher7: *…2-3 hours per week, not so much as* [the team leader] *or* [the Ph.D. student]. *I am busier with supervising 5 Ph.D. students, disciplinary research and publishing articles.* (Field Notes August 2010)

While junior researchers had to focus on their Ph.D. research more, the senior researchers involved were at the same time responsible for at least one self-standing work package within the project, that only little would contribute to and extract from the FTI experience. In order to fulfill the objectives of each work package, each senior scientist involved in the FTI experience, was additionally and with the prime focus conceptually, methodologically and operationally designing research activities that could but did not necessarily relate to their FTI work, supervise Ph.D.- and MA-students as well as research assistants and teach. In addition, they were required to write and publish peer reviewed papers, participate in conferences and seminars, attend academic activities and coordinate visits of collaborating scientists of the project from elsewhere. Besides, the project phase formally being the terminal phase, the project researchers decided to form a self-sustaining, non-governmental scientific and implementing agency called Khorezm Rural Agricultural Support Services (KRASS) for sustaining project efforts. Launching KRASS consumed a lot of time of all Urgench based post-doctoral researchers. As members and drivers of KRASS, the researchers needed to participate in preparing and negotiating proposals for and with donor agencies. As one outcome of this, KRASS managed to attract a research and implementation grant from the United Nations' Development Fund, which put further stress on researchers' time. The focus on FTI as a

cross-cutting key activity of the project's third phase therefore was constantly challenged and could hardly be maintained. Despite being aware and convinced of the necessity to discuss the FTI work in a structured and coordinated way within each team, as well as across teams, the key researchers involved rarely managed to actually hold these structured meetings and thus, the implementation of FTI activities, process documentation, attention to detail, and appropriate reflection within the teams was compromised.

What becomes evident from the above is that for any meaningful IDR activity by a team of scientists and assistants, the staff motivations need to be addressed in terms of what the engaged scientists, specialists, and their assistants will gain (data, information, increased capacity, publication, or financial rewards). Also, part-time staff assignments and staff assigned to multiple teams needs to be avoided as much as possible. Continuously adding on assignments, a tendency that was so frequently observed within the Uzbekistan project (Field Note July 2010) certainly led to frequent disruptions in researcher's schedules (discussed separately in the following section), and then the interdisciplinary research activities were the most common ones that got compromised because the researchers performances were not assessed based on their successful IDR.

7.4.4 Transitional Challenges

An important issue that remained challenging several teams as well as the overall FTI process was the sudden adding of new responsibilities for the involved researchers and the resultant changing priorities for the individual, which then again also impinged upon other FTI member's schedules. During each of the FTI trainings, for example, a few key FTI members had to miss important sessions due to ongoing field work, although the timing of the training had been jointly agreed between the FTI facilitator, external facilitator, social science coordinator, project's field coordinator and the project's science coordinator and announced two to three months in advance (Field Note May 2009). Despite the fact that the FTI teams identified milestones and timelines for the

performance of FTI activities themselves, very often, the teams were unable to follow their timelines. For example, it was discussed and agreed in the plenary during the third training workshop in November 2009 that the next interim review workshop was to be held in March 2010 (van Veldhuizen *et al.*, 2009). However in March 2010, due to the early arrival of water, the members of CA team were very busy carrying out or supervising field activities related to leaching of cotton fields, and the review had to be pushed to the end of April 2010 (Field Note March 2010). Even announcing the new date more than one month in advance did not help, as a sudden visit of two researchers from a collaborating organization did not let the CA expert participate in the review (Field Note April 2010). Here the priority setting sometimes was unclear and not in favor of the FTI process. Another example forms the compilation of annual process documentations by the teams, which by two teams were delayed by more than two months, due to the heavy involvement of the respective researchers in other research activities. Yet, the delay then again also impinged on the work schedules of those expected to work with these, i.e. the FTI facilitator and the social science coordinator (Field Note July 2010).

7.4.5 Team Coordination Challenges

Especially within the CA team and partly due to the multitude of assignments of the key members, tendencies could be observed, to undertake FTI interactions with stakeholders in a 'solo-flight' mode, basically dropping by the stakeholders whenever the researchers were passing by their locations without consulting or informing their FTI team members. Since note taking and process documentation related to such events were not systematically undertaken, the rest of the team members would remain unaware of interactions and the insightful discussions between the expert and the stakeholders. Comparing the four teams with regard to their internal coordination and interaction, it can be stated, that more frequent and structured stakeholder-FTI team discussions were common within the WUA and SA teams and happened rarely within the CA and AF teams. Part of the problem lied in the team design. In the case of the AF team for example, the members apart from the Ph. D. student comprised the project's field coordinator, the head of the Forestry Research Institute located close to Tashkent, and a tree specialist based at ZEF's Bonn office, all of which were rarely available for meetings

together or jointly with stakeholders. Only the Ph.D. student was in the field, but she was not an expert forester. In the case of the CA team, one senior member had to regularly travel to Tashkent for academic assignments there, while other members of the team had a multitude of assignments running in parallel. The coordination and scheduling of common meetings therefore remained difficult throughout the FTI exercise.

In order to counterbalance these observed difficulties and as a mitigation strategy, it was decided in the interim review workshop in May 2009 to hold fortnightly FTI coordination meetings in Urgench, coordinated by the overall FTI-facilitator (Ul-Hassan, 2009). These meetings were regularly held during the entire vegetation season of 2009 (June - October). The team leaders would share and discuss their plans and problems with other FTI teams and with the facilitator and decisions would be taken jointly. There were tendencies, however, that not all members of the FTI teams would participate but instead the 'team leader' or one representative only, which sometimes negatively affected the decision-making capacities during the meetings (Field Notes June-. October 2010). Nevertheless, the meetings were documented and the minutes were shared for comments and distributed to all FTI members based in Urgench, Bonn and elsewhere. The advantages of these meetings were: i) the overlaps and conflicts in schedules of separate meetings of the four teams were avoided by holding regular meetings with all four teams involved ii) each of the FTI groups knew what the other group was going to do; and c) decision-making was guided by collective wisdom of a relatively larger group, the overall FTI team. The disadvantage nevertheless was that detailed planning of individual groups was discussed briefly only, while finding time for separate meetings was difficult.

All of the above mentioned pragmatic challenges, however, have roots in the way ZEF designed its Uzbekistan project and the FTI work package and merely are the reflections of "symptoms" of the deep rooted problems prevalent with ZEF and its Uzbekistan project. The work package design assumed that the staff engaged along ZEF's strong departmental lines will be by itself motivated enough to work for an interdisciplinary work package in their own interest. However, as discussed above, the motivation to undertake "additional" work for "someone else" in addition to successfully complete and

be recognized for their own assigned work was much low compared to the assumptions. The key scientific staff could draw motivation from the potential to publish scientific outputs, but many of the staff involved were bio-physical scientists for whom publications in social science were merely "stories and journalism" (Field Note May 2010) as earlier pointed out by a bio-physical scientist in Chapter 6. This was further compounded by multiplicity of assignments and continuous addition to their already insurmountable workloads. For the Ph.D. students, the motivation could come from additional and complimentary data that they could use, but then as soon as the data needs were fulfilled, their motivations to participate effectively dwindled.

