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# From ‘Plausible Promises’ to Transdisciplinary Innovation Research in Uzbekistan – Process Outline and Lessons Learnt



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## I. Introduction

In 2008, the ZEF-UNESCO project ‘Sustainable Land and Water Resources Management in Uzbekistan’ introduced the ‘Follow the Innovation’ (FTI) work package into the third phase of the project, with the aim to foster a participatory approach of testing, adapting and finalizing institutional and technical innovations. The so called ‘plausible promises’ in sustainable land and water resource management had been developed in the first two phases of the project largely in isolation

from the real-life situation of local stakeholders and were now to be adapted to the local needs jointly with the local stakeholders. Additionally, this participatory process of innovation research was thought to empirically test and thus contribute to the development of a concept for innovation diffusion in Uzbekistan (Hornidge et al, 2009, forthcoming).

## 2. The ‘Follow the Innovation’ Approach

Earlier research stresses the importance of innovations being deployed in the specific social, political and cultural context to guarantee their local functioning and achieve a sufficient degree of acceptance amongst potential users for increasing the likelihood of future adoption (Bijker, 1997; Bijker and Law, 1997; Oudshoorn and Pinch, 2003; Duncan and Barnett, 2005; Rath and Barnett, 2006; Hall, 2007). Furthermore, research within the ZEF-UNESCO project has also shown that Uzbek farmers themselves actively experiment in order to improve their yields (Wall, 2008). This experimenting takes place within the agricultural processes as well as the social and cultural realm in which agriculture is performed. Hence, the ‘Follow-the-Innovation’ component focused on the integration of scientific research on the one side and local and tacit knowledge of stakeholders on the

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other (Nonaka and Takeuchi, 1995) in order to refine the innovations. The 'lack of fit' was addressed by the designed approach (Mollinga et al., 2006) integrating stakeholder's knowledge and the innovations at hand.

### 3. From Design to Implementation

#### The Design

In designing this transdisciplinary research component, the project borrowed and broadened the 'Follow the Technology (FTT)' framework of Douthwaite (2002) to include not only technologies, but innovations of all kinds. The 'Follow-the-Innovation' approach, as we termed it, was therefore elaborated in a series of steps (Hornidge et al, forthcoming), deliberately leaving room for reiteration (the so-called 'validation loop') to ensure that the concerns of partners could be adequately addressed by the modification of the innovations. Participatory monitoring and evaluation (PME) was incorporated into the implementation cycle to verify whether the innovation in its revised form would continue to hold a 'plausible promise', or whether it would need to be further refined or shelved. In case of the former, further research would be required to understand the entire innovation system and to eventually develop recommendations for the extension and technical assistance agencies for further out-scaling.

#### Capacity-Building for Transdisciplinary Research

The FTI component was put into operation at the beginning of 2008, engaging a full-time facilitator and an external consultant, both with strong expertise in participatory approaches to innovation development and diffusion. While the facilitator accompanied and supported the whole participatory process and transdisciplinary research, the external consultant was hired for conducting a series of five trainings for developing the required

capacities of the project's scientific staff. For regular internal reviews and self-evaluations, additionally two interim review workshops, as well as literature discussions, team building events and a training on communication skills and group facilitation were held as listed in Table 1. (next page)

During the second FTI training, seventeen innovations were proposed for inclusion into the FTI process (Hornidge et al 2009). Of these, the participants selected five and formed four interdisciplinary teams around these, which later, together with the stakeholders evolved into transdisciplinary teams. The selected innovations comprised a) conservation agriculture for irrigated areas (CA); b) strengthening Water user associations through a social mobilization strategy (WUA); c) express salinity assessment with the mapping tool EM38 (SA); d) flexible irrigation scheduling (FIS); and e) afforestation of marginal farmlands (AF). As soil salinity is strongly linked to the issue of water availability, SA and FIS were combined and addressed by one team.

#### Defining the Innovations

The WUA FTI team defined the purpose of its innovation as to transform an existing, weak water users association (WUA) through a social mobilization and institutional development approach (SMID) into a well functioning WUA. The process was expected to lead to the inclusion of a large share of water users and their concerns into the decision making process of the WUA (Abdullaev et al., 2008).



