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The impact of organic cotton cultivation on the livelihood of smallholder farmers in Meatu district, Tanzania

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Abstract

In Tanzania, as in many developing countries, cotton is an important source of income for smallholder farmers but also causes various negative effects through high pesticide and intensive land use. To overcome these effects organic agriculture is promoted by different non-governmental organizations (NGOs) and companies. This study examines how organic cotton cultivation influences the livelihood of smallholder farmers in rural Tanzania and focuses on three areas: (1) the motivation to change from conventional to organic farming, (2) experiences and challenges of farmers in the conversion process as well as in the period following the conversion, and (3) the attitude and perceptions of farmers toward organic farming in general. Qualitative interviews with organic farmers in Meatu district in the north of Tanzania, as well as expert interviews, were conducted and observations were made. Results show that although the organic price premium is an important incentive for farmers to convert to organic agriculture, access to training and advisory service are even more important, as no other sufficient agriculture extension service is available in the region. Due to a high level of poverty in the region, environmental motivations for conversion are not in the foreground. Furthermore, the study shows that organic farming can contribute greatly to the improvement of livelihoods in the region (improved soil fertility, increased yields and income, higher standard of living) and increases farmers' ability to cope with challenges, mainly through knowledge transfer, access to capital and capacity building on a local level. Although positive effects on female farmers were identified, cultural preconditions (e.g., polygamy) harm efforts to strengthen women to a higher degree and gender disparities are still challenging. Further social problems (i.e., high birth rates, a poor education system and a lack of health care), global trading schemes as well as environmental factors (i.e., water scarcity and extreme weather events) cannot be fully offset by the conversion to organic cotton cultivation. Farmers in the Meatu region profit to a high degree from organic agriculture, mainly due to access to knowledge and extension services, nevertheless important challenges remain for farmers and their families.

Key words: organic cotton production, cultivation, smallholder farmers, improvement of livelihood, sustainable development, Meatu, Shinyanga, Tanzania, Africa

Introduction

Cotton is the most important natural fiber, ahead of wool, linen and hemp, and raw material for around one-third of all textile products[1]. It is one of the leading agricultural crops and a heavily traded commodity[2]. Next to large-scale production schemes with high subsidies in the US[3] cotton is mainly cultivated by smallholder farmers in the developing world, where three-quarters of the global cotton is produced[4]. Ninety-nine percent of cotton farmers live and work in developing countries[5], where cotton is a very important source of income, mainly for the rural poor, and the basis for their livelihood[2,6]. Simultaneously, cotton production causes many undesirable effects. Even though only 2.5% of the global agricultural area is used for cotton production[2], 16% of all pesticides worldwide are applied on cotton fields[5]. Due to this high use of agrochemicals, cotton production causes lots of problems, such as pollution of ground water, and acute and chronic health problems for workers on the fields[7]. The World Health Organization (WHO) categorizes half of the chemicals used as hazardous to human health[5]. High water demand, salinization of soils and low labor standards are further key issues connected with cotton

production[1,5]. Additionally, pesticide resistance has been observed for several decades[8]. This caused a growing demand for pesticides and thus agricultural input costs further increased[9]. Every year chemicals amounting to US$2 billion are used[5]. Due to high input costs, competition with highly subsidized cotton from industrialized countries[3,4] and volatile markets with uncertain prices, smallholder farmers carry high economic risks[6]. All these issues show the environmental, economic and social dimensions of cotton production. As an alternative, organic cotton cultivation is regarded as one strategy to minimize negative effects for cotton farmers[7]. As organic farming is based on the principles of health, ecology, fairness and care, it covers environmental, economic and social dimensions simultaneously[10]. Several studies were done to analyze the ecological impact[11–13] while others valued the economic efficiency of organic cotton cultivation[14].