7.5 Foundational Challenges: The Project Organization

7.5.1 Contextual Challenge

The success of IDR carried out under the banner of FTI relied heavily on the strategy of integrating expert, local, and system knowledge, which required an active involvement of relevant stakeholders in Uzbekistan. Although there had been discussions since the beginning to identify and actively involve interested stakeholders, who were ready to validate and adapt the innovations together with the interdisciplinary teams, it proved to be hard in reality. Out of the four teams, the SA team's process eventually reached, partly due to the high dependency of the project on the stakeholder, the highest degree of stakeholder involvement, whereby the stakeholder took the charge of the process, designed the experiment together with the project scientists and assessed the validity of the innovations almost independently. The WUA stakeholders were initially integrated well through participatory processes, but since the departure of the team leader, the interactions remained rather limited due to lack of staff on one hand, and to a large extent due to a shift from initial joint experimentation to a gradual "laissez faire" innovation experimentation strategy. However, the results of monitoring had been shared and discussed with the WUA, who agreed to the results. For CA, while informal consultations and exchange of opinions and views and experiences regularly took place between the CA expert and the farmers, the farmers were not clear about the nature of the CA joint experiments and kept on referring to it as "expert's research trials". In case of AF, the

stakeholders appeared to rely much strongly on the visiting FTI member, basically for almost everything. Their perception was that even the choice of species was undertaken by the FTI member. However, the team very well integrated the head of the Forestry Research Institute into the FTI process, who described the FTI process as extremely "interesting" and "educating".

The Uzbek farmers remain quite busy due to not only their farming, but also due to their obligatory participation in state organized events, meetings, training seminars, as well as in resolving business issues with agricultural input providers and banks. Gauged only by their participation in FTI trainings would therefore not do justice. Regardless of whether the stakeholders could correctly spell out the nature of the joint experimentation or not, their agreement to participate in the experiments was no less important on several accounts. Firstly, within the extremely controlled production system of Uzbekistan, a farmer agreeing to experiment with agriculture for anything not recommended by state authorities is a substantial risk a farmer takes demonstrating his or her innovativeness. Secondly, by experimenting, farmer accepts a disproportionate risk of otherwise profitable agriculture. Thirdly, the input and labor contributions demonstrate farmers interest in innovations. Fourthly, some of the Uzbek farmers tend to trust experts more than their own knowledge on innovations they have never tried before, as in the case with AF, and thus might be perceived rather passive during meetings and discussions. Fifthly, they treat outsiders as guests and respect their guests. Arguing with visitors whom they do not see more frequently is socially unacceptable in local tradition. Thus, wherever they might have been identified as "less active" it might not necessarily mean they were not interested or integrated. All engaged farmers in AF and CA experiments actively participated in one-on-one meetings with CA expert or with AF Ph.D. student.

7.5.2 Staff Turnover and Sustainability Challenges

ZEF being a development research institute attached to a university faced a number of operational and academic constraints. For example, the number and types of academic staff that is on perpetual employment contracts, or tenure track positions, are rather

limited, which necessitates recruiting research staff on short and medium term project contracts. Once the project funding or tenure ends, the employment needs to be terminated, unless another vacancy is available within ZEF that requires same skills and qualification, a rather oblique possibility. The short and medium term contracts do not attract staff having long terms commitment to the institute or its work. This researcher has participated in ZEF's annual retreats and seen internal documentations raising concerns about challenges ZEF and its senior staff members face due to the project orientation of the institute. As a result, ZEF is unable to capitalize on the capacities of staff that it built, and thus has to re-invent the wheel. Capacity-built for IDR through FTI was no exception to this trend.

Despite the project phase being funded for a period of over three years (2007-2011), part of donor's conditionality was that BMBF would annually approve and guarantee funding for the respective year separately. By implication, ZEF could not issue contracts for longer than a year to any of the staff members working on project-funded positions, as it was unacceptable for the parent university to issue contracts against insecure funding. ZEF's inability to issue longer contracts affected its research in at least two important ways. Firstly, ZEF becomes a less attractive option for the candidates who preferred career jobs or at least a project-long contract. Secondly, staff members already appointed to project research positions keep on looking for more secure job opportunities elsewhere. For example, the most suitable candidate identified for the facilitator's position during the first round of recruitment did not accept the job offer, which somewhat thwarted the IDR capacity building processes in the beginning. Besides, six senior researchers involved in FTI left the project during the process because they found either better-paid or longer-term jobs.

The relationship between staff transitions and the team performance of IDR was critical within FTI. Amongst the senior staff, two senior economists, two senior water management specialists, a tree specialist, and a geographer changed their jobs during the course of the initial two years of the phase. Some of these vacancies were re-filled, but the replacements had missed the earlier discussions and trainings, and thus neither had

the interest nor the required exposure to the FTI work. Besides the missing FTI expertise, the newly joining staff, if at all interested in the FTI work, had to gain team's trust and respect again from scratch. The WUA, SA and AF teams substantially suffered under these set backs. To fill these gaps, the FTI facilitator was required to jump in and assume major responsibilities in two of the four teams. However, this gap filling strategy was not as ideal as having those senior scientists continuously involved who were also specialists with regard to the innovations at hand. The mitigation strategy of attaching the facilitator as a team member also violated the guidelines on effective facilitation as well as the conditions identified by the FTI participants for effective facilitation, both requiring the facilitator to be an outsider and not a team member.

In addition, most of the Ph.D. students who joined the teams initially out of the relevance of the innovation to their Ph.D. work had to leave at some stage for completing their write up and analysis of their research. There had been tendencies to fill that gap by contributions by the research assistants from relevant work packages. The research assistants nevertheless did not necessarily possess the required skills and knowledge required for working inter and transdisciplinary and always required to be supervised and coordinated by the respective senior scientists, putting additional workload on already loaded senior scientists.

In effect these transitions and departures of staff and Ph.D.-students to Germany resulted in an overall decrease in team members from 2008 to the end of 2009 in all four teams. The WUA team shrank from initial 10 members to 5, the CA team from 14 to 4, the SA team from 9 to 3, and the AL team from 7 to 5 project staff.

As far as the sustainability of the IDR capacity as such within ZEF is concerned, ZEF had designed FTI work package to contribute towards its internal capacity for IDR, and substantially invested in developing a cadre of human resources who had potential to capitalize on their built capacity and experiences to achieve higher degrees of IDR, ZEF's overwhelming dependence on donors to fund its research compromised its aims. At the time of this writing, most of the researchers who participated in IDR as ZEF staff

members, only three of them remain with ZEF. All others had to find jobs elsewhere as the BMBF had ceased its funding for Uzbekistan project. Although ZEF accords a high priority to the research in central Asian region (ZEF, 2011), as well as puts a high emphasis on carrying out research in interdisciplinary and transdisciplinary modes, it does not possess necessary financial means to achieve these objectives, at least in central Asia. The IDR in any current for future projects would imply for ZEF that it has to re-invent the wheel of capacity-building.

7.5.3 Consolidation Challenge

Continuous monitoring and evaluating of the conducted IDR processes took place in all teams but in a rather unstructured and unsystematic way for several reasons. For the WUA, CA and AF-teams, it was thought to be too early to assess the impacts as all of the addressed innovations were of relatively long term nature, which could start producing impacts only in a relatively longer term. For SA, the innovation needed to go through validation at selected stakeholders research site and methodology. The validation was successfully undertaken, but the dissemination needed further steps requiring more time and resources. Also, the cost of the equipment was considered relatively high for Uzbek salinity organizations, who were struggling to prevent staff departures and expertise loss (Wall, 2006) due to lack of funds.