The CA FTI team aimed at testing the basic tenets of conservation agriculture for irrigated areas (CA), which are no tillage, residue retention and crop rotation, with interested farmers. The goal was to identify benefits regarding water conservation and the enhancement of soil organic matter in comparison to the costs of inputs (Egamberdiev, 2008), as well as to adapt the innovation to the farmers' legal and resource limitations.

The initial aim of the Afforestation FTI team was to test in a real-life setting the potential of afforestation with the species Russian Olive (*lat.: Elaeagnus Angustifolia*), Elm (*lat.: Ulmus Pumila*) and Poplar

(*lat.: Populus Euphratica*) on marginal lands and to demonstrate it to farmers and policy makers as a profitable land use alternative (Khamzina, 2006; Lamers et al., 2008).

The primary aim of the SA FTI team was to create awareness about the use of EM38 as an express salinity mapping tool amongst the potential stakeholders and compare results with conventional methods used in Uzbekistan. The aim of flexible irrigation scheduling was to further develop the concepts for irrigation scheduling based on actual field characteristics (Akramkhanov, et. al., 2008).

Training Title/ Location	Timing	Focus	Number of Participants
FTI-I (Bonn)	February 2008 (4 days)	<ul style="list-style-type: none"> <li>• concepts and approaches to innovation diffusion</li> <li>• multi-, inter- and trans-disciplinary research</li> <li>• hard and soft systems thinking</li> </ul>	20 scientific staff
Research Discussions (Bonn, Urgench)	February 2008 to October 2009	<ul style="list-style-type: none"> <li>• discussion of conceptual papers on innovation development and transdisciplinary research</li> </ul>	Variable depending on availability
FTI-II (Urgench)	May 2008 (4 days)	<ul style="list-style-type: none"> <li>• stages and activities of the FTI approach</li> <li>• participatory research methods &amp; tools – selection of innovations for FTI</li> <li>• formation of transdisciplinary teams</li> </ul>	22 scientific staff
Effective Communication and Facilitation Skills (Urgench)	August 2008 (0.5 day)	<ul style="list-style-type: none"> <li>• skills in effective communication</li> <li>• skills in team facilitation</li> </ul>	14 scientific staff
Team Building (Urgench)	August 2008 (0.25 day)	<ul style="list-style-type: none"> <li>• Activity based team building exercises</li> </ul>	21 scientific staff
FTI-III (Urgench)	November 2008 (4 days)	<ul style="list-style-type: none"> <li>• review &amp; reflection on initial FTI implementation</li> <li>• learning additional participatory research methods and tools and developing skills in using them</li> <li>• re-assessment of the organization and working of FTI teams</li> <li>• re-design of strategy where needed</li> </ul>	21 scientific staff
Interim Review- I (Urgench)	May 2009 (2 days)	<ul style="list-style-type: none"> <li>• critical review of progress</li> <li>• planning of further steps</li> </ul>	22 scientific staff, 3 stakeholders
FTI-IV (Urgench)	November 2009 4 days)	<ul style="list-style-type: none"> <li>• critical review of FTI implementation</li> <li>• participatory impact assessment, methods and tools</li> <li>• review of FTI teams and their functioning</li> <li>• discussion of inclusion of additional innovations into FTI</li> </ul>	15 scientific staff 7 stakeholders
Interim Review II (Urgench)	April 2010	<ul style="list-style-type: none"> <li>• critical review of progress</li> <li>• planning of further steps</li> </ul>	11 scientific staff
FTI Write Shop (planned in Bonn)	January 2011	<ul style="list-style-type: none"> <li>• Currently being planed</li> </ul>	Not applicable

Table 1: FTI Capacity-Building Events



### Identifying Stakeholders and Designing Joint Experiments

Three of the four teams – WUA, CA, and AF – identified farmers as their primary stakeholders, whereas the fourth team identified higher level salinity mapping organizations as partners for cooperation. Additionally, each of the four teams elaborated innovation specific stakeholder engagement strategies comprising a series of sequential steps (Ul-Hassan and Hornidge, forthcoming).