Since the late 1980s, different non-governmental organizations (NGOs) have been promoting organic cotton cultivation in developing countries, due to the potentially positive effects on smallholder farmers[7,15]. In the same time period, there was also growing consumer interest in 'green' and sustainable clothes that triggered an increasing demand for organic cotton, which peaked in 2008[16]. To satisfy the increased demand and improve the livelihoods of smallholder farmers, several organic cotton projects were initiated in different countries. Currently, organic cotton is grown in 20 countries worldwide, with 68% of the organic cotton cultivated in India, followed by Syria and China with 11 and 8%, respectively[17]. As shown in Table 1, in 2011/12, organic cotton was cultivated on an area of approximately 317,000 ha, grown by around 215,000 certified organic cotton farmers[16,18]. Due to seed problems caused by a growing share of transgenic cotton and increasing competition through new upcoming sustainable initiatives, organic cotton still only accounts for 0.7% of global cotton production[16]. Therefore the question arises, whether it is worth promoting further organic cotton initiatives as a trigger of sustainable development for the rural poor.

According to different authors[19–23], organic agriculture provides considerable potential for sustainable development and can improve the livelihoods of smallholder farmers in developing countries. Organic farming aims to mainly include local natural resources for cultivation in a sustainable way, decreasing the dependency on external inputs such as synthetic pesticides, herbicides, chemical fertilizers, defoliants and genetically modified or chemically treated seeds[24,25]. Organic production is a knowledge-based approach[20,26–29], where the access to information is an important precondition to enable farmers to compensate for the lack of external synthetic inputs. To compensate, farmers are using different farming practices, such as intercropping, crop rotation and use of farmyard manure (FYM) and compost[30].

Socio-economic studies on organic cotton production (in India[6,31], in Central Asia[7] and parts of Africa[32]) showed the positive impact of organic cotton production on the livelihood of farmers. In the studies, increased yields, a better income situation as well as empowered and more sustainable communities were observed[6,7,32]. According to Eyhorn et al.[6] the potential positive impacts of organic cultivation can be further increased. Results of the above mentioned study on impacts in Central Asia show that organic farming can also have negative effects, for example on the workload of women[7]. Furthermore, due to long conversion periods without financial compensation[25], the transition from conventional to organic production is challenging for farmers[33]. Eyhorn et al.[6] state that further research is required to explore whether these results can be transferred to other regions.

Therefore this study aims to examine which effects organic cotton cultivation has on the livelihood of smallholder farmers in rural Tanzania. Special attention is paid to:

- the motivation to change from conventional to organic farming,
- experiences and challenges of farmers in the conversion process as well as in the period following the conversion, and
- the attitude and perceptions of farmers toward organic farming in general.

Cotton Production in Tanzania

Cotton was initially brought to Tanzania by the Germans in the 19th century[24]. Cooperative unions and the Tanzania Cotton Board dominated the cotton sector from the 1960s to the 1990s. Due to inefficiencies, this monopoly ended in 1994. Producers' share of export revenues increased while, as negative side-effects of this restructuring, the quality of cotton declined[34]. Due to a lack of investments, the demand of the domestic processing textile industry decreased[18]. Tanzania's cotton sector is still facing these challenges and is additionally confronted with poor infrastructure, a complex taxation system and poor data about cotton production[34]. In Tanzania, yields vary between 560 and 750 kg of seed cotton per hectare[24], making them one of the lowest worldwide[35].

Cotton is the largest export crop in Tanzania after coffee, accounting for 24% of its total agricultural exports[18]. On average 400,000 ha are under cotton production (see Table 1). The largest share of cotton is produced in the western region, where Shinyanga accounts for around 62% of Tanzania's total seed cotton production[18].

Cotton production in Tanzania is dominated by smallholder farmers, with an average farm size of 0.6 ha[35]. Farmers have limited access to agricultural inputs and the agricultural activities are mainly done by hand[36]. Handhoes are therefore the most common instruments, and soil preparations during planting and weeding are partly carried out by animal traction[24,35].

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Table 1. Cotton production in Tanzania and worldwide.

