

## BioDIVA – Transformation knowledge for equitable and sustainable use of agrobiodiversity: Building inter- and transdisciplinarity

Martina Padmanabhan, Melvin Lippe, Monish Jose, Isabelle Kunze, Hannah Arpke and Lydia Betz

*Leibniz Universität Hannover, padmanabhan@umwelt.uni-hannover.de; lippe@umwelt.uni-hannover.de; jose@umwelt.uni-hannover.de; kunze@umwelt.uni-hannover.de; betz@umwelt.uni-hannover.de; arpke@umwelt.uni-hannover.de*

**Abstract:** *The trans- and interdisciplinary research project BioDIVA aims to generate transformation knowledge towards a gender-equitable and sustainable use of agrobiodiversity. Approaching agrobiodiversity from the disciplinary perspectives of land use change, institutions, sociology, economics and ecology establishes per se a ground for an interdisciplinary analysis of the boundary spanning complexities. Using the case of rice-diversity in Kerala, South India, the paper outlines the initial steps to establish a research design for a transdisciplinary understanding of the dynamics of agrobiodiversity loss. Setting out for a four-year expedition to create a development perspective for farming communities and other actors involved in the upland rice farming system, we present the first BioDIVA research phase, where we approach the theoretical and methodological integration of disciplinary schools to achieve the joint development of a research design. We present the first results of integrating disciplinary theoretical assumptions of natural and social sciences on a conceptual level, and reflect on the process and tools to identify the specific perspectives and interdisciplinary intersections. This prepares for the confrontation with the field in an explorative case study as a means to build a thorough common ground at the very beginning of BioDIVA. The paper is structured as follows: 1) We introduce the key terms, which guide our research, 2) reflect on transdisciplinarity as a research paradigm, 3) explore the knowledge domains while presenting tools for generating disciplinary perspectives by merging them into intersections, 4) reflecting on the process, we proceed to build an interdisciplinary framework to prepare the transdisciplinary integration.*

**Keywords:** *transdisciplinarity, interdisciplinarity, agrobiodiversity, gender equity, sustainability, rice, methods*

### Introduction

The BioDIVA research group is part of the social-ecological research programme (SÖF) on inter- and transdisciplinary sustainability issues funded by the German Federal Ministry of Education and Research. Integration of both practical and disciplinary knowledge is understood as an explicit methodological challenge and training task. This paper aims at two goals simultaneously: on one hand it reflects the methodological steps taken towards inter-and transdisciplinary integration, on the other hand it demonstrates this process towards the outcome of our specific research problem: how to achieve a sustainable and gender-equitable use of agrobiodiversity in the case of rice in India.

Agrobiodiversity is the result of the interaction between human and natural systems since the beginning of agriculture. Loss of adapted species, varieties and genes not only reduces the potential to respond to climate change but also counteracts the balance in traditionally established farming-systems, hence affecting food security. The problem situation is characterised by the pressure on marginalised indigenous population groups from economically more favourable cash crops with multiple ecological consequences.

The paper is structured along the steps we took in the process of developing inter- and transdisciplinary following suggestions of Defila and Giulio (2003) and Defila et al. (2006).

Along this line, we will present the intermediate outcomes of each working session and underlying conceptual task. The identification of key terms within BioDIVA as a joint effort set the problem orientation at the centre. This distinct focus on life-world situations asks for a reflection of the transdisciplinary nature of BioDIVA. Returning to the central topics of sustainability and gender

equity, agrobiodiversity and rice, the disciplinary view on key terms are given prominence and illuminate their many perspectives. The top three disciplinary views on key terms are then merged into a disciplinary mind map where bilateral dialogues between disciplines identify interdisciplinary intersections. The disciplinary dimensions and the intersections make up the ingredients for a common BioDIVA conceptual framework that forms the base for a concerted research design.

The identification of the key terms was based on the overarching research question: “How to achieve sustainable and gender-equitable use of agrobiodiversity in the case of rice in India?” The involved disciplines of land use change and ecology as natural sciences and resource economics, sociology and institutional analysis as social sciences are asked to spell out their disciplinary view on the central concepts. While sustainability and gender-equity are obviously normative in content, agrobiodiversity with its target plant rice (*Oryza sativa*) stresses the ecological side.