An important reason of quickly wrapping up the process in all the four cases was that the project's ongoing phase had to end by April 2011, after duration of 3 years since FTI activities started. In addition, the start of FTI activities was already considerably delayed due to late recruitment of the facilitator. In addition, three of the four teams took more than a year to just plan their IDR experiments. As a result, till the end of the project phase, it was not clear whether the funds for the next phase would be available or not, and even if available, whether FTI would be continued or not.

Whatever could be achieved within this tight timeframe, the FTI experimentation took place in the real life, with too many variables influencing the situation, there was a

problem in ascertaining the attribution to impacts of FTI, which required more complex approaches and long-term data collection to ascertain impacts, which was not available at ZEF's disposal.

Part of the problem was a relative short duration for the IDR, which was implemented only during the final phase of the project. Duration of three years is relatively short for translating theory into practice, planning and implementing an approach and learning lessons from it, and consolidating those lessons into theory. Another phase of FTI would probably provide an opportunity to realistically assess the impacts of the process both on the stakeholders as well as on the involved researchers and provide adequate information to consolidate the findings.

7.6 Conclusions

As we have seen above, the IDR undertaking within the Uzbekistan project faced all types of challenges mentioned in literature on barriers to interdisciplinarity. Apart from the relatively small time period required to translate and interpret theory into practice, mentioned in the previous sub-section, the IDR exercise faced semantic, syntactic, pragmatic and foundational challenges. Through Figure 7.1, I attempt to expand the earlier typology (Carlile, 2002; Mollinga, 2007) of the challenges (top row) faced during FTI (middle rows), and some of the key mitigation strategies (bottom row) for resolving some of these issues.

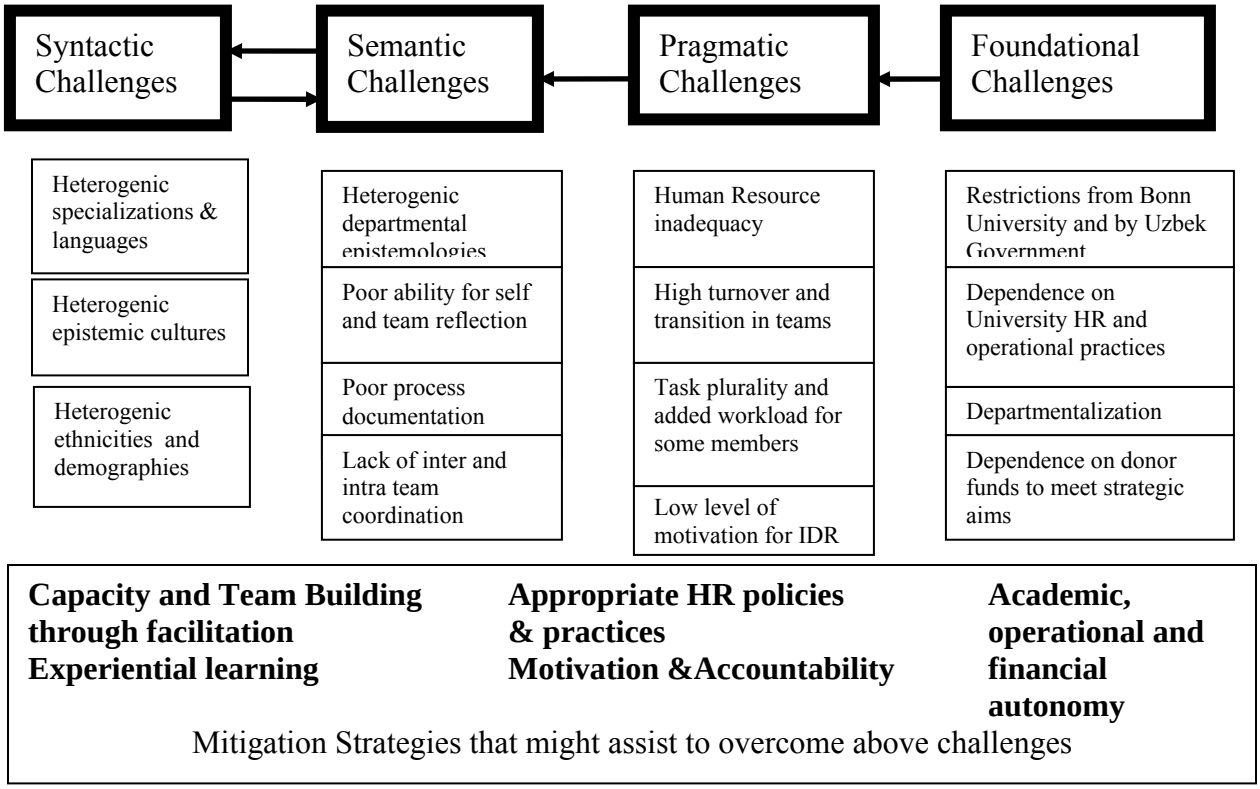
I call this a relational typology because various typologies (Top Row in Figure 7,1) are related to each other in a specific way. For example, the syntactic challenges, apart from those arising out of ethnicity of researchers, were an outcome of epistemologies prevalent within ZEF due to its departmentalized structures and systems and specializations within those departments. Issues with process documentation and reflection were due again to the epistemologies of the participants. These issues considerably challenged the FTI processes in the beginning, but with gradual capacity building and learning by doing, these tended to ease.

The process documentation challenge could not be fully resolved as two of the four teams did not progress beyond promises of completing their documentation till the final stages of the project. The members who were assigned responsibility of completing process documentation attributed their lack of action to their heavy workloads in other assignments, which were determined by their departmental and project supervisors, and therefore, due to task plurality that had origin in ZEF's highly departmentalized structure. Their departmental supervisors accorded higher priority to departmental research than attending to a relatively distant interdisciplinary task.

Part of the factors that eased some of syntactic challenges overtime was the consolidation of teams through continuous working together and developing a sense of belonging to their respective teams as well as to the larger FTI team. Thus, facilitated capacity and team building activities assisted in resolving some, if not most, of the syntactic and semantic challenges, and the evidence above and in the previous chapters suggests how some of these challenges were addressed, such as inducing reflection through assertion, pressure, reminders, and structured events on the innovations and the IDR processes through facilitation inputs.

Most of the pragmatic challenges, however, were due to how ZEF had organized its Uzbekistan project and the FTI work package as a part of the project. All of the pragmatic issues could not be fully addressed only through facilitation and capacity building. For example, the motivational challenge that most Ph. D. students and many senior researchers faced could not be addressed. The lack of motivation resulted into gradual withdrawal of research inputs, due to staff departures and completion of Ph.D. student field work. The research design that each of the senior researchers had to multi-task between various activities while IDR being only a small proportion of researcher's task domain had posed serious challenges to the way researcher would prioritize their research activities in terms of allocation of time, thought, and effort to IDR. Besides, the researchers had academic and organizational accountabilities only for their main research activities, and their performances were not assessed on the success or otherwise of the IDR. The pragmatic challenges appear to be rooted in the foundational issues ZEF faces.

