WoodCluster

Narrowing the East African Wood Supply Gap: Research and Teaching for national Bio-Economies based on Farm-Wood-Production

A project funded by the German Ministry for Education (BMBF) to promote

Partnerships for Sustainable Solutions with Sub-Saharan Africa:

Measures for Research and Integrated Postgraduate Training and Continuing Training

Project period: Module 1 (Research) 1 Feb 2017 – 31 Jan 2021

Module 2 (Training) 1 Dec 2016 – 30 Nov 2020

Project Summary

Project Partners

TECHNISCHE UNIVERSITÄT DRESDEN

HAWASSA UNIVERSITY

SOKOINE UNIVERSITY OF AGRICULTURE

HOCHSCHULE RHEIN-WAAL
Rhine-Waal University of Applied Sciences

CIPSEM

UNIVERSITY OF GONDAR

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German Academic Exchange Service

DLR Projektträger

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1. JUSTIFICATION

Most of the East African countries have suffered for many years now under a large deficit in the sustainable provision of wood products, including fuelwood, wood for construction as well as wood materials for local consumption[1,2]. Recent studies demonstrate a wood deficit of about 38 and 19 million m^3 annually in the project partner countries Ethiopia, Tanzania and Uganda[3,4,5]. This results in the destruction of forests and landscapes with drastic consequences for ecosystems as well as for the livelihoods of rural and urban residents, particularly women and children[6,7]. The complex interactions are demonstrated in Figure I.

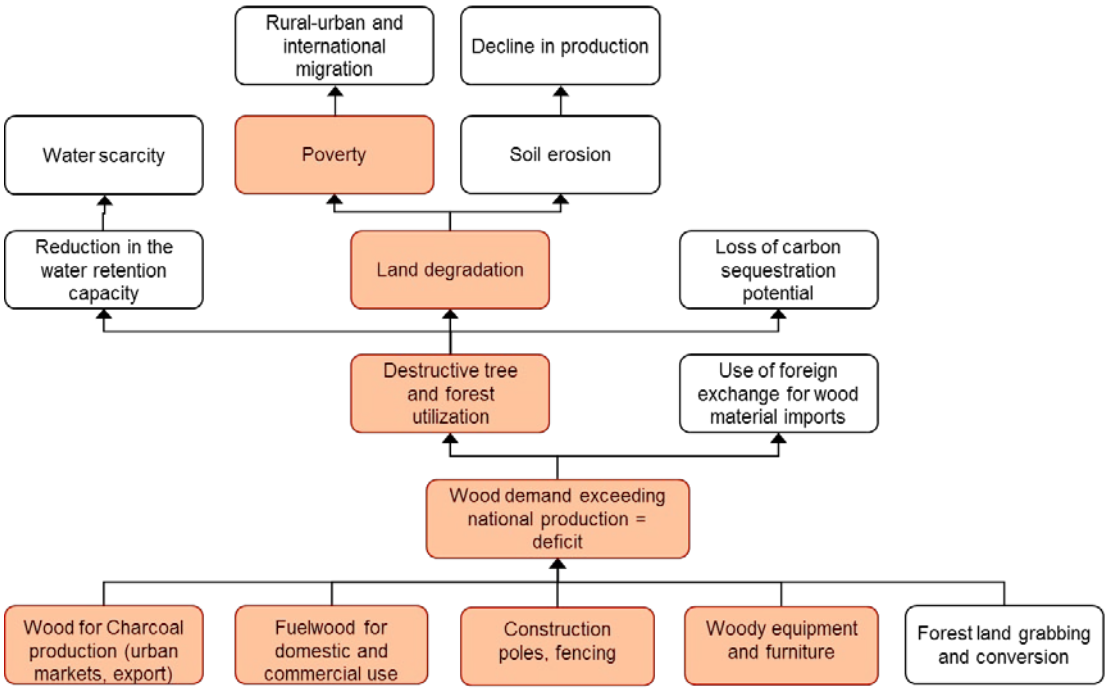

Figure I: Problem analysis of wood and energy scarcity in East African countries

The negative impacts of the wood biomass overuse are the reduction in water retention capacity and water scarcity, loss of carbon sequestration potential, soil erosion, land degradation and loss of

[1] AFF (2011) Forest plantations and woodlots in Tanzania. African Forest Forum, Nairobi, Kenya.

[2] INDUFOR (2011) Timber market dynamics in Tanzania and in key export markets. Private forestry and carbon trade project. Daressalaam.

[3] NAFORMA (2015) National Forest Resources Monitoring and Assessment of Tanzania Mainland. Ministry of Natural Resources & Tourism: Tanzania Forest Services (TFS) agency, Government of Finland, Food and Agriculture Organization (FAO) of the United Nations, Daressalam 1-124.

[4] Damte, A., Koch, S.F., Mekonnen, A. (2012) Coping with Fuelwood Scarcity: Household Response in Rural Ethiopia. Environment for Development, Discussion Paper Serious, Accessed from www.Rff.org/files/sharepoint/workimages/efd-dp-12-01-pdf on February 16, 2016.

[5] Personal communication with Dr. Habtemariam Kassa (CIFOR Ethiopia)

[6] Teketay, D. (2001) Deforestation, Wood Famine, and Environmental Degradation in Ethiopia's Highland Ecosystems: Urgent Need for Action. Northeast African Studies 8: 53-76.

[7] Benjaminsen, T.A., Maganga, F., Abdallah, J.M. (2009) The Kilosa Killings: Political Ecology of a Farmer-Herder Conflict in Tanzania. Development & Change 40 (3): 423-445.

biodiversity[8]. Along the value chain the unit price is decreasing because of high cost and low information, as well as competition on the local level. It results in poverty, rural-urban and even international migration, and increasing wood material imports[9]. At the same time, the present fuel wood consumption is a main driver of greenhouse gases in the atmosphere.