**Agrobiodiversity** is the diversity and variability of living organisms, which contribute to food security, agriculture and the related knowledge base (Jackson et al., 2007). The dual identity of agrobiodiversity as a natural resource and simultaneously as a cultural asset with social characteristics is a social-ecological phenomenon per se and requires differentiated and other approaches than general conservation of biological diversity. The silent replacement of local varieties by high-yielding ones results in a thinning out of the genetic base on which future breeding efforts, i.e., for the mitigation to climate change, rest. The unintended consequences of the agro-industrial success endanger the biological resource diversity in agricultural crops. An unsustainable farming system imperils the historical and cultural fruits of farmers’ breeding activities over centuries.

**Gender** refers to the socially assigned roles with the associated biological distinction between men and women. The strong integration of women in complex farming-systems has traditionally granted them status, which is undermined by market integration (Murthy, 2001). While in the debate on biodiversity, women’s knowledge gains increasing attention (GTZ, 2002; Howard, 2003), existing policies do not reflect the situation of marginalised women, who through their knowledge could occupy a central position in sustainable utilisation of agrobiodiversity. Genetic erosion poses a particular problem for women, who are in the position to use and conserve agrobiodiversity through their local knowledge while contributing to food security and income generation (Agarwal, 1991).

**Sustainability** is a concept, which needs to be broken down to concrete strategies to attain meanings beyond the call for intergenerational justice. Sustainability has to be practiced on many levels and across various sectors, while the conservation of ecosystems and biodiversity features prominently. The Indian national sustainability strategy focuses on the development of sustainable and productive land use systems, the protection of natural resources and ecosystems and the development of gender-equitable participation and conflict resolving mechanisms (Mital et al., 2005). In India sustainable development in conjunction with advanced regulations on utilisation reduces the pressure on common goods for the global sake.

**Rice** is the staple food in South India. The state of Kerala with its high diversity in rice landraces in the uplands is an exemplary case of continuous cultivation by marginalised indigenous groups, despite sinking prices and increasing conversion of land for plantations like bananas (Kumar, 1995; Kumar et al., 2003; Kumar, 2005). Rice cultivation is used to structure the agrarian relations, the ecosystem and the landscape. The observed change in land use is accompanied by degradation of the agroecosystem and the transformation of gender relations.

## Transdisciplinary reflections

Transdisciplinary research emphasises the co-ordination of all disciplines and interdisciplines involved in the education-innovation system on the basis of generalized axiomatic and emerging epistemological patterns (Erich, 1972). Pohl and Hirsch Hadorn, (2007) state that transdisciplinarity is needed when knowledge about a socially relevant problem field is uncertain, when the concrete nature of problems is disputed, and when there is great deal at stake for those concerned by the problems and involved in dealing with them. It links abstract and case specific knowledge and

constitutes knowledge and practices that promote what is perceived to be the common good. The use of transdisciplinarity is imperative in those kinds of complex heterogeneous domains like agrobiodiversity in which human systems interact with natural systems (Thompson Klein, 2004). In general, transdisciplinary research (Hirsch Hadorn et al., 2008) has been related to three types of knowledge: (i.) system knowledge which concerns the genesis, further development and interpretation of a problem in a life-world of empirical processes and interactions of factors including the interpretation given to these in the life world – the current status, (ii.) target knowledge determining and explaining the need for change, desired goals and better practices – the target status, and (iii.) transformation knowledge, referring to technical, social, legal cultural and other possible means of acting that aim to transform existing practices and introduce desired ones - how to make the transition from the current to the target status (ProClim, 1997).

As BioDIVA aims for transformation knowledge to promote gender-equitable and sustainable use of agrobiodiversity, it attains a transdisciplinary focus and falls into the following domains of transdisciplinarity: (i.) concentration on a life-world problem, (ii.) transcending and integration of disciplinary paradigms, (iii.) participatory research, and (iv.) search for unity of knowledge beyond disciplines (Hirsch Hadorn et al., 2008).