Figure 7.1 A Typology of IDR challenges at ZEF and Proposed Mitigation Strategies



Source: Author's visualization based on discussions in Chapter 7

The foundational challenges appear to be the most noticeable ones. Conducting IDR in a context where most of agriculture is strictly state controlled on the topic of innovative agriculture itself posed unique challenges which would not be serious in contexts where agricultural decisions are farmer's responsibility, or states do not micro-manage agriculture. However, the most important foundational challenge is the way ZEF organizes its research. ZEF's inability to provide a guaranteed job for the entire duration of the project or after the end of the project is due largely to donors' and parent university's conditionality. The researcher's career aspirations, on the other hand, led six of the FTI researchers to leave the exercise in the middle in pursuit of job opportunities with better terms and conditions, salaries or job security and tenure, which were beyond ZEF's authority. Owing to these limitations, one can argue that ZEF can not sustain its capacity for IDR research in any of its research projects and has to re-invent the wheel every time it aspires to indulge in IDR. The proposed mitigation strategies, that might

address most, if not all, of ZEF's foundational problems, would be to attain a real autonomy from the university structure in terms of securing reasonable levels of core funding that frees ZEF from donor vulnerabilities and allows ZEF to strategically allocate resources in terms of its identified research priorities and methodological independence as is available with other similar development research institutions in Europe (chapter 2). Potential ways of securing larger core funds would be to charge a reasonable tuition fee for its doctoral program teaching and supervision, and/or to charge an overhead cost on project funds. What ZEF also needs is an independence to devise and practice its human resource policies. Currently, ZEF follows policies and practices devised by the Bonn University. The departmentalized structures suit an educational university, as it needs to excel in disciplinary and specialized basic research, and is located within Germany and has all of its facilities, campuses, and staff largely recruited and located within Bonn. The same policies do not fit well ZEF, as it has to undertake applied research at a global scale, and needs to recruit from international human resource market of development research professionals, and also has to undertake research in many developing countries, where contextual challenges are not the same as faced in a developed country like Germany. Unless ZEF attains such autonomy, it will remain vulnerable to shocks produced by the policies and practices of both academic and research funding organizations, and therefore, unable to reap the benefits of developing capacity for achieving its intended objectives, such as capacity for undertaking and supervising inter and transdisciplinary research.

Chapter 8: Conclusions

8.1 Introduction

This thesis is about the role that facilitated and structured capacity-building plays in nurturing interdisciplinary research amongst the scientific teams of a research institute. This study was needed to contextualize the applied research response of Center for Development Research (German Acronym- ZEF) to solving complex problems in agriculture through interdisciplinary research, which claims to use research projects as a vehicle for guiding agricultural policies and practices in developing countries and, to deploy cutting edge science to find these credible solutions. Due to ZEF's mandate, ZEF needs to ensure that its projects have a sufficient degree of interdisciplinary research (IDR). One of the central question that ZEF faces is how actually to induce and nurture IDR, given that it is organized around disciplines having their discipline specific mandates, epistemologies, organization, career and peer review structures. As interdisciplinarity in teaching and research are two different types of interdisciplinarities (Porter *et al.*, 2006), these need to be tackled differently. This study focused on ZEF's interdisciplinary research in one of its project only and, thus, interdisciplinary teaching carried out by its graduate program was out of the scope of this research.

The study used the case of ZEF's Uzbekistan Project, which intended to test, adapt, and validate agricultural innovations through interdisciplinary research, that were earlier found promising to offer credible solutions to resolve some of the problems Uzbekistan's agriculture faces in its Khorezm province. Four innovations were chosen for this IDR exercise. Each of the chosen innovation was tested, together with identified stakeholders, by a scientific team comprising relevant bio-physical, social and economic science disciplines. The IDR teams had to design, implement, and evaluate their testing experiments in close collaboration with the ultimate users of those innovations. Thus, these IDR exercises had both interdisciplinary as well as transdisciplinary tasks. However, this study limits itself to the analysis of interdisciplinary aspects of these experiments that of how scientific teams comprising diverse fields of expertise and knowledge managed to work together, understood their disciplinary differences, and

managed to resolve those differences to achieve mutually agreed solutions. This study, therefore, assesses and discusses the ways in which capacity-building assisted in nurturing the interdisciplinarity amongst the scientific teams. The study also offers potential ways to induce, nurture, and sustain interdisciplinarity in agricultural research institutions, and how this capacity-building can be used to modify epistemologies of involved researchers. It also discusses how various contextual and foundational conditions provided to researchers of the project played out as potential barriers or facilitating factors. It discusses how the barriers related to each other, and offers ways in which some of these barriers could be overcome.

The main question addressed in this study is "to what extent and how the ZEF's longitudinal model of facilitated, structured and incremental capacity building combined with problem based interdisciplinary action research shaped interdisciplinarity amongst its innovation teams of collaborating scientific staff, and how sustainable this interdisciplinarity was"?

In order to give a satisfactory answer to this question, first the organization of ZEF itself, and how it relates to its parent university, how it funds its research, and how it conducts its research were studied (Chapter 2). The conceptual and methodological aspects of interdisciplinary research and the key insights from the literature about understanding of interdisciplinarity, need and role of capacity building in enhancing interdisciplinarity, and potential barriers and challenges are examined (Chapter 3) to guide key research question, and to adapt a suitable methodological framework. Furthermore, the analysis of the actual capacity building program of ZEF that aimed at inducing interdisciplinarity (Chapter 4) and the analysis of subsequent action research by the interdisciplinary teams (Chapter 5) form integral parts of this study. As the process was accompanied by full time facilitation inputs to all the teams, the role of facilitation is also examined (Chapter 6) with respect to learning by teams and by individual team members. Finally, the challenges and barriers that these teams faced during actual interdisciplinary research are discussed (Chapter 7). The findings of these discussions are summarized and reflected below for implications for theory, methodology and practice.

8.2 Role of contextual and foundational conditions in nurturing interdisciplinarity

The evidence presented in this study demonstrates that context plays an important role in nurturing or frustrating interdisciplinarity initiatives. Uzbekistan's agriculture, where ZEF undertook interdisciplinary research project that was studied, required recommendations based on rigorous interdisciplinary analysis as it involved all dimensions of the studied problems- ecological disaster of the Aral Sea, and the resultant economically and ecologically unsustainable land and water use leading to dwindling livelihoods for its population. The Uzbekistan project had a complex natural resource management (NRM) research design (Wall, 2006) that aspired to provide solutions for restructuring land and water system of Khorezm region in order to improve livelihoods and sustain the environment through an interdisciplinary research effort.

ZEF's main vehicles to undertake development research and interdisciplinary analysis are limited to donor funded research projects, which have their own limitation due to donor restrictions in terms of research themes and project designs given the donor priorities for the substance as well as organization of the research projects. Besides, ZEF as an interdisciplinary development research institute subordinated to Bonn University, with very little core funding is strongly departmentalized along disciplinary lines of natural, economic and social sciences. This departmentalization favors a largely disciplinary, and to some extent multidisciplinary research designs, and thus makes interdisciplinary research (IDR) initiatives more challenging. As the staff members have departmental recruitment, research interests, and accountability, the project was designed along a departmentalized disciplinary fashion. The natural, economic and social science work packages, mostly undertaken through student doctoral projects at earlier two phases of the project looked at issues from purely disciplinary perspectives. The number of multi - disciplinary work packages was much lower than disciplinary work packages. There were only two interdisciplinary work packages, one of them was Follow- The- Innovation (FTI), which was conceived in the last phase only. Though there was a successful induction of IDR during this brief period of three years, it proved clearly inadequate to

sustain the IDR capacity within ZEF due to ZEF's financial inability to retain trained staff.