The WUA stakeholders argued for a broader approach of WUA strengthening, namely a blend of ‘hard’ and ‘soft’ interventions. They claimed that minor repairs of the WUA office would give the WUA a ‘face of recognition’, while the provision of bicycles would facilitate the mobility of the water managers and thus the interaction with water users. Additionally, a computer and printer were to facilitate the record keeping. Consequently, the WUA stakeholders came up with a 12 step WUA improvement plan (Abdullaev et al., 2008) covering next steps, timing, inputs, finances, as well as the division of responsibilities. The

ZEF project was responsible for a) providing trainings for the WUA; b) a study tour to well functioning WUAs in Ferghana Valley; c) financing office refurbishment and bicycles; and d) collection of hydrological and other monitoring data. The WUA on the other hand was responsible for: a) identifying social mobilizers and undertaking social mobilization efforts in the WUA; b) inventorizing WUA assets; c) convincing farmers to build hydroposts; d) carrying out its routine operation and maintenance tasks; e) approaching higher level authorities for the provision of canal cleaning equipment; and f) sending monthly progress reports to the project.

Within the CA team, the CA expert and team leader held several rounds of informal discussions with farmers regarding joint experiments and the division of roles and responsibilities. This was then followed up in regular field visits, phone calls and clarifying discussions on the nature and content of the proposed roadmap. During these interactions, main attention was paid to the technical aspects of the collaboration and far less on the process of interaction or different conceptual approaches to innovation development. So while the objectives of the interaction were formulated as to a) conduct joint experimentation; b) monitor and evaluate CA adoption; and c) refine and disseminate CA on a regional scale, the roadmap to implement the process was written first by the scientists for later discussion with farmers only.

The AF team from the onset closely collaborated with a local forestry expert, who – keen to learn about the differences between the scientifically developed innovation and farmers’ real-life situations – became the team leader. Important determinant for the timing of cooperation was the availability of the selected specie saplings, negotiated with the local branch of the Forest Research Institute (FRI). Between November 2008 and March 2009, the farmer selection process was finalized through field visits during which farmers’ interests were explored and the land screened for suitability. One concern for all farmers was the obtaining of a state permission to grow trees on land, registered by the state as productive while in fact being highly saline. While initially the farmers agreed to approach the authorities themselves, it soon became clear that it would be more effective if the project



hydro-technicians according to the hydrographical layout of infrastructure thus making them responsible for a group of farmers within their hydrological jurisdiction; b) approving the budget and the proposed water plan, c) appointing a conflict resolution committee and a water inspector; d) shifting the informal responsibility for the operation and maintenance of pumps to the farmers whose lands were irrigated by pumps – addressing the problems in the recovery of electricity bills from farmers due to cash unavailability;

wrote to the authorities soliciting the permission to release these lands from state crop production for afforestation.

The SA team, however, struggled with gauging the interest of the identified stakeholders until mid 2009 when finally a series of meetings with identified stakeholders were confirmed. Hence the project researchers presented the idea and the previous results from the use of EM38. Although several contacted stakeholders showed interest, only the Central Asian Irrigation Research Institute (Russian Acronym: SANIIRI) followed it up, resulting in a formalized collaboration.

### Joint Innovation Testing and Adaptation

While the implementation of joint experiments had already begun, the formal agreements of collaboration were signed between January and July 2009 in English and Uzbek between the four FTI teams and their respective stakeholders. Overall the stakeholders provided land, manpower and other on-farm/ institute facilities free of charge, while the project covered small investment costs, training and monitoring costs and counterbalanced the farmers' risks, for example in the case of CA the risk of weed infestation.

In January 2009, the cooperating WUA convened its first ever general assembly approving the 12 step WUA improvement plan as well as the following proposals from the WUA management: a) nominating

e) providing labor by farmers to clean canals and drains; f) requesting the water management organizations (WMOs) to provide machinery for the canals budgeted by WMO but managed by the WUA; and g) rotating the water supply on a turn-by-turn basis between the two WUA canals in case of water scarcity. Since outstanding water payments continuously led to outstanding salary payments of WUA staff, the WUA additionally began to charge kitchen garden water users a flat cash rate for irrigation (UZ Som 2000 per user<sup>4</sup>).

For the CA team, the farmers allocated plots for testing and subdivided these into an experimental and a conventional plot. While the farmer would grow crops using conventional agronomic practices, the experimental plot was cultivated according to CA practices. Some elements of the experiments were however changed based on the farmer's suggestions. As such the seed rate for winter wheat was increased in one case. In another case, herbicides were applied during the second crop growth to suppress the weed population. Furthermore the fertilizer doses and residue amounts were adjusted in some cases by mutual agreement.