Transdisciplinarity also refers to the art of discovering bridges between areas of knowledge by emphasizing intersections among disciplines. However, it is essential to critically engage with the key terms that link the disciplines involved in a project. Therefore, here we present the first step of an interdisciplinary exchange achieved by understanding the diverse scientific and societal views of a problem and its mutual dependencies within the problem solving cycle.

## Exploring BioDIVA knowledge domains

### Disciplinary focal areas

As a response to the critical reflection on transdisciplinarity concepts, an exploration of the BioDIVA knowledge domains from each discipline is set into focus. Building upon the four BioDIVA core themes, each disciplinary scholar had to answer the following question: *“As a land use modeller / resource economist / institutional economist / ecologist / social scientist, how do you understand gender, sustainability, agrobiodiversity and rice?”* in a written exercise.

Building on these concise papers, an interdisciplinary discourse of the BioDIVA objectives derived from the different theoretical avenues could be started. This procedure fostered a critical reflection on the multiple meanings and understandings of the BioDIVA core themes. After presentation and group discussion of the respective individual glossaries, the three most relevant topics for each BioDIVA research project were identified (Table 1).

In this context, the combined disciplinary papers provide the basis for identifying shared interests and intersections between each project which will be further discussed in this paper. The next paragraph explains the methodology of developing a disciplinary focused mind map based on the content presented in Table 1.

**Table 1.** Outcome - Exploring BioDIVA knowledge domains per discipline.

	<b>Agrobiodiversity</b>	<b>Rice</b>	<b>Sustainability</b>	<b>Gender Equity</b>
<b>Resource Economics</b>	<ul style="list-style-type: none"> <li>- Direct use value</li> <li>- Indirect use value</li> <li>- Cultural &amp; traditional norms</li> </ul>	<ul style="list-style-type: none"> <li>- Food Security</li> <li>- Labour intensive</li> <li>- Water resource management</li> </ul>	<ul style="list-style-type: none"> <li>- Profitability</li> <li>- Economic incentives</li> <li>- Market and, consumer behaviour</li> </ul>	<ul style="list-style-type: none"> <li>- Ecosystem value and benefits</li> <li>- Services</li> <li>- Distribution in gender</li> </ul>
<b>Land Use Change Modelling</b>	<ul style="list-style-type: none"> <li>- Number of landraces</li> <li>- Land use change</li> <li>- Indicators of agrobiodiversity</li> </ul>	<ul style="list-style-type: none"> <li>- Existing farm systems</li> <li>- Land use history</li> <li>- Geography &amp; climate</li> </ul>	<ul style="list-style-type: none"> <li>- Level of resilience</li> <li>- Transition paths (scenario)</li> <li>- Land use concepts</li> </ul>	<ul style="list-style-type: none"> <li>- Social interests</li> <li>- Knowledge dimension</li> <li>- Ethnicities</li> </ul>
<b>Institutional Analysis</b>	<ul style="list-style-type: none"> <li>- Human-nature relationship</li> <li>- Social organisation regulations</li> <li>- Unintended consequences</li> </ul>	<ul style="list-style-type: none"> <li>- Properties of transaction in rice</li> <li>- Transaction costs</li> <li>- User perspectives</li> </ul>	<ul style="list-style-type: none"> <li>- Adaptability to shocks</li> <li>- Learning &amp; debate</li> <li>- Flexibility</li> </ul>	<ul style="list-style-type: none"> <li>- Social interests</li> <li>- Power relations</li> <li>- Contested nature-gender relations</li> </ul>
<b>Rural Sociology</b>	<ul style="list-style-type: none"> <li>- Gendered agricultural knowledge</li> <li>- Gendered interests and needs</li> <li>- Gendered nature of decision-making processes</li> </ul>	<ul style="list-style-type: none"> <li>- Cultural value of South Indian cuisine</li> <li>- Ecological knowledge</li> <li>- Changing consumption habits</li> </ul>	<ul style="list-style-type: none"> <li>- Inclusion of marginalised/ women's voices</li> <li>- Multiple layers of sustainability</li> <li>- Poverty reduction</li> </ul>	<ul style="list-style-type: none"> <li>- Gendered roles in agrobiodiversity management</li> <li>- Dynamic system</li> <li>- Gender equity/justice</li> </ul>
<b>Ecology</b>	<ul style="list-style-type: none"> <li>- Categories of landraces</li> <li>- Ecosystem interactions</li> <li>- Ecological parameters</li> </ul>	<ul style="list-style-type: none"> <li>- Input-output balance</li> <li>- Applied ecological knowledge on a local level</li> <li>- Cultivation practices</li> </ul>	<ul style="list-style-type: none"> <li>- Water shortage, quality</li> <li>- Soil degradation</li> <li>- Loss of biodiversity</li> </ul>	<ul style="list-style-type: none"> <li>- Gendered ecological knowledge</li> <li>- Manipulative techniques</li> <li>- Conservation practices</li> </ul>