The lack of availability of regular research staff positions within ZEF makes the institute prone to intellectual memory loss as there are higher incentives for staff turnover due to lack of opportunities for vertical career progression within ZEF. Therefore, ZEF's main challenge remains as how to sustain the capacity for IDR that is created through its research projects.

In ZEF's attempt to induce IDR through structured capacity-building within its FTI framework, the foundational conditions around its project research and the researchers involved performed as framing conditions for how much interdisciplinarity could be learned and practiced by the research staff involved, as well as how much of it could be sustained within ZEF as an institute. Thus, the IDR research conducted through its FTI as a result became a negotiated outcome between ZEF's IDR aspirations, contextual factors, influences of its parent university and the project donors, as well as its departmental organization.

8.3 Conceptual and Methodological Framework

The study operationalizes interdisciplinarity as an integration of disciplines in terms of problem definition, conceptual and methodological frameworks in order to achieve an agreed theorization (or understanding) of the subject in question by specialists of various disciplines involved. Since the study aimed at understanding and analyzing an interdisciplinary research process it required multiple research methods. The data collection tools included participant profiles, self reported perception surveys, semi structured interviews, participant observations, observing participation, life with researchers, text mining of event and session reports, team minutes and planning documents, and institutional ethnographic techniques. The use of multiple methods not only generated adequate qualitative and quantitative data sets that were used for analysis of interdisciplinarity within ZEF's Uzbekistan project, but also provided ways of

ensuring internal validity of data through triangulation, and provided deeper insights into explaining various aspects studied. The methodological approach used in this research contrasted sharply to earlier approaches used for the study of interdisciplinary, such as bibiliometric analyses, telephonic interviews, or reflexive accounts by participants. Most of the earlier empirical research about interdisciplinarity uses single method approaches.

For the nurture and analysis of interdisciplinarity within ZEF's Uzbekistan project, the roles of facilitator and investigator were packed into a single individual, which had potential limitations for biases, but extensive process documentation by various individuals in the forms of meeting notes and minutes, record of discussions, capacity building reports by the external facilitator, extensive record of researcher's own observations, interviews with research participants, and regular reflections on the data and processes provided sufficient safety valves against biases due to the combination of these two roles.

8.4 Building capacity to undertake interdisciplinary research

ZEF's structured capacity-building evolved into a training program comprising three dimensions: a) participatory but class room style step-by-step facilitated structured learning); b) unstructured learning through informal discussions with facilitators and supervisors as well as within teams; and c) learning while doing and reflecting. The stepwise incremental capacity-building program was designed to facilitate participant researchers' reflexive thinking about their own and their team mate's epistemic boundaries and biases, to recognize that each of the team members belonged to one or more of epistemic tribes, and thus boundaries and barriers did exist due to participant epistemologies, and that to actually validate and refine innovations, these boundaries needed to be crossed and overcome. Secondly, it attempted to promote interdisciplinarity in a gradual fashion by delivering skills and knowledge in discipline of participatory research. It left space for the research teams to adapt the learning to their team and individual needs. The training content was kept flexible and on the way got modified to incorporate emerging needs as those appeared. However, the design assumed that it had

no conflict with participant and project manager's priorities, which was unrealistic. It also did not consider that the project staff was located at two distant locations and that spatial distances could pose additional challenges in undertaking IDR. Many of the field based research staff, the ones who had to actually carry out the interdisciplinary tasks in the field, had missed the first training, which was about understanding and overcoming epistemic barriers. Likewise, many of those who were based at Bonn, were only able to attend structured capacity building events and could not become part of team learning while doing. The training intervals of six months led to some knowledge loss, which were to some degree compensated by organizing interim reflective sessions. During evaluations and interviews, some participants complained about a lack of opportunity to practice learned tools and methods. Participant evaluations indicate that capacity building influenced their epistemic grounds, but they expected more direct role by the facilitator as a "whistle blower", "external peer reviewer", "supervisor", as well as a "co-participant".

Since ZEF used project funds to further its strategic goal of carrying out interdisciplinary research, the important role that foundational conditions around the IDR exercise played in framing the experience of nurturing interdisciplinarity within ZEF's Uzbekistan project became clear as soon as the project started taking actions to achieve the ambition. The recruitment experience for the FTI facilitator showed that for ZEF as a research institute relying heavily on externally funded projects, recruiting someone from an unusual job market was particularly cumbersome. The delayed recruitment did not allow ZEF to nurture interdisciplinary in the way it had originally designed and ZEF had to proceed to implement the first FTI training without the staff member that was to carry the process further and thus had to forego critical inputs that the FTI facilitator's presence from the start could provide. Likewise, the key Urgench-based staff that had to actually carry the implementation process forward could not attend the first training due to complications with financing their travel. The critical role of foundational conditions in nurturing interdisciplinarity was also visible from the overtime participation of staff in FTI training events. In none of the trainings all participants from the previous training could participate, either due to financial and administrative reasons, or due to clashing field activities.

The literature discussion sessions as a follow-up of the critical discussions during the first training, could potentially act as a first bridge in narrowing epistemological gaps prevalent within ZEF's three departments, but these exercises resulted in creating confusion. The literature discussions were thought to create broader understanding on relevant conceptual, methodological and theoretical issues, and need for interdisciplinarity and integration of sources of knowledge. Since many of the Urgench based staff were not exposed to the critical discussions that took place during the first FTI training in Bonn on why interdisciplinarity was needed in the first place, they could not relate to the critical literature on agricultural adoption, system thinking, or hard and soft systems till the second FTI training, and found it burdensome, irrelevant, and unrelated to FTI. Part of these confusions could be due to the presenter's skills and the choice of literature, which largely belonged to critical realism. However, this experience also points to the complications in understanding due to varying epistemologies of the participants of these discussions.

The choice of innovations during the second FTI training for FTI process proved to be reflection of the past history of power distribution within ZEF, and was proportionate to the relative degree of research that the three departments had carried out in the project.

The experience following from training on facilitation and communication skills showed that learning soft skills required much more practice by research team members than learning hard skills. This became evident from the continuous desire to learn and practice more facilitation skills by the participants.

The combination of delivery methods (power point presentation, group work, energizers, visualizations and charts, discussions in plenary sessions) used during various trainings was found useful by participants. Thus, mixing and combing the delivery methods appeared to be a successful training strategy.

The participant expectations were generally met in almost all training events, but the last one, where participants expected more tools. However, the desire to learn more tools or

tools that precisely matched an FTI team's needs, suggested that a section of participants, the research assistants, desired rather prescriptive style of training. This once more points to the complexity involved in training staff on participatory and social science research methods of research in organizations where positivist analytical methods generally dominate and a hierarchical organizational culture prevails.

Despite the above-mentioned issues and challenges, the incremental, additive, and longitudinal design of capacity-building appeared to work in general for FTI teams. The gradual learning amongst all FTI teams about the complexity of their respective innovations, system complexity, importance of processes and process variables, and the need to adapt the innovations further to fit the local context did happen. The proponents of innovations, who initially believed that the innovation was "great" were found moving forward to understand that it is not the innovation alone that can address the problems Khorezmian agriculture faces, rather each of the innovation has to be tailored to work in a bigger context that is shaped by not only the variables addressed by a single discipline.