Efforts to combat this situation were often not successful. Responsible institutions have not been effective to develop adequate concepts to control and to turn these destructive trends during previous decades. The problem of the "fuel-wood crisis" was often tackled with a disciplinary and "from-outside-intervention" approach, being dominated by Western knowledge, technologies and large-scale investments. Hardly any statistics exist about the wood sector in East African countries in general and about specific components. Research was mostly concentrated on efforts to increase wood production and, hence, failed due to competition with agriculture, a rather analytical focus, and a weak market organization. An operational approach linking research with teaching was lacking. All forestry curricula contain abundant descriptive facts on the fuelwood crisis, forest destruction and the respective consequences for environmental services. The students are hardly guided in practical projects to develop and implement problem solving strategies together with the affected rural population and chain actors.

2. OBJECTIVES & EXPECTED OUTCOMES

Subsistence and market demand must drive innovations. There is a need to better document and plan wood clusters[10]. The link between the national wood demand balance and the local level needs to be strengthened. Although land resources are scarce, there are still many options to produce biomass on marginal, degraded land or well-integrated in small farm production, which requires technological solutions like agroforestry[11]. With the integration of trees and shrubs in the farm, the productivity can increase without replacing food production. This also has positive implications for climate change mitigation and adaptation: more productive trees on farms sequestrate carbon dioxide and mitigate the greenhouse effect. At the same time, it stabilizes the farm production system and effectively supports the adaptation of farm household to climate change.

This project's applied holistic approach of bottom up bio-economy integrates all actors along a chain and members of the broader cluster in problem solution, including women as main producers and consumers of fuelwood and charcoal[12,13]. Scenario techniques are applied to identify and discuss

[8] Alemu, M. (1999) Rural Household Biomass Fuel Production and Consumption in Ethiopia. A Case Study. Journal of Forest Economics 5: 69-97.

[9] Dessie, G., Carl, C. (2008) Forest decline and its causes in the south-central rift valley of Ethiopia: human impact over a one hundred year perspective. Ambio: A Journal of the Human Environment 37: 263-271.

[10] Cluster analysis in Germany of competitive advantage of wood production. Research has led to a more advanced perception of the forestry sector (see U. Kies, D. Klein und A. Schulte (2010)). Germany's forest cluster: exploratory spatial data analysis of regional agglomerations and structural change in wood-based employment – Primary wood processing. Forstarchiv 81 (6): 236-245.

[11] Batamuzi, K., Silayo, D., Mombo, F., Kajembe, G. (2014) Livelihood implications of REDD+ and costs-benefits of agricultural intensification in REDD+ pilot area of Kilosa, Tanzania. Journal of Ecosystem & Ecography 4 (1): 144.

[12] Von Braun, J. (2014) Bioeconomy and sustainable development – dimensions. Rural 21 – 03/2014: 6-9

[13] Von Braun, J. (2015) Global forum for food and agriculture 2015. Federal Ministry of Food and Agriculture (BMEL): Berlin.

possible innovative production systems for livelihood improvement with relevant stakeholders. The multi-stakeholder setting is complemented by multi-disciplinary and gender sensitive research and teaching, which leads to the following project objectives:

1. Based on national wood-cluster analysis, an overview is given on the national wood sector, its flows, and interdependencies with other sectors, employment, gender and sector development.
2. Wood value chains are documented exemplary and possible upgrading instruments and technologies are identified in participative technology innovation workshops. Commercialization platforms are designed and developed.
3. Farm wood production and its reaction to market access and changing demand structure is assessed in a holistic way, including technology solutions, allocation of production factors in social groups, including gender differentiation, livelihoods development and farm planning. Options of local institutions like micro enterprises or cooperatives including traditional social organizations will be investigated. Compensation measures will be designed if different products and value chains lead to unfavorable conditions for any social groups (e.g., women).
4. Two postgraduate teaching courses are developed, tested and implemented in the four participating forestry faculties; the courses are demand driven and strongly interlinked with research. One course focuses on theories and concepts for wood bio-economy, cluster, and wood chains; the other course deals with practical implementation and research along the cluster-chain-farm continuum.
5. A training course on farm based wood bio-economy, cluster development and value chain upgrading is developed, tested and implemented. The program addresses various stakeholder groups in Africa as well as in Germany.
6. Based on the above mentioned two teaching courses, an e-learning course is developed, tested and implemented.

Strong medium and long term impacts are expected. The extreme gaps present in national wood production will be narrowed, efficiency in the use of the raw material will be increased and quality of the wood based products improved, especially in the field of wood-based energy. Research results and teaching will contribute essentially to stabilize rural areas, for example by the creation of additional green jobs, income generation by value chain upgrading[14] and improving livelihoods on farm level[15]. On a macro level, the trade balance of the participating African countries will be improved with reduced imports of oil, wood and wood based products. University cooperation contributes to higher education development and capacity building and training. The research and problem solving capacity of all four involved universities will be increased essentially. South-South cooperation between institutions from Ethiopia, Tanzania and Uganda in research and teaching (e.g. e-learning), and the involvement of the German University strengthens the existing research and teaching network.

[14] Kambugu, R. K., Banana, A.Y., Turyahabwe, N., and Okure, M. (2013) An institutional analysis of commodity chain evolution: a case study of sawn wood in Uganda. International Forestry Review 15 (4): 489 – 498.

[15] Poschen, P. (2015) Decent work, green jobs and the sustainable economy. Solutions for climate change and sustainable development. Greenleaf Publishing Ltd. Sheffield.