	Cotton cultivation in total (2010/2011–12)		Organic cotton cultivation (2011–12)	
	Tanzania	**Worldwide**	**Tanzania**	**Worldwide**
Cultivated land (ha)	400,000[18]	35,520,000[16]	27,270[16]	317,000[16]
Annual production (t)	315,000[18]	27,100,000[16]	6900[16]	139,000[16]
Farm households engaged (no.)	500,000[18]	–	7000[16]	215,000[16]

Cotton production provides employment to approximately 500,000 rural households in Tanzania[18], representing around 9% of all agricultural households in Tanzania[37].

Due to its importance for rural households, the cotton sector would offer huge potential to combat poverty and improve the livelihood of people in Tanzania on a local as well as on a national level[24].

But although conventional cotton production made a desirable contribution to the overall economic growth in the Shinyanga region since Tanzania gained independency in 1961, it failed to contribute to poverty alleviation, as 42% of farmers in the region are still considered as poor[38]. Low productivity and falling global cotton prices pushed even more farmers even further below the poverty line[38].

Thus, and due to the existing low usage of chemicals and fertilizers, Tanzania seems to be well suited to the production of organic cotton[34].

In 2011/12, in total 27,270 ha were under organic cotton production in Tanzania, cultivated by around 7000 registered farmers (see Table 1). With this share Tanzania accounts for over three-quarters (77%) of Africa's organic cotton production. In the season 2011/12 Tanzania ranked as the fourth biggest producer of organic cotton worldwide, responsible for around 5% of the global organic cotton production[16]. Two projects in Tanzania are working on organic cotton production: bioSustain in the Singida region and bioRe in Meatu district in the Shinyanga region.

Study Region: Meatu District, Shinyanga, Tanzania

The empirical research for this study was conducted in Meatu district in the Shinyanga region in the north of Tanzania.

The main ethnic group in the Meatu district is the Sukuma tribe. All farmers interviewed belong to this ethnic group. Sukuma are settled agro-pastoralists and therefore livestock keeping still plays an important role and fulfills both social and economic functions for farmers. Traditionally, farmers in the Meatu district support each other on the fields in social groups during harvest, called '*Bukomba Komba*'.

In the Sukuma culture polygamy is still allowed and more wives and children indicate a higher economic status and symbolize wealth as, for example, high nuptial money (normally a certain number of cattle) has to be paid.

The Shinyanga region has a mean annual precipitation of 700 mm, varying between 600 and 900 mm within the region. Rainfall is erratic, poorly distributed and varies greatly within and between seasons[39]. Originally the region was forested with woodland and bushland species. During the 1920s and 1930s, large parts of land were cleared of bush and trees to eradicate pathogenic organisms like the tsetse fly[39]. Additionally, the high demand for fuelwood for household consumption further increased deforestation. This, the increasing number of livestock and cultivation pressure through high birth rates increase the depletion of natural resources, which influences living conditions of people in the region to a high degree.

Organic farming in the Meatu district started in 1994 in one village with 45 farmers, founded by 'CIC', a private textile mill, with the support of the Swiss-based company Remei AG. In 2000, Remei AG, which was one of CIC's customers, took over the project and established bioRe Tanzania Ltd (www.biore.ch) as an independent company, with around 320 farmers in two villages[40]. Today, bioRe encompasses 15 villages and around 1600 farmers.

bioRe purchases organic cotton in the region with a 15% price premium on actual local market prices. This is possible through a long established supply chain in cooperation with Remei AG and the Swiss retail company Coop, Switzerland's second largest supermarket[27].

Farmers have to register to become full members of bioRe Tanzania Ltd. These bioRe farmers are certified according to US Department of Agriculture National Organic Program (USDA NOP) for the US market and Austria Bio Guarantee-Production Standard (ABG-PS) for the European Union. Farmers hold a group certification—therefore the project operates an internal control system (ICS). External organic certification bodies—bio.inspecta (www.bio-inspecta.ch) and TanCert (www.tancert.or.tz)—carry out inspections once a year. bioRe Tanzania also follows internal social and environmental standards, which are verified annually through an independent audit by FLO-CERT (www.flocert.net).