### Individual mind mapping

In this step, each BioDIVA researcher created a mind map following the identification of the three main disciplinary topics in conjunction to the BioDIVA core themes (agrobiodiversity, sustainability, rice and gender-equity). A mind map is a diagram or graphic used to capture ideas, terms and words in order to reveal the connection to an overall topic (Buzan and Buzan, 1996; Mento et al., 1999). From an interdisciplinary research perspective, mind mapping was regarded as a helpful tool to structure the understanding of the BioDIVA key themes and ideas seeking to identify intersections between each research project. In that sense, mind mapping is essential as it fosters problem-oriented research and, therefore, is the second step towards the generation of the conceptual BioDIVA framework.

Interestingly, each mind map (Fig. 1) signified a specific perspective of how a BioDIVA research endeavour (institutional analysis, land use change, resource economics, rural sociology and ecology) is viewed and understood. Even though the BioDIVA team members took a similar approach in identifying the three major topics, the maps proved to be diverse in design and style. They were different in shape and structure, in their use of colour as a means of clustering, as well as in regard to intersections between the core themes.

The findings of the mind map exercise can be described as an interdisciplinary outcome emphasising the heterogenic learning process in the case of BioDIVA. Based on the individual mind maps, a brief team discussion facilitated agreement on the process for identifying the interdisciplinary intersections described in the following paragraph.