<sup>4</sup> According to the official conversion rate on September 02, 2010 this converts into Euro 0.97 (Source: [http://coinmill.com/UZS\\_calculator.html](http://coinmill.com/UZS_calculator.html)).

The SA team, after signing the agreement with SANIIRI, tested the EM38 equipment at SANIIRI's research station in Khonka district, for which SANIIRI provided salinity assessment data obtained by its common soil sampling techniques. In the field, the FTI researcher explained the technical details of the device, the measuring principle, the depth of signal penetration depending on orientation mode of the device, and the method of calibration. Additionally a project's field assistant demonstrated the device calibration before taking measurements and assisted with further EM38 and GPS measurements where needed. The SANIIRI researcher was supported by two assistants for soil sampling to compare the results. Altogether 20 locations were sampled and measured using the conventional methods as well as EM38. Soil samples were taken to SANIIRI for further analyses. By mid December 2009 the collected data were analyzed and a draft report was shared with the project in mid January 2010. SANIIRI felt that the equipment needed to be tested in several locations and proposed to undertake similar measurements at their own cost in the Syr Darya region, to which the project agreed. These measurements were ongoing at the time of writing.

For the AF team, the start of the field activities was considerably delayed by the final selection of the farmers and negotiations about species and planting methods. Although late planting (exacerbated by the early arrival of spring) was feared to cause poor tree survival, it was mutually decided to initiate the implementation process and planting was accomplished in two marginal sites on 20th and 26th of March, 2009. The late planting brought about the concern of water availability for post-planting irrigation. Due to the specifics of water turns assigned to the farmers, the irrigation was exceedingly delayed and added to the stressful conditions of the saline soil on the saplings. By mobilizing social capital, one of the two farmers was able to get irrigation water on time, whilst the



other farmer could not and the project decided to assist in approaching the responsible authorities. This resulted in assuring the arrival of the first irrigation on time. The initial planting was then followed up in regular field visits during which the trees' conditions and survival rates were observed and discussed with the farmers.

### **Participatory monitoring and evaluation**

Within the WUA team the monitoring arrangements were two-fold: a) the lead social mobilizer was responsible for submitting a brief monthly progress report to the project partners, and b) project staff would collect data on water availability, distribution and use and provide these to the WUA. The WUA's own financial and water management records were also monitored. The progress reports by the social mobilization group were submitted on time, but merely reported success stories while neglecting the challenges the WUA continued to face. A WUA performance discussion meeting on 24 July 2009 with farmers and WUA staff as well as a water user perception survey were used as additional tools to assess the outcomes.

The CA team largely regarded monitoring and evaluation as a scientific evaluation, whereby the CA researchers identified and assessed indicators. Regular data collection activities in the field had been launched to monitor input and water use as well as crop growth. To supplement these scientific assessments

of the innovation (not the transdisciplinary process), the research team arranged a field day at the cotton research institute, where elements of CA research trials were ongoing. This was thought as a possibility for the visiting farmers to assess elements of CA.

The SA team, as outlined earlier, decided to let SANIIRI collect and analyze data of the equipment testing itself. Cautionary explanations were provided that peer reviewed research existed explaining the relationships between technical parameters of soil and accuracy of the estimates. However, the SANIIRI scientists produced elaborate research reports double checking these.

The AF team's monitoring design comprised monthly visits by one team member to all three sites to monitor the germination, establishment and growth of trees and discuss with the farmer specifics of their experience and in-between agronomic practices. The team leader paid visits to these farmers once every year and occasionally provided advice over the phone to the regularly visiting staff member, who then conveyed this to the farmers.

#### 4. 'Plausible' or 'Implausible Promises'?

The monitoring reports indicated that the WUA performed well during the first year, especially regarding hardware interventions. The WUA office was refurbished, most farmers had installed hydrometers, the inventory of infrastructure was completed, the pumps were transferred to farmers, and the shared canals and drains had been cleaned. In preparation for droughts, the lake was filled with water whenever water was abundant. The year 2009 however was a water abundant year, in which the WUA received 275 % of its planned water supply between July and September.<sup>5</sup> Merely a hydrological water users' federation along the main Zey Yop canal was not formed, as originally intended, as upstream WUAs were not interested.