The bioRe farmers in villages are organized in farmer groups, where training and meetings are regularly held. In each farmer group there is one farmer representative and two to three host farmers, where farmer training is held on the spot.

In every village there are, on average, two extension workers and one supervisor. Extension workers are

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carrying out training and supervision including regular visits to farmers on their fields. Supervisors are responsible for internal inspections and are supporting extension workers.

Often, several extended family members pool their land and register as a single family unit, where one farmer is registered officially for this family unit. Therefore, an organic cotton farmer of bioRe has an average registered farm size of 32 ha. Family members, such as uncles, sons and brothers, cultivate parts of the registered acreage as so-called *family producers*. Due to the high proportion of fallow land, on average only one-quarter of registered land is used for organic cotton cultivation.

Methods and Interviewee Characteristics

On the basis of a holistic qualitative approach to research, a field study was conducted in Meatu district in Shinyanga region from July to September 2013 in order to explore the impact of organic cotton production on farm families and its complex nature. The aim of this research approach is to get a better understanding of effects and interactions between different factors influencing people's livelihoods. Therefore the study is based on verbal statements (qualitative data) of farmers and focuses on motivations and effects of organic farming realized by farmers. The use of a set of qualitative methods including participant observation, expert interviews and qualitative interviews of farmers provides a multifarious picture, including the individual perspectives of the various actors. Quantifying or counting frequencies of selected aspects of the phenomenon was not part of the study design.

Participant observation was made during field visits, external inspections and group discussions during the whole research period and was recorded in field notes to further understand and complement gathered data[41]. Five expert interviews[42] with representatives of organic certification bodies, the Tanzania Cotton Board—still an important player in the cotton sector—and both the management of bioRe and bioSustain were conducted, to complement observations made during farmer interviews and to receive background information for further clarification.

As this in-depth study aims to give an insight into the wide range of motivations and attitudes of farmers toward organic farming, the impact of organic farming on people's livelihood and the variety of context, 25 qualitative interviews with organic farmers were conducted.

In order to get a comprehensive picture, the selection of farmers was done sequentially by theoretical sampling[43]. Simultaneously the characteristics were pre-analyzed. Farmers with specific characteristics and preconditions (duration of membership at bioRe, gender, village, distance to bioRe offices in villages, acreage) were selected iteratively from bioRe's lists of organic farmers before every interview, to cover a wide range of farmer characteristics. This process was carried out until the stage when no further new information could be gathered[44].

The interviews focused on the perceptions and experiences of farmers, based on a semi-structured interview guide[41]. For additional data about farm characteristics, information access, food security and water access a standardized questionnaire with closed questions was used[45].

The duration of interviews was between one and two and a half hours. A translator was needed to communicate with farmers because most of them speak the local language Kisukuma or the national language Kiswahili. This was a special challenge during field visits and had to be taken into account during interpretations of interviews[46]. Interviews were recorded by a digital voice recorder and additional observations were noted manual by the researcher.

To process the gathered information, conducted interviews were transcribed using f4 audio transcription software and further analyzed according to the content analysis approach[47,48] supported by the software Atlas.ti. Both deductive and inductive coding were used to build thematic categories in code families. In a first step, codes were defined based on the interview guide and in a further step assigned to relevant text passages using a top-down approach. During this procedure further codes were created for emerging topics (bottom-up approach)[44,47].

Characteristics of interviewees

Nineteen male and six female registered bioRe farmers from different villages were interviewed, having an average age of 45 years. Most farmers' highest education level was Standard VII, which means 7 years of primary education. Five farmers had a lower education level than this, and one female and one male farmer interviewed had never gone to school. Only one young male farmer had reached secondary ordinary level.

Eight out of 19 male farmers interviewed had more than one wife, while none were unmarried. Of the six female farmers interviewed, one was divorced, one separated and one widowed, while three were married to husbands with several wives. The average household size was 12 people, with an average of seven children per household.