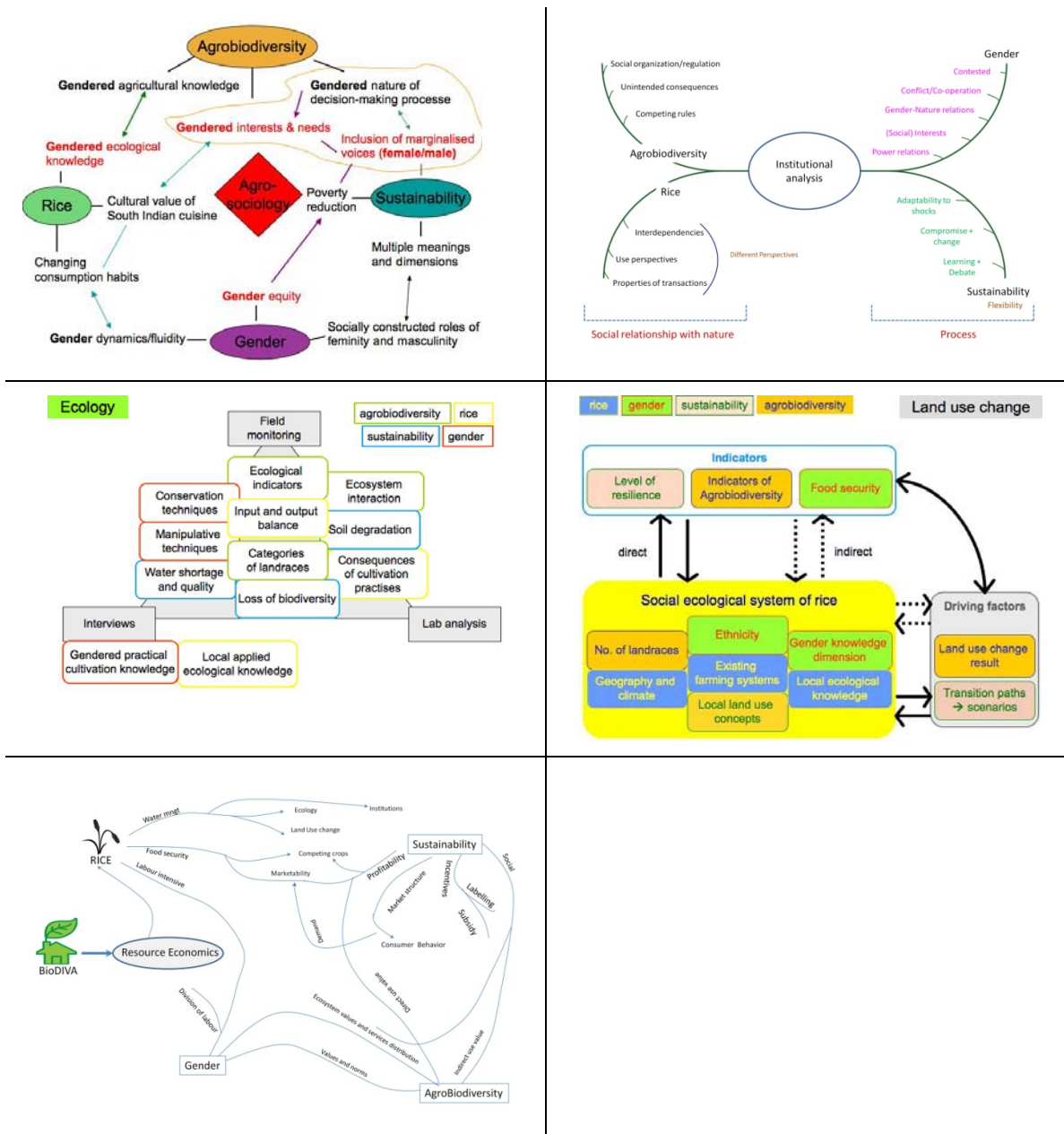


Figure 1. Individual Mind Maps.

### Identifying intersections

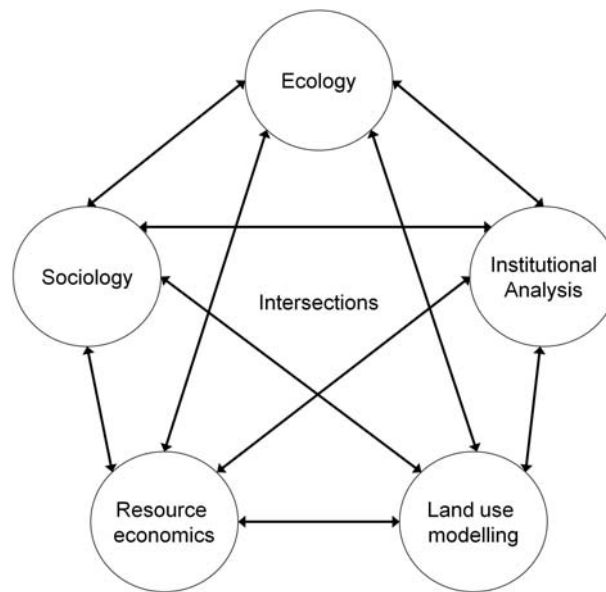
The aim was to identify intersections between each BioDIVA research project. Therefore, small groups consisting of two persons were chosen in order to compare key research ideas and examine shared interests for each BioDIVA core theme. This process gave the opportunity to cross disciplinary boundaries while searching for possible intersections to be further developed. Based on individual mind maps and discussion among the BioDIVA team members, two main intersections between each discipline had to be identified.

Narrowing the intersections down to two main fields of research interest can also be described as a way of categorisation. However, remaining research interests can still be added at a more advanced study stage as future research processes can be easier clustered around the clearly defined study areas. Furthermore, a time limit of ten minutes for a two-party conversation (“speed-dating”) providing training for group and individual time management skills. The common result of all discussions was a short summary on each intersection from a disciplinary point of view. Summarizing the outcomes on paper cards nurtured the finding of key terms and proved to be a useful way to

avoid content overlapping between all intersections. This process provided the basis to create a common map that, in turn, leads into the conceptual BioDIVA framework.