<sup>5</sup> The filling of lakes thus counteracted as it led to a rising of groundwater to the root zone of crops. The farmers had planted an earlier maturing and drought resistant variety of cotton, which badly failed. Twenty of the twenty-one farmers could not meet their state plan and thus got into debt.

The WUA staff supposed to have raised the water users' awareness about the WUA, while farmers continued to ignore WUA's rules and took water when needed. The efforts for strengthening the WUA in the first 6 months were characterized by a high degree of enthusiasm. Nevertheless the heavy work load of the WUA staff for installing pumps and solving electricity problems negatively impacted the time invested into awareness raising measures amongst water users. Furthermore, fee collection from water users remained difficult. Until June 2009, only 15 % of the fees for kitchen garden owners and 15-20 % for commercial farmers under state-plan could be collected. The total outstanding debt of the farmers to the WUA was estimated as around 2.5 million Uzbek Soms.<sup>6</sup> Some farmers claimed that they had paid, but possessed no record of payments since part of their farm was previously cultivated by someone else.<sup>7</sup> The WUA identified the farmers' perception of the role of the WUA and of water being a free of charge resource as main reason for the arising water management problems. According to the farmers, nevertheless, it was the WUA's task to provide irrigation water in accordance with the crop demand and timing, and without the users' involvement (comparable to the water master during Soviet time). Overall the perception survey indicated that while an increasing number of commercial and household farmers were aware of the WUA's existence, the aspired feeling of ownership and identification of the WUA as an organization of the water users had not been achieved.

The CA experiments indicated the following findings: a) any changes in the application rates of fertilizers, e.g. non-use, or varied amounts of nitrogen, were highly questioned by farmers, irrespective of whether it might yield better results; b) the farmers did not

<sup>6</sup> According to the official conversion rate on September 02, 2010 this converts into Euro 1213.85 (Source: [http://coinmill.com/UZS\\_calculator.html](http://coinmill.com/UZS_calculator.html)).

<sup>7</sup> In November-December 2008, a 'farm optimization' program by the central government merged cotton and wheat farms (10-25 ha) into farms of an average size of 75 ha. This change meant that many of the old farmers who had to pay debts were no longer farmers, and thus the WUA had no mean for cost recovery. The only way to collect defaulted amounts from such farmers was by launching a time- and finance-consuming law suit.



distinguish between plowed and unplowed winter wheat plots, whilst the tillage practice and retention of crop residues on cotton plots attracted wide attention; c) farmers expressed their interest in receiving a cost-benefit analysis on cotton sown under CA; d) since planting of wheat on cotton fields is a common practice, farmers saw no difference between their practice and the researchers' suggestion. Consequently, the status of wheat stand was not associated with the level of crop residues, which indicated the need for better arguments to convince farmers to retain residue, as the effect of residues on soil improvement could not be evaluated visually only. Therefore, alternative solutions for crop residue management (e.g. length and amount of residues left from harvesting; fuel wood substitutes) should be offered to farmers in the future, complementing the prevalent use of residue as livestock feed and fuel. Furthermore, winter wheat could be planted as part of CA (like minimum tillage into cotton or surface seeding into rice).

Regarding the validation of EM38, SANIIRI's analysis indicated that EM38 was – with some caution – accepted as a valid tool for rapid salinity assessment over large areas. While the device performs well on average soils, it nevertheless needs to be further calibrated for sandy soils. As next step, the team plans to discuss the results with the technical specialist of SANIIRI and carry out a matrix ranking of various methods of soil salinity assessment in comparison with EM38.

The AF experimentation on all sites experienced a germination rate of the trees less than expected. While on the site, where Poplars were planted as field borders, the trees did not at all germinate, on the other two sites, Russian Olives germinated and grew better than the Poplar and Elms. From the researchers' perspective, the following reasons could be identified: (a) according to the agricultural season late planting, (b) inaccurate planting of the cuttings, (c) choice of species along cultural and economic parameters rather than ecological (i.e. degree of salinity). The later two, according to the researchers, could partly be explained with the limited farmers' experience in growing trees for plantation purposes and would require further capacity development in the future and importantly before the actual planting. Furthermore it became

clear that the interaction process had not been able to build the hoped for degree of ownership amongst the farmers, meaning that despite a clear division of responsibilities, roles and input provision at the beginning, the farmers (and seemingly the researchers, who implicitly agreed to meet these expectations) largely perceived the experiments as the researchers' trials and consequently relied on the researchers to manage and look after the plantations.