In a nutshell, ZEF's capacity building programs for inducing interdisciplinarity assisted most participants to understand and overcome epistemological and personal barriers, but could be further made effective through:

a) Ensuring the commitment from participants and their convenience to participate in terms of availability and addressing participant's motivational issues;
b) Ensuring that the actual "doers" of interdisciplinary research participate in capacity building initiatives right from the start;
c) Providing adequate opportunity for hands on practice for new skills and tools taught at various trainings;
d) Proactively acquiring and accommodating critical feedback on content, methods of delivery, timing of various training events and their use during actual IDR research; and
e) Ensuring unstinted support from the senior project management for interdisciplinarity.

8.5 Interdisciplinary Research within ZEF's Uzbekistan Project

The disciplinary composition of various IDR teams of the Uzbekistan project indicated that at the initial stages, there were considerable differences in terms of senior-junior mix, a condition that had the potential to create miss-understanding due to hierarchical differences (Stokols, et al., 2008). Also, as the project was largely populated by natural scientists and economists, availability of social science inputs posed a challenge. The project management attempted to resolve this challenge by inducting missing disciplinary expertise through nominating senior and junior researchers to fill disciplinary gaps. In such cases the motivation to learn was induced from outside against the advice from andragogists that adult learner's learning is effective when the motivation to learn comes from inside. The challenges of integrating junior members into the teams at the beginning stages of team formation can partially be attributed to the lack of internal motivation by some of those members, but also in some instances as a display of what Barbra Gray calls *Challenger Disaster* (Gray, 2008: S125), whereby team members having different views do not share their differential views due to power distortions within the team. Stokols and colleagues (2008) argue that member's incentives to remain involved in IDR should exceed personal costs they incur through their participation. The project could not offer additional incentives due to restrictions imposed by Bonn University and project donors. The training opportunities available in case of FTI appeared to be not enough incentives for the Ph.D. researchers, or senior researchers, some of whom decided to drop out during the course of IDR.

Facilitation attempts to assist the teams in participatory goal setting, which is believed to enhance team performance by encouraging feeling of inclusiveness among team members and providing them structure, connection, and shared beliefs as well as enhancing collective efficacy (Stokols *et al.*, 2008), prolonged the initial planning stages in case of three of the four teams. The preparatory and planning phases took disproportionately longer time than envisaged, leaving much less time for actual implementation and reflexive learning. Though these delays in the beginning were expected, making changes to the overall duration of the project phase was not in project management hands, as the

duration of the phase was fixed by the donors, and all the work had to be completed within the specified duration of three years, that appeared to be insufficient in this case.

The complexity of IDR (Klein, 2004), in terms of conceiving, discussing and communicating research and implementation ideas (Kostoff, 2002), role specification and actual implementation of activities (MacMynowski, 2007) became quite visible as the road maps, the first IDR exercise of each of the four teams, got revised several times in terms of content and methodology to proceed. In terms of interdisciplinarity, the teams after an initial period of two years adjusting to each other, and various team and leadership styles prevalent within each of the four teams, frequently and comfortably used terms and concepts of the participatory science, and to a large extent internalized these. All the teams used some of the taught tools and procedures as well. Tools that were disregarded, the teams forwarded logical reasons for not using these. However, in effect, only SA team was able to achieve its intended outcome of validating the innovation under real life setting, and WUA and SA teams were able to achieve critical interdisciplinarity, through peer reviewed interdisciplinary analysis of the experiences.

Overall, all the teams had common interdisciplinary learning, both in terms of means and forms of collaboration in several ways (Pohl and Hirsch, 2008). For example, the team members gradually started to use more and more same language reflecting various aspects of innovation testing and FTI team processes, though none of the teams prepared a glossary of terms suggested by Pohl and Hirsch (2008:115). Team members also referred to and used key theoretical concepts adapted to team specific requirements. All the teams attempted participatory monitoring and evaluation analytical model, though with varying levels of details and with mixed successes in doing so. WUA and SA teams generated integrated analysis of their respective innovation, and published it as analytical account of key aspects of their team process of innovation validation and testing. The forms of interdisciplinarity were use of common language and terminology, theoretical concepts, analytical model and output, and means of integration in terms of team deliberations and integration by sub-groups or individuals reflecting considerable

advances in terms of interdisciplinarity, if assessed by the methods of Pohl and Hirsch (2008).

What also became clear during the implementation and consolidation phases of IDR was the fact that since the effective implementation activities were largely undertaken by the Urgench-based research and support staff, the team's effective membership shrank considerably. Those based in Bonn, as well as Ph.D. students who completed their field work gradually withdrew themselves from the IDR. Those based in Urgench aspired for an IDR capacity-development and implementation model that was more "prescriptive" in terms of the use of taught concepts, tools, and implementation procedures. Thus, the members who were located far and had more hold on theoretical and critical aspects of interdisciplinarity gradually withdrew from the exercise as soon as the interdisciplinary research moved to implementation phases, and those based at field locations got more and more involved in action and did not consider "theoretical discussions" of much relevance. This is another dimension that needs to be addressed while discussing Stokols et al.'s, (2008) challenges faced by dispersed and collocated teams undertaking IDR.

The analysis of team stages after fifteen months of team working showed that the team members perceived their teams to frequently transition between norming and performing stages of Tuckman's Model (Tuckman, 1965). Dichotomy between member's fundamental and superficial epistemologies was identified during the survey of FTI member epistemic profiles. As each of the respondents was part of an interdisciplinary research team, they tended to respond to questions on the desirability and potential of IDR in a socially desirable manner, and therefore, tended to agree to project's desirable propositions that IDR was the way in which science could help resolve societal problems. This I call superficial epistemology. On the other hand, and more fundamentally, the team members belonged to the tribes of their own disciplines (Becher and Trowler, 2001) and believed that their own discipline alone was largely adequate in offering credible solutions to the prevalent problems in Khorezmian agriculture, which I call fundamental epistemology. Therefore it is important to recognize that team members engaged in IDR may retain fundamental and superficial epistemologies simultaneously. Any change in

fundamental epistemologies as a result of capacity-building is the intended change, but changes in superficial epistemologies can be deceptive, as these only reflect individual response to project's stated preferences. Besides, prevalence of this dichotomy of epistemologies amongst team members is an expression of member's belief that the difference of opinion might not be appreciated or tolerated by the project management or their peers. This explains the challenger disaster (Gray, 2008) that some of the teams faced due to the groupthink phenomenon prevalent in teams where project's senior management guided the discussions. Therefore, the involvement of senior management together with the staff they supervise in IDR teams needs to be exercised with caution.

Thompson Klein's instrumental IDR (Klein, 1990) in the case of FTI was limited to borrowing analytical procedures, tools, data and methods, for example stakeholder identification tools of ranking and scoring, or using Venn diagrams, or using hydrological, economic and social data sets. The initial tendency amongst the FTI teams with natural science innovations was not to use a social science tool. Such teams rather tended to rely on traditional paragraphed descriptions unless forced by the facilitator. Likewise, the social science team tended in the beginning to rely more on data generated through participatory rural appraisals and perception surveys. Towards the end, however, as the facilitators asserted the need for integration of sources of knowledge and approaches, all the four teams used data from natural, economic and social science disciplines in various proportions depending upon team needs. This points to the importance of mentoring, coaching, supervision, and peer review roles of IDR facilitation.