3. PARTNERS & EXPERTISE

All participating universities and research entities (Fig. II) have longstanding and excellent research and teaching experiences in tropical forestry in general, and in the field of wood production systems[16], including the socio-economic and political framework condition of farm forestry and they cooperated intensively before, for example in the BMBF-funded projects "Welcome to Africa"[17] and "CHAINS"[18]. The previous cooperation is documented in numerous M.Sc. theses, doctoral dissertations and scientific publications[19,20,21].

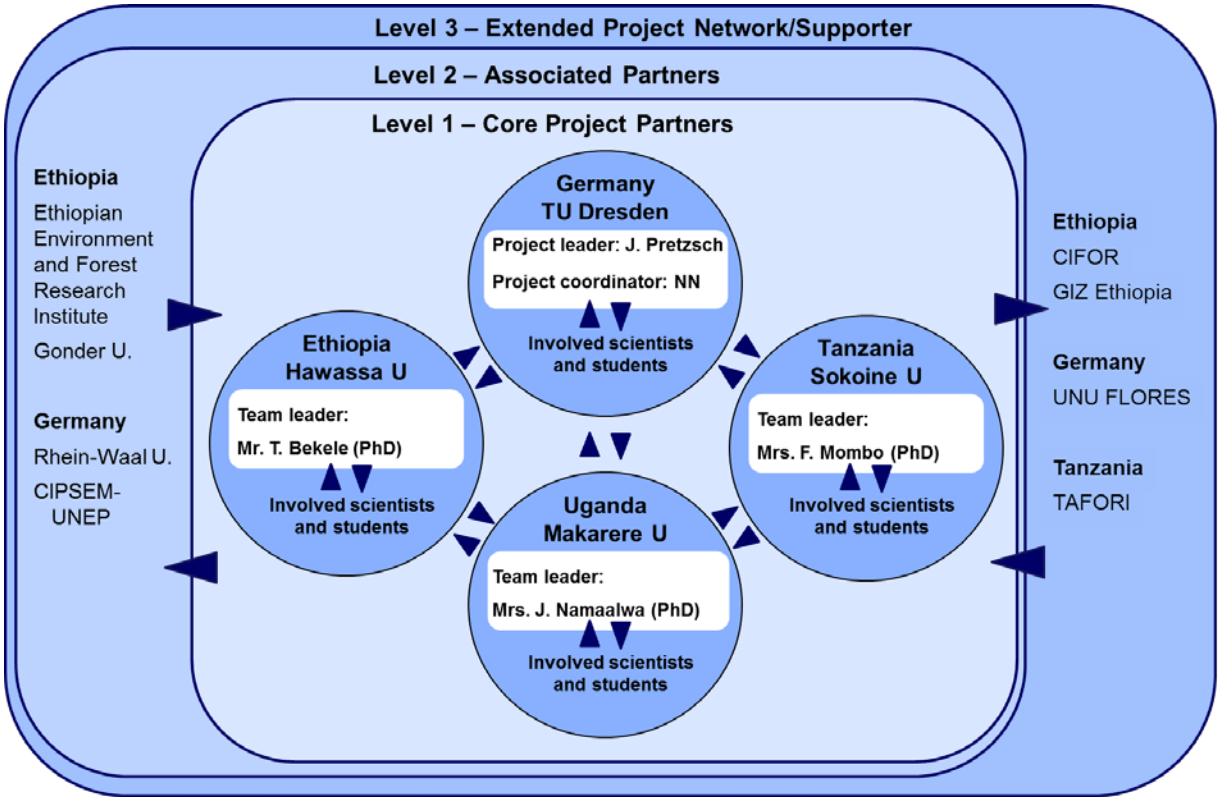

Figure II: Project partners

The three African core partners, Hawassa University (Ethiopia), Sokoine University of Agriculture (Tanzania) and Makerere University (Uganda), are the guiding centers for forestry research and teaching in their respective countries, with a high reputation in East Africa, sub-Saharan Africa and the world at large. The associated partners are incorporated for knowledge exchange and support.

[16] Zziwa A., Kaboggoza J.R.S., Mwakali J.A., Banana A.Y. and Kambugu R.K. (2006): Physical and mechanical properties of some less utilised tropical timber tree species growing in Uganda. Uganda Journal of Agricultural Sciences 12 (1): 29-37. Uganda.

[17] https://www.tu-dresden.de/forst/w2a

[18] https://tu-dresden.de/forst/chains

[19] Endalamaw, T., Lindner, A., Pretzsch, J. (2013) Indicators and Determinants of Small-Scale Bamboo Commercialization in Ethiopia. Forests 4: 710-729.

[20] Pretzsch, J., Darr, D., Uibrig, H., Auch, E. (eds.) (2014) Forests and Rural Development. Springer. Berlin, Heidelberg.

[21] Worku, A., Pretzsch, J., Kassa, H., Auch, E. (2014) The significance of dry forest income for livelihood resilience: The case of the pastoralists and agro-pastoralists in the drylands of southeastern Ethiopia. Forest Policy and Economics 41: 51-59.

The applying Institute of International Forestry and Forest Products of TU Dresden is the oldest academic institution in Germany working in tropical forestry. It has extensive research experiences on farm-forestry system development in Ethiopia, with a special focus on-farm development, value chain analysis and upgrading[17,18], and integration of forestry production in the landscape. Essential is also the expertise with participative research methodologies, like Socio-economic Field Laboratories. They were developed tested and implemented in the TUD INCA-project[22],[23] in cooperation with universities in Bolivia and Peru to investigate the local farm level implementation of the Convention on Biological Diversity and of climate change adaptation strategies.