## 5. Concluding Remarks & Lessons Learnt

The project's approach to the development of agricultural innovations comprised a stepwise transition from multi- to inter- and finally transdisciplinary research. The scientists developed innovations and assessed their scientific promise through a multi-disciplinary approach. Once developed, the group of scientists screened and ranked innovations using an interdisciplinary approach in a participatory manner with an intention to field test, and adapt accordingly the selected innovations under real-life conditions. This was accompanied by a stepwise capacity-building of scientists, which was undertaken through a series of workshops and continuous facilitation of the processes.

The above illustrates the degree to which a participatory transdisciplinary process to innovation development and diffusion in post-Soviet Uzbekistan poses a challenge while at the same time an absolute necessity if locally acceptable innovations are to be developed. As such, the Follow-the-Innovation experience has generated a number of lessons both for the validation of the chosen innovations as well as the designed approach.

As far as the innovations are concerned, it became clear that relatively simpler innovations, such as the use of the EM38 equipment as a tool to monitor and map salinity, can be easily verified under any setting within a relatively short period of time, provided the right stakeholder is identified. The simpler technical innovations which nevertheless are time-intensive in their implementation (i.e. growing trees), can neither be technically nor socio-culturally validated in 3 years. Relatively complex technological innovations, such as conservation agriculture, which have both

technical (laser leveling, raised beds, specific planters and cultivators, etc.) and institutional (suitability for specific cropping systems, state push for monoculture of key crops, competing uses of crop residue as fodder and fuel) imperatives will require far more time than the given 3-years to validate and locally adapt. Same holds true for institutional innovations, such as the strengthening of WUAs through social mobilization. Designed around a single hypothesis it might prove working in the beginning, but the long-term validity can only be assessed after the innovation has moved from joint experimentation to a 'laissez faire' interaction between researchers and stakeholders during which the innovation sustains, develops further and potentially even spreads to other WUAs. Even if fully validated, the CA and EM38 innovations will continue to face the problem that the required equipment is cost-intensive and beyond the reach of targeted stakeholders. This problem of high- versus low-external-input technologies (Röling, 2009: 25ff) poses an immense challenge for wide scale adoption.

With regard to the four FTI processes, the main challenges faced have previously (Hornidge et al forthcoming) been assessed by differentiating between (a) knowledge creation and dissemination in rural Uzbekistan, (b) administrative challenges, (c) scientists' versus farmers' knowledge, (d) team composition and organization, (e) contested transdisciplinary cooperation. While this categorisation still holds, we identify several practical lessons learnt in the following. These range from easy to implement practical lessons to content challenges which partly originated from the practical issues identified: (1) The participatory, transdisciplinary process to innovation research was launched in order to adapt the project innovations to the local setting. The relatively late introduction in terms of the project cycle (6 years into the project) nevertheless meant that the innovations had already been developed to a substantial degree within the ivory tower of a scientific research project and the possibility for modifying the innovations according to the farmers' needs was limited. The space for choosing an entirely different innovation or agricultural sub-sector to be innovated by addressing aspects, in which the farmer's legal (in terms of the individual's decision-making power) and financial 'window of opportunity' (Röling 2009) to innovate