8.6 Facilitation, Reflection and Learning

One of the key characteristics of interdisciplinary nurturing in the FTI case was its multi-faceted facilitation. The facilitation role, though originally vested in one person, was in practice performed by several individuals. The dimensions of facilitation included supervision, coordination, mentoring, coaching, criticism and peer review.

Individuals other than the appointed facilitator often performed the supervisory and critical aspects of facilitation. The appointed facilitator, in effect acted as a resource person in some instances, and as a coordinator, as a coach, as a mentor, as a researcher, in several other instances. The facilitator also acted as a team member for two of the four teams which were facing acute shortage of staff due to departure of the required expertise in those teams. The facilitator, external facilitator, and the social science coordinator shared the event facilitation roles.

The sharing of roles on one hand made the interdisciplinary research experience more effective, as it pooled together the knowledge, skills and capacities of more than one person with diverse research and experience backgrounds. On the other hand, two of the four teams where the project's field coordinator provided inputs, got somewhat confused about the nature of interdisciplinary research they were to undertake. Likewise, the team, where the project's science coordinator was a member, faced teething problems till it managed to disentangle the two innovations that it aimed to test. This implies that when senior managers perform facilitation roles, they need to be cautious that their managerial thinking and their own epistemologies do not interfere with their facilitation responsibilities. Avoiding facilitation by managers would therefore be advisable.

8.7 Challenges and Barriers to Interdisciplinary Research

The teams faced several challenges while undertaking IDR. These are categorized along semantic, syntactic, pragmatic and foundational ones. For the FTI teams, the syntactic challenges included the lingual and terminological differences amongst social, economic and natural scientists, but also the styles of narratives and description of a problem, phenomenon or explanations and the language to report inferences drawn from the problem analysis.

An important dimension of the semantic challenges was related to hesitance regarding adaptation of tools from social science, and in the same way, the social scientists were found reluctant to make use of natural science tools. The disciplinary backgrounds and expertise of the team members provide an explanation to the degree to which the tools and methods from the participation science were used by natural and social science teams. The degree of motivation, therefore, to indulge into the processes beyond the expertise of the participants and accompany themselves with new tools, methods as well as theoretical concepts highly varied. This partly explains the lack of interest to pursue analytical writing by two of the four teams.

Most of the semantic challenges were experienced during the early to mid phases of FTI. From the later part of 2009 onwards, as the teams members became more stable as well embedded within their respective teams, they found languages to communicate to each other as well as got used to differential styles of communication and expression by their team mates belonging to other disciplines. Thus, it can be inferred that team building processes, whether through training or working together over a considerable period assisted the teams to overcome semantic challenges.

The syntactic challenges in the present inquiry were those related to the team vision of the purpose of the IDR exercise. The initial interpretations of IDR by the four FTI teams matched more the characteristics of what various scholars have labeled as "problem – solving science" in the sense that the teams intended to solve a practical problem facing Uzbek agriculture through their collaborative research and action exercise rather than undertaking IDR to initiate TRD for testing, validation and improving the innovations to further suit local reality. Despite having devoted substantial time, numerous meetings and two four-day training workshops on this question, it nevertheless became clear that the invested time and held discussions were not sufficient enough in clarifying the actual objectives and clear aims of the overall exercise at the beginning of the IDR exercise. Therefore, spending more time in the beginning to clarify the purpose and intent of IDR appears to be crucial.

The pragmatic barriers that at times influenced the rigor, frequency, and degree of IDR related to the late recruitment of the facilitator, and therefore, a lack of understanding by the participants of the first and the most critical training event about the nature and purpose of the entire IDR exercise. An over ambitious choice of launching four IDR teams by a project facing extremely scarce human resources availability, and then an attempt to fill these staff gaps by Ph.D. students, clearly compromised the otherwise achievable rigor of the IDR process. Owing to this overstretching burden on the project scientists, the participants had to multi-task a lot, which resulted into under-investment of time by most participants.

The most critical challenges were, however, related to the foundational conditions of ZEF, and its Uzbekistan project. The late start of IDR within the project only during its last phase clearly indicates a departmentalized view of interdisciplinarity at ZEF. It implied a thinking that the research problems could be researched first using disciplinary lenses during the first two phases and then these disciplinary solutions could somehow be made suitable for adoption within a phase through interdisciplinary research. The late recruitment of facilitator was not just a pragmatic problem, but was due to ZEF's inability due to Bonn University's directives, that ZEF could not offer a contract longer than a year to a project staff member, whereas the potential candidate wanted a project long contract.

In addition, since ZEF is not a career institute for researchers, the team leader of the WUA team and a senior groundwater scientist, two senior economists from the AF team successively, changed their jobs during the course of the IDR due to finding a better opportunity, which resulted in short term gaps in the team performance. In project management's attempt to overcome lean staffing, it involved Ph.D. students as co-researchers to various IDR teams. This strategy clearly did not work as the Ph.D. students only played a limited supporting logistical roles as they had their own research agendas, which were not always in line with the objectives of FTI. In the end, most Ph.D. students divorced themselves from IDR as soon as their knowledge acquisition needs were met.

Another foundational challenge was due to ZEF's lack of ability to retain staff beyond the tenure of project financing. All the capacities for disciplinary and interdisciplinary research that were generated through the tedious work over several project years, was just lost due to staff departures because the donors decided not to extend the project further and ZEF did not possess financial means to capitalize on those capacities for its future or other ongoing projects. Reliance on project funding as its main source for research funding incapacitates ZEF's in sustaining interdisciplinarity in its research.

The thesis brings out the key message that when achieving interdisciplinarity is a central aim for a research institute like ZEF, capacity-building may provide an induction avenue. However, to nurture and sustain interdisciplinarity in research, foundational barriers need to be overcome, without which an institute like ZEF will have to re-invent the wheel every time its projects require interdisciplinary research.

8.8 Implications for Theory, Methodology, and Practice

8.8.1 Implications for Theory

This research has several theoretical implications. The popular belief of epistemic boundaries, and resistance based on such grounds by the participant researchers to accept validity of concepts, methods, data or theorizations of other disciplines (Dressel and Reichard, 1970; Klein, 1990; Funtowics and Ravetz, 1993; Brewer, 1999; Golde and Gallagher, 1999; Becher and Trowler, 2001; Cash *et al.*, 2002; Conrad, 2002; de Boer *et al.*, 2006; Draggan, 2007; Barry *et al.*, 2008; Gray, 2008; Falk-Krzesinski *et al.*, 2010; Aram, 2011), and therefore resistance to interdisciplinarity, appeared to be a temporary one in the present case. The research team members in the beginning exhibited two types of epistemologies: superficial and fundamental. Superficial epistemology refers to a team member agreeing to the popular and socially desirable epistemology, displayed with a purpose to not disappoint the superiors or their team mates. Fundamental epistemology

refers to an epistemology of a team member that s/he might be having at a deeper level, for example, researchers' belief that their own disciplines are superior to other disciplines. This study shows that if the researchers undergo a carefully designed longitudinal capacity development program, and reasonable time is allowed for research teams to discuss and understand each other's epistemologies, coupled with team building events and collaborative working, regardless of epistemological affiliations, researchers' epistemologies from various disciplines appeared to converge. For example, during the latter half of collaborative working, the team members from various disciplines started to not only reconsider and adjust their disciplinary differences, but also were able to bridge their divides to a large extent, and two of the four teams produced analytical accounts of the IDR processes. By implication, through capacity-building and working on an agreed subproject, specialists from various disciplines do come together as teams and start performing narrowing the gap between their superficial and fundamental epistemologies.