The reputed TU Dresden M.Sc. course "Tropical Forestry"[24] is used as an important instrument to create academic teaching networks and to induce Research & Development cooperation. Numerous alumni with master and doctoral grades have high positions in East African countries and facilitate the establishment and active development of research and teaching networks.

4. PROJEKT FRAMEWORK, METHODLOGICAL APPROACH & WORKPACKAGES

The project is composed of two modules, *M1 Research* and *M2 Education and Training*, which have an individual planning and funding frame. Their interrelation is presented in figure III. The complementary modules shall deliver results within both fields and create additional, fruitful cooperation effects.

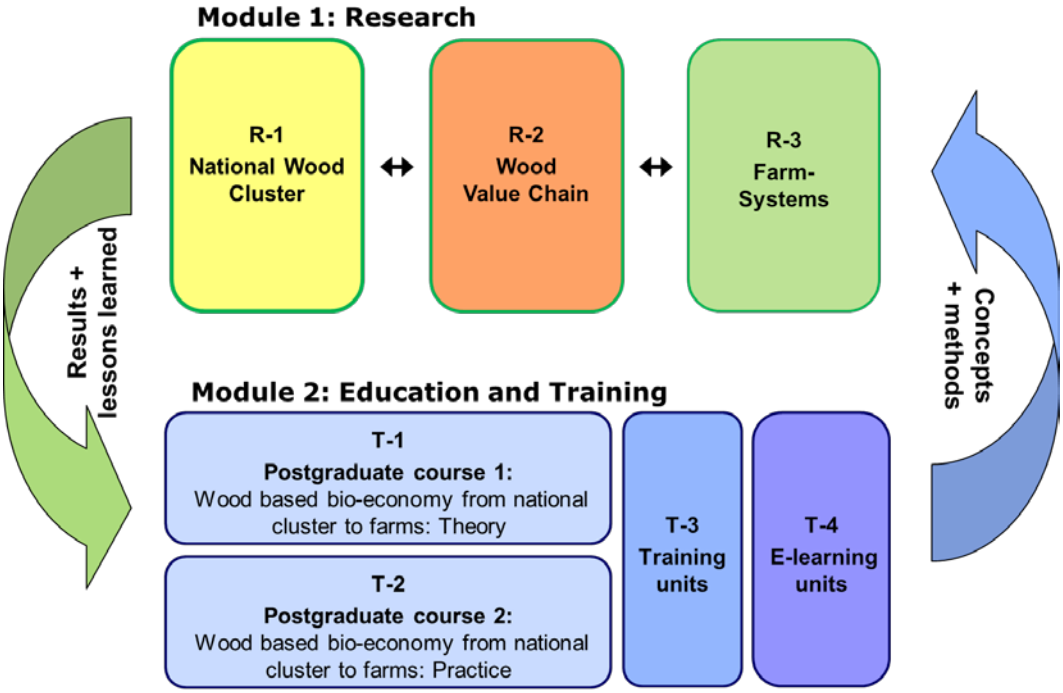

Figure III: Project framework

[22] Lindner, A., Pretzsch, J. (2013) An International Network on Climate Change Impacts on Small Farmers in the Tropical Andes-Global Conventions from a Local Perspective. Sustainable Agriculture Research 2 (2): 92–98.

[23] INCA project description. online available: http://tu-dresden.de/forst/inter (accessed 20.02.2016)

[24] The course was successfully accredited by ASIIN in 2008 and honored for the "Quality label for the top ten Master courses at German universities" by Stifterverband der deutschen Wissenschaft (Association of German Scientific Foundations).

The project roots in a strong interaction between research and academic teaching. Action research, which is a key concept in the curricula that is to be developed, responds to the academic problems of highly focusing on theoretical aspects, lack of real life problem solving and leaving aside all other stakeholders. In Module 2, students will be involved in practical field work and on-farm research through the instrument of Socio-economic Field Laboratories. The research results are directly transmitted to a broad auditorium by teaching and training modules because of the strong interrelation between the research and the education module. The researchers will be part of the teaching staff and academic teaching will be strongly related to training.

A further strong link is given by the field-study related postgraduate course 2. Students do field researches on farm level, along the value chain and related to the national supply and demand situation in wood products. The interchange of knowledge at the different levels lead to a knowledge transfer related to the whole cluster from farm to macro-level. By understanding this interrelation and by implementing research based innovations the extreme wood deficits may be reduced by enhancing on-farm wood production. To escape international “development fashions” and the respective “waves”, teaching as well as research will completely be demand driven. The project’s approach to relate research and teaching is hereby characterized by the following elements:

- Increasing the practical focus of academic education, by putting learning in practice
- Learning by doing: training for transferring academic knowledge into field practice
- Educating and training students and researchers according to the labor market demands
- Testing research ideas in villages and community service programs, as on-site research for quick adoption of innovations

The implementation and coordination of the project is organized in work packages for the two modules plus a central coordination, based on the applying partner TU Dresden (Tables I + II).