might be bigger or more clearly defined, did not exist anymore. Consequently and despite all four teams incorporating to some degree the ideas and opinions of the stakeholders into the innovations<sup>8</sup>, the attempted 'participatory innovation adaptation' developed into a 'participatory innovation validation'. (2) Furthermore and also due to the late introduction, the overall transdisciplinary process was merely given a time span of 3 years. Yet, as trust forms a crucial basis for the exchange of different types of knowledge, and especially of implicit, tacit knowledge, while trust building takes time, 5-6 years would have been the possible minimum. (3) Besides time, the nurturing of a participatory, transdisciplinary process to innovation development requires substantial financial resources and well trained local staff, who is able to bridge the gap between foreigners and locals, as well as researchers and farmers. Staff continuity is therefore important. (4) The relevance of the transdisciplinary process with regard to the overall project aim and therefore the roles and responsibilities of the team members should be clarified right from the start and consequently appropriate time allocated. All four outlined FTI processes were regularly disrupted by conflicting scientific and teaching responsibilities which drew the attention of the staff. (5) Regarding role distribution, it became obvious that the initial decision by the teams to identify the senior scientist either responsible for the development of the innovation or coming from the same discipline as team leader proved not always useful. Instead the created vertical hierarchy along the lines of technical expertise rather than process knowledge proved highly demotivating for other team members while at the same time it became obvious that good researchers are not necessarily good facilitators of participatory transdisciplinary processes. This led to a separation of process and technical leadership in 3 out of 4 teams. (6) Continuous project-internal as well as punctual external facilitation, building the capacities for and adding legitimacy to nurturing the participatory transdisciplinary processes proved extremely useful.

<sup>8</sup> The WUA team adjusted its innovation focusing on 'soft' aspects only to a suggested blend of 'hard' and 'soft' attributes. The CA team accepted the fertilizer and seed rates as well as crop choices suggested by stakeholders, and the AF team incorporated farmers' suggestions on agroforestry practices and species.

While team members initially debated the innovation specific process design rigorously, it could nevertheless be observed that they gradually got caught up in the process itself, neglecting adequate reflection and thus not making full use of the learning opportunity presented. This correlates with research findings on action based learning (Markham, et al, 2003). Consequently and with the processes proceeding towards greater interaction with the stakeholders, the tendencies to look back critically and identify gaps and loopholes reduced. While the series of FTI training aimed to explicitly address this issue, the team presentations and discussions during the meetings indicated the difficulty of self- and process criticism (Veldhuizen et al., 2010). A mitigation strategy that proved useful was to review the four process documentations of the teams through the FTI facilitator, the social science coordinator and the external consultant facilitating the training series and as such assist in indicating points for critical reflection. To facilitate critical analysis further, the team members were helped to analyze their own process documentation in an attempt to prepare analytical publications based on their experiences. The later also acting as incentive for the researchers. (7) While this reflection based on the process documentations proved useful, it also brought to light, that the whole idea and process of documenting the processes of interaction had been interpreted by each team differently, and the level, focus and detail of the documentations varied greatly. In retrospect a lot more time on clarifying the need and purpose of, besides fostering, also documenting the transdisciplinary processes should have been spent. (8) Connected to this, continuous capacity building and development in participatory methods and concepts of transdisciplinary innovation research within the interdisciplinary teams of researchers as well as the transdisciplinary teams with stakeholders proved elementary. A great challenge therefore posed the high degree of staff and expertise transitions that drastically influenced the performance of the interdisciplinary teams (WUA, SA and AF)<sup>9</sup>. (9) Yet, one of the key process challenges with regard to content, but influenced by the practical process challenges mentioned, was the identification of stakeholders and engaging them in a systematic way. The SA team, as the only team of all four, undertook a systematic and

in-depth analysis of stakeholders, their mandates and perceived benefits in joint experimentation, which consumed most of the first year of the FTI process. Other teams restricted their choice of stakeholders by selecting stakeholders that had previously interacted with the project, yet generally to a lesser degree and with a different purpose (WUA, CA, AF). In most cases (CA and AF), this resulted in a lack of ownership on the side of the stakeholders from the start (as in previous interactions, the stakeholders' ownership in the nature of interaction had not been of immediate importance, but was concentrated on the technical nature of the innovation only). We therefore learned that significant effort and patience should be allocated for identifying stakeholders and, together with them, fostering and continuously negotiating the overall process.

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<sup>9</sup> Amongst the senior staff, two senior economists, two senior water management specialists, and a tree specialist changed their jobs during the course of the initial two years. Some of these vacancies were re-filled, but the replacements had missed the earlier discussions and trainings, and thus lacked the interest and required exposure to the FTI process. Overall, and for various reasons, the number of project staff involved in FTI in 2008 and reduced drastically by the end of 2009 in almost all cases (WUA from 10 to 5; CA from 14 to 4; SA from 9 to 3; and AF from 7 to 5).

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