The current scholarship interprets epistemology having a single dimension. This study argues that researchers might have their epistemologies along two different dimensions; i.e. superficial and fundamental. The epistemology as understood in the literature related to IDR refers more to fundamental dimension, and the superficial epistemology has not received due recognition in the literature. Individual scientists may show that they exhibit same epistemology as that desired by their team mates or project management if they believe that revealing fundamental epistemology might endanger their career or cause conflicts with their team mates or management. Many young researchers had their academic or work supervisors, or another academic celebrity, that inspired their thinking and thus followed the epistemic foundation of their celebrity. For example, the evidence presented in this thesis (Chapter 5) suggests that the research assistants were more active in teams where their supervisors were directly involved as key researchers in those teams.

Another key finding of this research is that while researchers themselves might expect from their respondents to provide unbiased answers to the questions posed by the scientists, they themselves replicated the behaviors of survey respondents without noticing it when they reported on their epistemologies. By implication, the social science

research methods deployed to understand behavioral aspects amongst sociological groups, including their underlying assumptions, are equally valid for researching members of scientific communities.

Another implication is that the conflicting epistemic foundations of positivists and constructivists sciences prevalent within the Uzbekistan project were not the deterministic barriers to interdisciplinarity in this case. The participating researchers were -more often than not - already practicing some degree of interdisciplinarity, though in an unstructured and un-informed way, as they co-worked with their peers and assistants on ground, and therefore, were more inclined to overcome their epistemological barriers unknowingly. Foundational and pragmatic barriers, such as the conditionality set by project donors or Bonn University, around ZEF's IDR determined and shaped what kind of, how much of and how deep IDR could be undertaken by ZEF.

The link between syntactic, semantic, pragmatic, and foundational challenges reveals that the syntactic and semantic barriers can be addressed to a large degree using an appropriately tailored capacity building approach. The pragmatic challenges are rooted in the way an organization is structured and how it relates to the rest of the world in terms of finances and management, which need to be addressed systematically for nurture and sustainability of IDR within a research organization like ZEF.

8.8.2 Implications for Methodology

Sociologists of science generally empirically assess interdisciplinarity using diverse methodologies. These methods include journal citation analyses, bibiliometric indicators, reflective auto-ethnographies by the participating scientists, interview research, institutional ethnographies and surveys of research. Most of the empirical research on interdisciplinarity tends to deploy a single method of inquiry. The methodological implication of the findings of this study is that using mixed research methods in an

embedded case study research has several advantages compared to relying on a single method.

In order to provide a 'grounded' evidence for an assessment of a targeted project that intended to induce interdisciplinarity through capacity building and its underlying premises, none of these methods was found enough alone. For example, without institutional ethnography, one would not be able to understand why several researchers divorced their interdisciplinarity and changed their jobs during an interdisciplinary collaboration about which they were very keen in the beginning. Without a review of process reports, the dynamics as well as the whys and hows of the process would not have been understood. Use of multiple methodologies and tools in this case assisted in triangulation of information as well as enhanced its internal validity.

Tentatively, it could be suggested that the research instruments deployed to understand an individual's epistemology in an IDR team should contain questions that are capable of identifying whether or not the differences between fundamental and superficial epistemologies exist. In this particular case, for example, since the self-reporting survey included separate sections on respondent's perceptions on the role of science for society and their views on their own disciplines, it could reveal contradiction in what the participants expected from science in general, and how their own discipline was embedded in the overall context of science in their own view.

Methodologically, two aspects need special mention. Firstly, the design of self reported survey instrument that placed questions, relating to views on desirability of IDR and views about researcher's own discipline's power to provide solutions, at considerably distant locations within the instrument helped to identify epistemological contradictions amongst participants. Secondly, this strategy acted as a triangulation method that identified biases in the survey due to tendencies amongst some participants to provide socially desirable answers. However, if the same survey could have been repeated overtime, as suggested by Stokols et al. (2008), the responses could have been statistically compared to establish the relationship between capacity development and

narrowing of the gap between superficial and fundamental epistemologies. Future research efforts should attempt to verify this link.

Another methodological implication of the study is that there are trade-offs between what is scientifically desirable and what is pragmatically possible when the process facilitation and process analysis tasks are vested with a single researcher. However, there are also trade-offs in the quality of data. If facilitator is also vested with the role of process researcher, he/she might have much deeper insights gathered from continuous process reflection as it happens, as well as access to information that otherwise might not be revealed by the scientists being studied by a researcher outside of the process.

The research on barriers to interdisciplinarity often tends to contend with taxonomic classification of barriers in various contexts. I show in Chapter 7 that a mere classification of challenges and barriers provides a critical realistic perspective only, and does not assist in identifying areas and approaches to intervention aimed at addressing those challenges. I show and argue that a relational analysis of challenges yields insights into identification of intervention areas and approaches. However, the relational analysis proposed here is just an approach that needs further application, testing, validation and refinement. The methodological implication would be that the future research should not only contend with yielding taxonomic classification of challenges only, rather it should expose these taxonomies to meaningful analyses.

8.8.3 Implications for Practice

The training about interdisciplinary research is generally imparted through the formal education models run by graduate schools (Morse *et al.*, 2007; Moslemi *et al.*, 2009; Karen *et al.*, 2010; Aram, 2011), or through single shot conference events (MacMynowski, 2007), or through interdisciplinary conferences and seminars (Morse *et al.*, 2007). Most of these capacity-building models are of a single focused event spanning over a single day or a few days, but in a concentrated time span. Such models require the participants to put their rest of the research tasks on hold for the duration of the capacity-

building. The content design of many of such initiatives is that a host of knowledge, skills, insights, frameworks, and tools are dumped on the participants, who are then left to decide whether or not to deploy these in their actual IDR practice. Besides, such training programs are of top-down nature, offering little or no feedback or monitoring mechanism of participant's actual practice.

As scientific research teams engaged in interdisciplinary research and action comprise not only scientists, but also managers and assistants, with varying levels of epistemic maturity working in an IDR project, inducing interdisciplinarity through a combination of "a few shots capacity-building" coupled with problem solving projects assists in overcoming epistemological challenges. However, it needs to be ensured that the participants achieve a comfortable level of understanding about the taught knowledge, and tools. The trainers, facilitators and project managers need to make sure that there are adequate opportunities available for the participants to practice the learned knowledge and skills.

The design of the capacity-building program to nurture capacity for interdisciplinary research needs to pay sufficient attention to the motivation of the participants, content of the training, choice of venue and timing, delivery methods and formats, facilitation roles and skills, as well as be flexible enough to incorporate the feedback from the trainees into the design of subsequent events.

Another implication is that the research organizations designed around a project culture may find it difficult to sustain interdisciplinarity. Thus, if organizations like ZEF aim at creating, nurturing and sustaining interdisciplinary capacity, they need to seriously question their own institutional environment as well as their recruitment, funding, and organizational sub-systems.

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