Table I: Project coordination for both modules

	Work Package	**Deliverable**	**Indicator**
K-1	Establish project coordination	- Identify and contract project staff - Schedule and organize kick-off and coordination workshop - Design monitoring procedures	- Work contracts - Refined planning
K-2	Joint kick-off and coordination workshop in Wondo Genet, Ethiopia *Refine contents and planning per module*	- Adapted and fine-tuned work plans - Responsibilities on operational level - Course development per partner - Agreed monitoring procedures - Agreement on data exchange between modules and researchers - Agreements (MoU or contracts)	- 2 Course content descriptions - Confirmed work plan - MoU/code of conduct/ contracts
K-3	Program Kick-off, Bonn		
K-4	Mid-term meetings, each team individual, in Ethiopia, Tanzania, Uganda	- Evaluation of implemented activities - Decision on work plan adaptations - Updated work plans	- Updated work plan

	Work Package	Deliverable	Indicator
K-5	Mid-term meeting, Bonn		
K-6	Joint final coordination workshop for both modules, Tanzania or Uganda	- Evaluation of implemented activities - Identification of lessons learned - Way forward	- Lessons learned and recommendations

Table II: Delivery plan including definition of measurable indicators

Work Package		Deliverable	Indicator
Module 1 Research			
R-1	1. Cluster analysis 2. Cluster scenarios	- Stakeholder overview (profile and contact) - Cluster documentation - Cluster development scenarios - Recommendations for decision maker and practitioner	- 30% of core stakeholders on macro-level contacted - Reports submitted - 4 M.Sc. thesis - 2 Doctoral dissertations - 3 Articles int. journal
R-2	1. Wood value chain (VC) diagnosis 2. Participative WS on VC upgrading 3. Model implementation of VC upgrading interventions	- Methodological guidelines (Farm and VC assessment) - VC diagnosis report - State of the art report incl. stakeholder list and contacts - Catalogue of (innovative) practices; VC upgrading recommendations	- Value chain report - Method. guidelines printed - 3 country-specific papers submitted - 4 M.Sc. thesis - 1 Doctoral dissertation - 2 Articles int. journal
R-3	1. Farm diagnosis with focus on wood production 2. Farm wood production planning and model implementation	- Methodological guidelines (Field laboratories) - Farm diagnosis report - Farm forestry development plans including innovative instruments for organization and commercialization	- Method. guidelines printed - 5 M.Sc. thesis - 2 Doctoral dissertations - 3 Articles int. journal
Module 2 Training			
T-1	1. Elaborate, test and implement theory oriented 5-7 credit course on *Wood based bio-economy from farms to national cluster*	- Course documentation incl. curriculum and syllabus - Lecture materials - Final theses on course related research question	- Course documents - Lecture materials - Course conducted 2 times with 20 - 40 students - 5 M.Sc. theses
T-2	1. Elaborate, test and implement 5-7 credit *Integrative wood-based value chains from farms to national cluster*	- Course documentation incl. curriculum and syllabus - Lecture materials - Final theses on course related research question	- Course documents - Lecture materials - Course conducted 2 times with 20 – 40 students - 5 M.Sc. theses

Work Package		Deliverable	Indicator
T-3	Training units for specific target groups elaborated, tested and implemented	- Training program and manual - Training materials	- Manual available - Training tested 2 times with 20 – 40 participants
T-4	1. Transfer identified contents into e-learning units 2. Converting the basic e-course into an interactive multimedia product by hiring a professional service provider	- Consensus on the adequate platform - Created e-learning units	- Manual for implementer available - E-learning units available and 2 times tested with 20 – 40 students

5. MODULE 1: RESEARCH

Module 1 has 3 research components (figure IV). Starting with the wood supply gap in East Africa and especially in the partner countries the first research field consists of the macro level, the *national wood cluster* (R-1). The respective methodology was recently further developed in Europe and will be adapted to the situation in Africa, were data availability is rather limited. The main actor groups and actors from the national wood cluster will be described individually and in their linkages. Input-output relation between the wood sectors and other relevant sectors like energy and infrastructure needs to be documented, using existing data sources, expert interviews and triangulation methods. A general development trend will be derived and a separation in small and large wood providers and their future potential will give some idea about the wood cluster development.

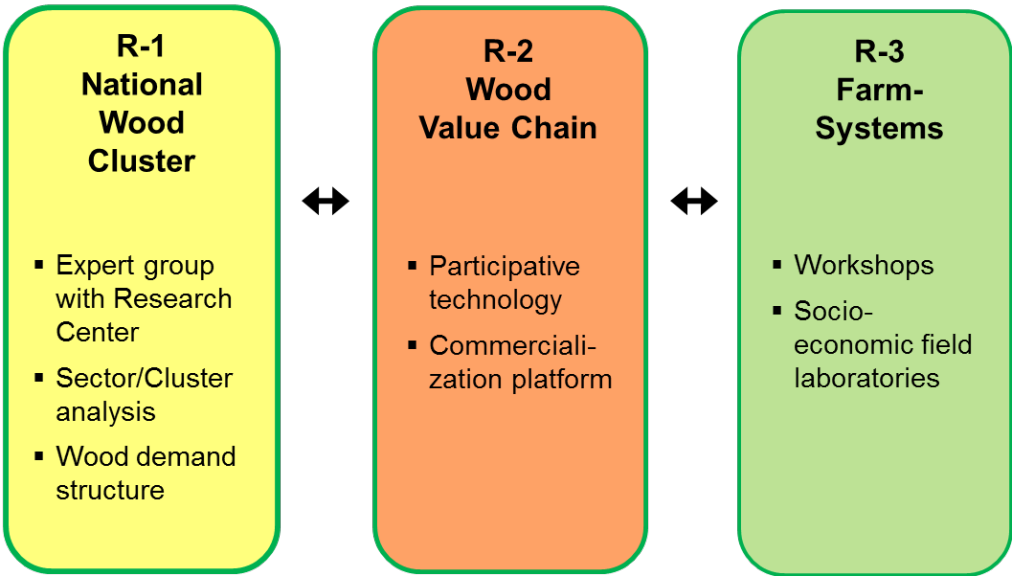

Figure IV: Research steps and overall methodology

Research field two (R-2) comprises the *value chain* linkages between national and regional level and local production units. Special focus is put on linkages with small producers and the commercialization of their products. Often these wood chains are dominated by middlemen and informal markets, which hardly any price and cost transparency. The underlying institutions enable and enforce the exchange

partners and protect the mostly orally stipulated contracts. These institutions are well adapted to local circumstances and are embedded into the culture of the people in the areas. Institutions and the respective mechanisms for change and the market interaction will be investigated. The creation of commercialization platforms and the better-quality sorting wood products are possible actions proposed by partner institutions and must be discussed in Participatory Innovation Platforms (PIP), which were developed and successfully implemented in the CHAINS-project[25]. Research will focus on the development of prototypes and their testing in the field.