The registered farm sizes of the interviewed farmers were on average 31 ha, with eight farmers having less than 7 ha. The registered farmers on average included additional three extended family members, so-called family producers, cultivating organic cotton on the registered land. Similar to the average figure for all bioRe farmers, the interviewees used on average one-quarter of their owned land for cotton cultivation.

Out of the 25 interviewees three farmers were still 'in conversion' (second year of membership), while the others had been bioRe members for 5–14 years and therefore 'fully organic'. On average the interviewed farmers had joined bioRe 8 years ago. Four of the interviewed male

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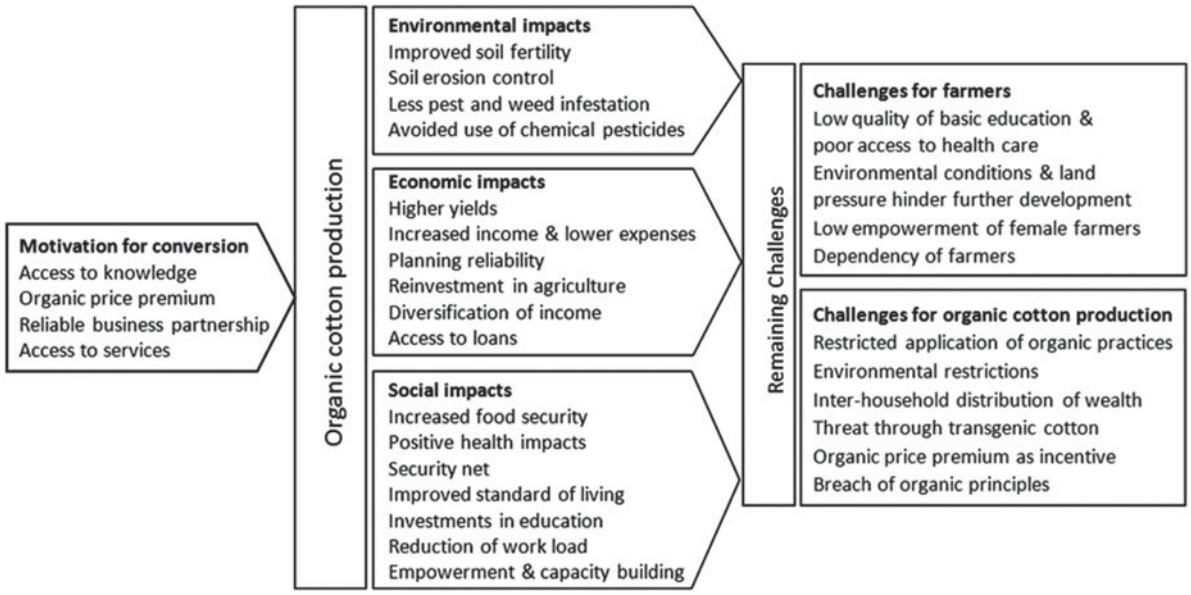

Figure 1. Organic cotton production in Tanzania—motivation, impacts and challenges.

farmers were host farmers and one was a farmer representative. All other farmers were normal members of the groups.

Results and Discussion

The results of this study on organic cotton production in Meatu district, Tanzania, are summarized in Figure 1. Experiences and observations of farmers from the interviews were the main source of information, supplemented with expert interviews and participant observations, especially for analysis of social impacts.

Farmers' motivation to convert to organic farming

Most organic farmers in the region first came across organic farming through village meetings, where the idea of organic cotton production was introduced by extension workers of bioRe. After initially establishing organic cotton production in a few villages, the idea of organic farming spread through exchange of experiences between farmers and observations of neighbors and relatives. Nowadays *kilimo hai* (Kiswahili for organic farming) and bioRe are well known to farmers throughout Meatu district.