## Conceptual framework

The conceptual framework integrates the previously identified intersections of the BioDIVA research disciplines (Fig. 2). Along the line of BioDIVA's core research endeavor *agrobiodiversity, gender, rice, and sustainability* the intersection findings channel the development of a common research design. To strengthen the intersection discourse, every researcher was asked to compile a paragraph of 100 words maximum to describe the intersection concisely. This exercise was conducted to understand each disciplinary perception of a pre-defined intersection to reduce misunderstandings and disciplinary bias.



**Figure 2.** Conceptual framework of BioDIVA's intersections sphere.

The following section presents a selected example of the written paragraph of an intersection between the discipline of resource economics and sociology.

### Example: Intersection Resource Economics & Sociology

#### *Sociological perspective*

“Sustainable consumer behaviour in regard to rice consumption has been identified as a shared point of interests. Both the cultural value of the South Indian cuisine as well as changing consumption habits fit into an economic approach to consumer behaviour of rice and or other crops/plants.

The second intersection is concerned with the notion of sustainability. In order to reveal the multiple meanings and dimensions of sustainability relevant to the BioDIVA project, social values and norms attached to agrobiodiversity management from a community perspective are issues relevant for both social sciences and resource economics. Poverty reduction will be one essential component to look at. The deconstruction of the socially and culturally constructed gender roles will be essential in this regard too.”

#### *Perspective of resource economics*

“The first identified intersection will answer the questions regarding the values and norms of the community, socially constructed roles in maintaining the agrobiodiversity. In the context of the rice

farming system in south India, this intersection is backed by the consumption pattern and culture and tradition of the society. The sustainability of any product in the market depends on the demand and the consumer behavior. The cultural values of South Indian cuisines and the transformations in the consumption habits which influence the marketability and demand of the particular variety of rice showing another intersection of interest.”

It becomes obvious that a critical discourse at this stage was required with a mutual reflection among disciplinary terms and definitions. Therefore, a final group discussion was conducted to discuss the varying disciplinary understandings of an intersection node. Table 2 presents the commonly agreed final intersection themes. The table is considered as the basic conceptual BioDIVA research framework, setting out a four-year expedition to create a development perspective for farming communities and other actors involved in the upland rice farming system of Kerala, South India.

**Table 2.** Intersections identified among BioDIVA disciplines.

	Eco	InstAna	LuMod	ResEco	Socio
Eco	—	Rules, regulation of cultivation practices	Defining ecological indicators	Categories of landraces	Gender role of conservation techniques
InstAna	Institutional influence on agrobiodiversity	—	Land use change driven by policies	Market structure	Gender dynamics
LuMod	Quantify soil degradation	Adaptability to shocks	—	Existing farming systems	Ethnicity and gender dynamics
ResEco	Valuation of ecosystem services	Norms and values of decision making process	Labour availability and intensity	—	Consumer behaviour
Socio	Cultivation knowledge among gender	Organisation patterns of agrobiodiversity management	Ecological knowledge and land use history	Socially structured norms and values	—

In this context, we presented the first chapter of an ongoing narrative. The theoretical and methodological integration is rooted in(?) disciplinary schools and may result in the joint development and refining of the bridging-concept interface to conceptualise gendered negotiations over the social-ecological artefact ‘agrobiodiversity’.

The preliminary results achieved by integrating discipline-based theoretical assumptions of natural and social sciences on a conceptual level will be confronted in the field through an explorative case study in close cooperation with transdisciplinary experts. The study will serve as methodological training and as a mean to build a common ground for the next phase of BioDIVA. A common data pool building on satellite images, and quantitative and qualitative data will be subject to validation by stakeholder groups. Based on BioDIVA experiences and lessons learned, the production of a handbook for development cooperation is planned to integrate transdisciplinary knowledge and the translation of scientific results into relevant transformation knowledge. Therefore, joint publications across disciplines and beyond the scientific community support the synthesis and the translation of research results into policy recommendations.