Research field three represents the production sphere focusing on *small farms* (R-3). In each of the partner countries two villages will be selected, in which farms will be analyzed and innovative strategies to increase wood production will be assessed. The respective instruments will be Farming Systems Analysis and the Livelihood Analysis. In each partner country one Socio-economic Field Laboratories will be established, because they require intensive scientific support and involvement of students. They represent a strong link to academic teaching (see figure III, T-2). In the second case study village in each African partner country, research will be rooted in participatory on-farm approaches.

The situation in the small farms will be investigated in detail, looking for comparative advantages of wood production systems in relation to agriculture and other production systems. As an important precondition it is claimed that food production is not negatively affected, which can be avoided by using agroforestry systems and improving degraded sites. The selection of the case study villages is presented in Table III.

Table III: Overview on the local case study research sites

Country, Region	Research site	Agro-ecology	Land scape and land use
Ethiopia, Amhara Regional State	**Awi zone**, Banja District	High rainfall area, 1200-2000 mm with a bimodal distribution	Highland, 1800-3100 m a.s.l., natural forest remnants, eucalyptus plantation forests, mixed farming (barley, wheat, teff, pulse crops), livestock (sheep, cattle) transhumance practice
Ethiopia, Southern Nations, Nationalities and Peoples Region	**Sidama, Kembata-Tembaro, Wolayita** administrative zones	Mean annual rainfall ranges 800-1600 mm	Transect from lowland to highland, 1800-3000 m a.s.l., Various agroforestry systems Eucalyptus plantation and remnants of indigenous tree species on farms
Tanzania, Iringa	Njombe District Kilolo District	Mean annual rainfall ranges 500-2700 mm Fertile soils	Miombo woodland Small scale agriculture, maize, beans, sunflower Livestock cattle, small scale tree planting for timber, poles and wood energy production

[25] Alemu A., Auch E. (2016) Guideline for analysis and development of commercial forest product value chains in Sudan and Ethiopia. CHAINS Working Paper, 2nd ed. CHAnces IN Sustainability: promoting natural resource based product chains in East Africa (CHAINS). Technische Universität Dresden. Tharandt.

Country, Region	Research site	Agro-ecology	Land scape and land use
Tanzania, Arusha	SUA Forestry Training Institute, Arusha	Mean annual rainfall ranges 500-2700 mm Fertile soils	Savanna; Agriculture maize, beans, livestock fodder, plantation for timber production owned by SUA, sawmill in full operation with high amount of biomass waste
Uganda, South Western Uganda	Kabale District	Tropical climate, av. 18 °C, with high humidity, annual rainfall < 800–1700 mm	Highlands with intensive cultivated slopes, 1200-2300 m a.s.l.; Agroforestry systems with various eucalyptus woodlot technologies; part of cattle corridor, tree growing and zero grazing as innovation
Uganda, Eastern Uganda	Sironko District	Temperature average 23 °C. Average annual rainfall 1200 mm	Agriculture with a focus on food crops such as beans, groundnuts, sorghum, millet, cassava, potatoes and sweet potatoes. Coffee and cotton are the main cash crops

Most field research will be conducted through M.Sc. and PhD theses, supervised by scientists of the four participating universities and cooperating partners, who will regularly visit the case study villages. Among the junior researchers, who will be integrated in the project, a research network with an internet platform has already been established[26].

Expected Outcomes of Module 1

The research is rooted in the demand of the participating countries, results are directly relevant for problem solving on the various levels. The following research results are expected:

- On the level of the macro-wood cluster (R-1) the input-output structure will be assessed and documented in a model, involving wood processing. This model permits to estimate the future supply and demand structure and the respective wood supply gap. Outcomes additionally permit an overview on the cluster-related labor demand as well as the external trade balance of the wood sector. All is highly demanded by the partner countries.
- The farm gate price depends much on the value chain (R-2) between the macro wood cluster and the producing villages and farms. Commercialization platforms and value chain upgrading by quality differentiation lead to increasing farm-gate prices and motivation for an innovative farm management, and increased on-farm wood production.
- On-farm level wood production (R-3) will be intensified with the implementation of innovative technologies. The use of PIPs integrates all stakeholders in decision making and implementation of innovations.
- An innovative teaching package on bottom-up wood based bio-economy will be available, which is implemented in university as well as in training of researchers.
- Socio-economic Field Laboratories are further developed and tested and form an important element for participative research as well as training on the job for students.

[26] Internet Exchange platform

6. MODULE 2: Postgraduate training and continuing training

The four proposed packages are an innovative step for dynamic teaching: two post-graduate trainings (T-1, T-2), a continuing training course (T-3) and an e-learning course (T-4) (figure V). The most important objectives are:

- To address one of the most challenging problems in African countries with a proper integration in university curricula, teaching and training.
- To contribute and grade up university teaching with the innovative subject of wood based bio-economy as well as new didactical approaches, including e-learning.
- To familiarize various groups as farmers, traders, NGOs and scientists with concepts of the bottom up wood based bio-economy as well with the instrument of Participative Innovation Platforms (PIP) to initiate action.
- To further develop the instrument of Socio-economic Field Laboratories (SFL) as instrument to train students "on the job" and to facilitate problem orientation and solution on farm level.