Four key motives to convert to organic cotton production and to become a member of bioRe Tanzania Ltd were identified through interviews of farmers:

Access to knowledge to improve soil quality and increase yields. Interviews showed that access to *mafunso* (Kiswahili for knowledge and training) about agricultural practices was the main reason for the conversion to organic farming. Farmers joined bioRe to obtain knowledge about new farming practices, expecting to combat soil erosion, improve soil fertility and increase harvest yields. bioRe has a comprehensive extension service, where extension workers give advice during the conversion period and afterwards during each production step. This extension service is a crucial factor for farmers, as the government does not provide any sufficient extension service in the region, due to lack of money and labor force. According to farmers there was also no reliable support for agriculture or any other kind of support available from other organizations or cotton purchasers. The literature describes that organic farming is information intensive[28] and lack of knowledge is one of the main barriers to adopting organic agriculture[29]. These results confirm that access to knowledge is an important incentive to switch to organic cultivation and crucial to enable farmers to successfully convert to organic farming.

Organic price premium. Another main incentive for farmers to convert to organic farming is the organic price premium provided by bioRe as soon as farmers reach the 'fully organic' status.

Farmers receive nearly 15% more for their cotton than conventional farmers, compared to the average price paid by other local purchasers at the time of purchase. As cotton prices are low in the region, and indeed in Tanzania as a whole, this is an important economic incentive for farmers. Many farmers in the region are eager to join bioRe for this reason. This confirms previous studies[28], which revealed that economic incentives, such as subsidy payments, play an important role as motivation for transition.

Reliable business partnership. Farmers described reliable payment on the spot as an important incentive for conversion. Interviewees reported the many problems farmers are facing with local cotton purchasers, such as

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unreliable, late or even no payment; incorrect weighing scales, etc. bioRe farmers receive payment immediately when delivering their organic cotton at the local buying station and weighing scales are checked regularly. Additionally, conventional buyers are only in villages during the purchasing period, while bioRe is available for farmers year round. Therefore many organic farmers mentioned that it is advantageous for them to constantly have a trustworthy business partner and a purchase guarantee through contract farming.

Access to different services. Diverse services provided by bioRe offer an additional incentive to farmers to produce organic cotton. Farmers have access to farm implements, loans and inputs, such as seeds and botanical pesticides. According to farmers, access to seeds was especially challenging before bioRe, as gained income was expended before the new season started, which meant that required seeds could not be purchased when needed. Some farmers also reported previous problems with seeds that did not germinate properly. To address these issues, bioRe provides farmers with organic seeds and retains money from the previous harvest to cover the costs.

Studies about motivations for conversion in developed countries show ecological awareness as a decisive reason to convert[28]. The interviews in Meatu district showed, on the contrary, that ecological concerns in general are not in the foreground for farmers. Local technical environmental improvements, like better soil fertility and soil erosion control, were mentioned by farmers as a decisive motivation but with the goal of increased yields rather than enhanced ecological conditions. The main incentives for farmers to convert to organic cotton are supervision, increase of yields, higher income, trust and support.

Farmers' challenges during the conversion period

Farmers who decided to convert to organic required on average a conversion period of 2–3 years, depending on the field history of their plots. Although there are many incentives for the transition to organic farming in the region, not all farmers manage to convert successfully and reach 'fully organic' status, as the conversion period can be a serious barrier for farmers.

Data of bioRe showed half of all 'in conversion' farmers had to be excluded from the project during internal inspections in 2013, due, for example, to the use of chemical pesticides or treated seeds. This shows that the conversion period is a critical time for farmers. This confirms what has been described in previous studies[28,33].

Investigating the reasons behind the described challenges, bioRe farmers made contrary statements about the process of conversion. On one hand, some farmers stated that there were no challenges during the conversion period, due to the supervision and training of bioRe. On the other hand, some described the lack of subsidy payments and access to loans during this conversion period as major challenges.

For some farmers it was also difficult to get used to the new farming practices, such as using farmyard manure, doing crop rotation, scouting for pests and sowing in rows. Some farmers also faced a low quality of cotton during this time, due to heavy rainfall and damage to cotton through careless, manual harvest.