As transdisciplinarity is understood as an ongoing process, achieving the transformation of different knowledge entities into for example, local policy recommendations, information dissemination of basic research findings through stakeholder feedback and the integration of institutional actors in the BioDIVA inquiry, will follow. As such, generated systems and target knowledge could be transformed into transformation knowledge leading to a discourse of a gender-equitable and sustainable utilization of the agrobiodiversity of the rice-based farming systems in the uplands of Kerala, South India.

## References

- Agarwal, B. (1991) *Engendering the environment debate. Lessons from the Indian subcontinent*. East Lansing: Centre for the Advanced Study of International Development, Michigan State University.
- Buzan, T. and B. Buzan (1996) *The mind map book: how to use radiant thinking to maximize your brain's untapped potential*. New York: Plume.
- Defila, R. and A. Di Giulio (2001) Inter and transdisciplinary processes – experience and lessons learnt. In: R. Kaufmann-Hayoz and H. Gutscher (eds): *Changing things – moving people. Strategies for promoting sustainable development at the local level*. Themenheft des Schwerpunktprogramms Umwelt (SPPU). Basel: Birkhäuser. S., pp. 125–142.
- Defila, R., Di Giulio, R. and M., Scheuermann (2006) *Forschungsverbundmanagement. Handbuch für die Gestaltung inter- transdisziplinärer Projekte*. Zürich: vdf.
- Erich, J. (1972) Towards interdisciplinarity and transdisciplinarity in education and innovation. In: L. Apostel (ed.) *Interdisciplinarity: problems of teaching and research in universities*. OECD Publications Center, Washington, D.C.
- GTZ (2002) *The convention on biological diversity: Ensuring gender-sensitive implementation*. Eschborn: GTZ.
- Hirsch Hadorn, G., Hoffmann-Riem, H., Biber-Klemm, S., Grossenbacher-Mansuy, W., Joye, D., Pohl, C., Wiesmann, U. and E. Zemp (2008) The emergence of transdisciplinarity as a form of research. In: G. Hirsch Hadorn, H. Hoffmann-Riem, S. Biber-Klemm, W. Grossenbacher-Mansuy, D. Joye, C. Pohl, U. Wiesmann and E. Zemp (eds) *Handbook of transdisciplinary research*. Heidelberg: Springer, pp. 19-39.
- Howard, P.L. (2003) Women and the plant world: An exploration. In: P.L. Howard (ed.) *Women & plants. Gender relations in biodiversity management & conservation*. London: Zed Books, pp. 1-48.
- Jackson, L. E., Pascual, U. and T. Hodgkin (2007) Utilizing and conserving agrobiodiversity in agricultural landscapes. *Agriculture, Ecosystems & Environment* 121(3): 196-210.
- Kumar, A. N. (1995) *Indigenous communities contribution to the conservation of threatened plant genetic resources*. Centre for Our Common Future, Geneva. The Bulletin 25: 57.
- Kumar, A. N, Girigian, G.N. and V. Balakrishnan (2003) Medicinal rice varieties of Kerala. In: Amrith. FRLHT Newsletter.
- Kumar, B.H. (2005) Land use in Kerala: changing scenarios and shifting paradigms. *Journal of Tropical Agriculture* 42(1-2): 1-12.
- Mento, A.J., Martinelli, P. and R. Jones (1999) Mind mapping in executive education: applications and outcomes. *Journal of Management Development* 18(4): 390-407.
- Mital, S., S.K. Srivastava, R. Kher, A. Taneja and N.K. Singh (2005) BRICS+G in India. Results of the National Workshop. Rat für Nachhaltige Entwicklung, Gesellschaft für Technische Zusammenarbeit.
- Murthy, R.K. (2001) Sowing seeds for social change: Lessons in gender and social relations from the Seed Village Project of MSSRF. Chennai: Tata Ecotechnology Centre.
- Pohl, C. and G. Hirsch Hadorn (2007) Principles for designing transdisciplinary research proposed by the Swiss Academies of Arts and Sciences, München: oekom Verlag.
- ProClim (1997) Research regarding sustainability and global change – science policy visions of Swiss scientists. CASS/SANW, Bern.
- Thompson Klein, J. (2004) Prospects for transdisciplinarity. *Futures* 36(4): 515-526.