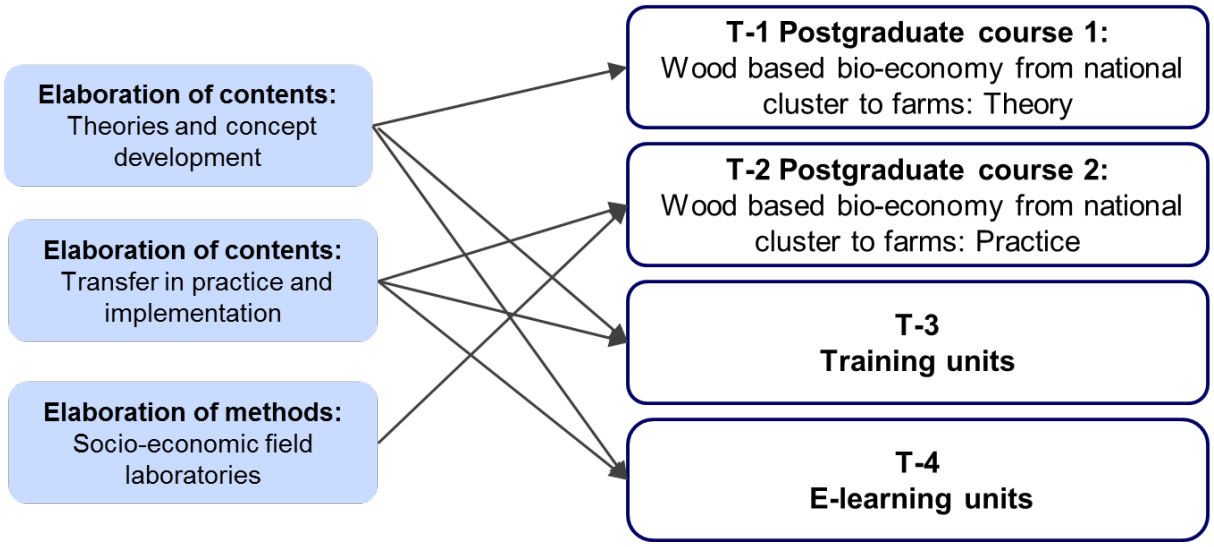

Figure V: Conceptual overview on the training module

The module's important components are the two Master-level courses of 5-7 credits, which will be designed, tested, and implemented in the three African Universities and at TU Dresden. They are innovative, filling a present gap by initiating wood based bio-economy teaching and research. All steps from the national wood cluster, along the wood chains to the production units, with a special focus on small farms are integrated in the curricula thematically and with practical components. The courses will be placed as elective disciplines in running M.Sc. Programs[27]. Special emphasis is put on the selection of female students. They prove to have an excellent access to on-farm initiatives, and generally women have a strong stake in on-farm decision making. They will be important accelerators of on-farm bio-economy innovations.

[27] The partner universities have communicated first ideas in which of their post-graduate programs the two academic courses might be integrated: M.Sc. and PhD Biomass energy development (Hawassa University); M.Sc. Environmental and Natural Resource Economics and M.Sc. Management of Natural Resources and Sustainable Agriculture (Sokoine University)

Course T-1 "Wood based bio-economy from national cluster to farms: Theory" deals with theories and methodologies to investigate the whole continuum from the national wood cluster along value webs/chains till the farm production units. Contents are: physical features of this chain, related to wood biomass production and consumption, marketing, processing technologies, harvesting as well as post-harvest handling, the physical aggregation for commercialization as well as the farm production. The production pattern of small farms will be described in detail. Based on this, socio-economic parameters, models and methodologies are introduced. Details of the wood-cluster analysis are explained. Methodologies of the value chain and network analysis involve the value-added calculation under cost and distribution aspects. Special reference is put to governance aspects and value chain conduction. On-farm level technological aspects as well as a detailed economic analysis of the farm are communicated. A special subject will be the three dimensions of farm forest production, subsistence products like fuel- and construction wood, market production and the generation of environmental services, which mostly have a welfare oriented character.

Course T-2 "Wood based bio-economy from national cluster to farms: Practice" profits much from the research component of the project and it is highly oriented toward practice, implementation of innovation and creative teamwork of the students. In small teams of 2-3 students small projects are elaborated along the cluster-value chain-farm continuum. The small projects shall contribute to problem solution. On the cluster level they are related to analysis on macroeconomic and large enterprise level. Practical teamwork is placed around the cluster analysis related to import-export calculations, the interrelation with other sectors by input-output calculations, large enterprise studies as well as estimations of the urban and rural wood demand. Scenario techniques will be used to get an idea about future demand. Studies along the value chain deal with stakeholder analyses, value added and chain governance studies. Students will study innovative technologies, which will be derived from the Participatory Innovation Platforms (PIP)[28].

On-farm studies cover a large field of subjects. The Socio-economic Field Laboratories will be fully integrated in teaching module T-2. To avoid ethical problem of the "use" of farmers for education targets, a compensation with active support in farm development has to be assured. Numerous subjects which are identified by farmers or in the multi stakeholder PIP are suited for student group works. Examples are farm labor studies under different production scenarios, wood production technologies, farm income studies, livelihood assessments or the analysis of small scale wood processing.