It was observed that farmers 'in conversion' had a lower level of knowledge about farming practices than fully organic farmers. Poor attendance of training sessions and meetings, especially of farmers with long distances to training locations, additionally restricted the possibilities to overcome challenges during the conversion period. Therefore remote areas and far distances to village head offices can be a critical challenge for farmers, as well as a low level of knowledge about farming practices in general.

Organic farmers who reached 'fully organic' status mentioned support during the conversion period, such as training and technical advice during regular visits from extension workers, as the most important factors for overcoming the challenges. Farmers also described the access to organic seeds and farm implements to facilitate the new farming practices as important support during the conversion period. Unlike other studies[33], decreasing yields were not mentioned by farmers as a barrier during the conversion period.

These results about the challenges in the conversion period comply with incentives identified above and additionally show the importance of access to knowledge and training. They further reveal, a disparity between farmer's access to knowledge and services, depending on their location as distances are far and have to be covered usually by foot or bicycle.

Although farmers were facing challenges during the conversion period, as described above, positive impacts on the environment observed by farmers, already at an early stage during the conversion process, motivate farmers to continue with organic cotton cultivation.

Environmental impacts of organic cotton production

Environmental conditions have a direct influence on people's livelihood in rural areas of developing countries[49–51]. The farmers interviewed reported poor soils, soil degradation and erosion, especially when plots were flooded after heavy rainfalls. Through the access to knowledge and training, farmers learned practices that enabled them to combat degradation of soils, improve soil fertility and water-holding capacity, as well as to reduce pest and weed infestation on fields. Therefore the observations of farmers, although not confirmed by soil sampling, verify previous studies[30], which also revealed positive impacts on the environment through organic

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farming. In the following, environmental impacts reported by farmers are described in more detail.

Improved soil fertility and water-holding capacity. Farmers are advised to plant different crops on their plots, including leguminous plants such as mung beans (*Vigna radiata*), to have a good crop sequence or to leave some parts of the land fallow. According to farmers, through this crop rotation they could increase the soil fertility of their land to a high extent. Also, the application of farmyard manure reduced soil degradation and farmers observed an improved water-holding capacity.

Soil erosion control. Different methods, like planting giant grass such as Napier (*Pennisetum purpureum*), application of litter, cutting fewer trees, planting of trees and adding soil, where it is uneven, enabled farmers to prevent soil erosion. Although farmers were also trained to cultivate on slopes and to dig water channels to make water available, flooded fields are still challenging when heavy rainfall occurs. According to farmers, this flooding causes rotting of cotton and small cotton fruits.

Less pest and weed infestation and avoiding use of chemical pesticides. Through intercropping with sunflower and crop rotation there is less pest infestation in cotton, as sunflower acts as a trap crop and attracts insects and crop rotation ensures that harmful insects cannot persist on fields. In addition, scouting for pests, as instructed in training sessions, and the use of botanical pesticides provided by bioRe enable farmers to control pests without spraying agrochemicals. Farmers reported negative effects, such as damaged crops, through the application of toxic pesticides in the past. As the use of agrochemicals is not allowed and botanical pesticides are less harmful, this causes positive impacts on the environment, such as the survival of beneficial insects and healthier plants. Weed infestation could also be reduced due to crop rotation and efficient weed control through usage of farm implements provided by bioRe during weeding.

Economic impacts of organic cotton production

In the region there are not many opportunities for farmers to generate income other than through the cultivation of cotton. Therefore higher yields and higher prices for cotton, as well as services provided by bioRe, have a huge impact on farmers' economic status.

Higher yields. The interviewed farmers reported increased yields after converting to organic farming. They described that their productivity per acre increased through better soil quality (through crop rotation, intercropping and use of farmyard manure), sowing in rows (some farmers also did experiments on it and compared yields) and better seeds. They also reported an improvement in time weeding, sowing and harvesting and more efficient farming through access to farm implements. Nevertheless some farmers in certain areas reported decreasing yields through unfavorable climatic conditions (like unpredictable, little or no rainfall) during the past 2–3 years.