The whole student group will be supported with methodologies in common lectures which will be rooted course T-1 and which accompany the practical work in T-2. Students have to report about the advance in their micro-projects once in a month in the plenum. Final results will be presented in a public forum. Profound experiences are available especially at TU Dresden about these innovative forms of teaching. Support and tutoring will be possible by advanced M.Sc. students and doctoral students. Students learn early to focus on project solutions and to understand the context of the knowledge they acquire.

[28] See explanations on PIP in chapter on Module 1: Research

The contents of the post-graduate training course and the field experience from the research module are used to develop a *training unit* (T-3), which will be designed for various target groups like national research centers, NGOs, trade associations and farmer.[29] The training units have to be designed demand driven, in straight coordination with the requesting institution. These training units might become a business field for the offering universities. An interest to implement such a practical training module was expressed by German institutions.

An *e-learning course on "Designing a wood-based bio-economy"* (T-4) will be developed based on contents of the courses T-1 and T-2, and experiences with the training course. It will be offered in the three participating African countries with a length of two weeks. The 1st week will involve 10-15 hours of coursework with e-learning, exercises and quizzes. In the 2nd week the learned content shall be applied in form of a practical training course, including visits to exemplary sites (genetic material generation, nurseries, plantations, trading points, marketing agents, etc.). The modular e-course will include all the above mentioned thematic blocks with specifications for the three countries Ethiopia, Tanzania and Uganda. The credit valuation in ECTS will be determined by all partners.

The procedure of elaborating the e-learning module involves the following steps:

(1) Identification of learning objectives, contents, didactical concepts; material selection from the body of the postgraduate courses T-1 and T-1;

(2) Elaborate a course concept and select thematic animated PowerPoint slides with narration; (3) Review, streamline and integrate the different presentations into a modular basic e-course in small editorial group with staff from the universities will;

(3) Refine the basis e-course by a professional service provider. The slides have to be converted into an interactive multimedia format (e.g., html with shockwave flash), including voice-over recording of the narration;

(4) Test e-course in a summer module;

(5) The course shall be offered periodically at the African partner universities and in Germany.

Exams in the two post-graduate courses will be organized based on the national curricula. Course T-1 is characterized by the transmission of basic and factual knowledge which gives preference for oral exams. In T-2 a group based report is the main base for examination. A further part is the presentation of the results, in the best case in presence of practitioners. In course T-3 and T-4 the type of the examination depends on the users. In T-1 it is favorably related to group work in the field. Examination in the e-learning module is composed of report writing and active participation in group tasks.

Expected Outcomes of Module 2

The wood based bio-economy concept offers a unique chance for a paradigm change in research and teaching. Students get an overall introduction to the linkages between the national sector and local farm production. The research is fully integrated in the courses, especially in the field research based course T-2 "Implementing integrative biomass value chains". The establishment of Socio-economic

[29] In the project's pre-assessment stage, many stakeholder groups in Ethiopia and Tanzania expressed their demand for it.

Field Laboratories in each of the partner countries facilitates the cooperation between farmers, researchers and students. The development of a training unit and an e-learning course contribute to the broad dissemination of knowledge in an actual practice and problem solving oriented manner.

7. OVERALL NATIONAL & INTERNATIONAL RELEVANCE

The project is well integrated in the target of the Africa strategy of the German Ministry for Education and Research 2014 - 2018 and is linked with the bio-economy concept, which exists in Tanzania[30] and Uganda[31], and also, e.g., in the frame of the *National Adaptation Programme of Action (*NAPA). In Ethiopia, the *Climate Resilient Green Economy Strategy* and Growth and Transformation Plan[32,33] represent a framework in which the bio-economy is embedded.

The project follows the Pan-African research strategy. It picks up main topics of the New Partnership for Africa's Development (NEPAD) and its cooperation TerrAfrica: demand driven capacity building support to African universities, tertiary and research institutions; the adoption of appropriate and effective innovations as well as contribution to economic growth and poverty eradication. The research and teaching components of the project match the priorities of COMESA (Common Market for East and Southern Africa), CAADP (Comprehensive Africa Agriculture Development Program): enhancing biodiversity in lived-in working landscapes through sustainable agricultural, *agroforestry and forestry practices*, and enhancing and safeguarding the productivity of farm fields through sustainable land and water management. COMESA - working within the CAADP framework and in partnership arrangements with the World Agroforestry Center (ICRAF) and Worldwide Fund for Nature (WWF) - seeks to promote and support *adaptation, mitigation and related agricultural, land use and livelihood strategies* in East and Southern Africa. The Project also complies with SADC (Southern African Development Community) which has developed a forestry strategy (2010-2020) identifying priority areas for program development. The project contributes to Joint African-EU strategy.

On a global level the project contributes especially to the UN Sustainable Development Goals (SDG)[34]: Climate Action (13) and Life on Land (15) as well as additionally to poverty reduction (1); quality education (4); industry, innovation and infrastructure (9); and responsible consumption and production (12). In this context, several UN conventions like the UNFCCC, CDB as well as the Forest principles are followed. Social responsibilities are covered by following ILO targets; rural areas will be stabilized by the creation of green jobs and the reduction of migration.

[30] National Biotechnology Policy (2010)

[31] Biomass Energy Strategy Uganda (2014), National Biotechnology and Biosafety Policy (2008), The Renewable Energy Policy for Uganda (2007).

[32] MoFED (Ministry of Finance and Economic Development) (2010) Growth and Transformation Plan 2010/11-2014/15, Addis Ababa, Ethiopia.

[33] MoEF (Ministry of Environment and Forest) (2012) Ethiopia's Green Economy Strategy, Addis Ababa, Ethiopia.

[34] For further information on the SDGs: https://sustainabledevelopment.un.org/.