Increased income and lower expenses. All farmers reported an increased income since producing organic cotton, triggered by increased yields and the organic price premium. Through the use of oxen and farm implements of bioRe, productivity per acre is higher and there are fewer weeds. Therefore, less hired labor is necessary during the work-intensive weeding time. As hiring labor is an important financial factor, expenses could be reduced. Also other input costs for farming decreased. Although some farmers could not really afford agrochemicals in the past, a lot of farmers did apply high quantities of pesticides on their fields before conversion. These expensive chemicals are now substituted by cheaper botanical pesticides. Chemical fertilizers are replaced by farmyard manure from their own livestock. Farmers also do not have to buy expensive treated seeds anymore, as bioRe provides organic seeds.

Planning reliability through contract farming. bioRe has 5-year contracts with farmers and guarantees to purchase 80% of the cotton harvest of registered farmers. Farmers indicated that it is very advantageous for them to have a secured purchaser and planning reliability through contract farming. Conventional farmers are selling to different purchasers, depending on the season and prices offered. As some purchasers of conventional cotton are not reliable and disappear without, or with only low payment, farmers mentioned payment on the spot as an important advantage: they get paid immediately when delivering cotton to the bioRe center of the village.

Reinvestments in agriculture. As interviews showed, the generated income is, to a high extent, invested to increase the size of the land, in agricultural implements, such as ox weeders and ox carts, and for livestock. Livestock is a very important investment in the region, as it has different functions for farmers. Apart from providing a means of transport and as a source of food, it is also a security net for farmers as it replaces bank accounts and insurance. For instance, when there are food shortages, farmers sell livestock to overcome this period.

Diversification of income. Another economic impact is that farmers can invest their additional income into further activities beside agriculture. Many farmers set into practice their own ideas, possible through higher income due to organic farming. One female farmer, for example, reported that she could open a small vegetable shop due to the increased income, and thereby generate additional revenue. Furthermore bioRe provides sewing machines to women and trains them in tailoring to enable them to add a small earning.

Additionally, through increased cultivation of sunflower through intercropping, farmers can extract oil for home use and sell the excess. Farmers are also encouraged by bioRe to cultivate sesame, which can also be sold,

although the lack of local markets for organic products hinders the sale of these products with an organic price premium.

Access to loans. Farmers in developing countries often lack access to financial means, which hinders efforts of rural poor people to develop[52–54]. To receive a loan people in the region often have to accept very high interest rates, making them pay back up to double the amount they received. Therefore, a further important impact for bioRe farmers is the possibility of getting a loan with zero interest rate. Farmers are mainly using loans to invest in agriculture, for example to pay work labor on their fields or to buy new land. Therefore for bioRe farmers this is a great opportunity, although some are not satisfied with the allocation and the limited amount of loans. As 'in conversion' farmers are excluded from this possibility, they have to wait to get full organic status, which can be challenging for them.

The described environmental and economic impacts also triggered social impacts, both at household and community level.

Social impacts of organic cotton production

Various favorable social impacts were observed, mainly due to changed farming practices, increased income and services from bioRe Tanzania.

Increased food security. By converting to organic farming, food security of farmers improved due to organic farming practices such as the application of manure, intercropping and crop rotation. These practices made land more fertile, thereby increasing yields, while intercropping and crop rotation also made it possible to grow food crops, such as sunflowers and leguminous plants, in addition to the cash crop cotton. Farmers use sunflowers to produce oil for home consumption, generate revenue from the excess and can use the residues as fodder for cattle. Mungbean is a widespread leguminous plant and an important trap crop. It offers a healthy option to supplement the carbohydrate-intensive diets dominant in the region. As the socially preferred food by farmers is very carbohydrate-intensive and lacks vitamins and proteins, bioRe also provides cooking lessons for female farmers to foster the consumption of mungbeans and turn them into a socially better accepted food source. Nevertheless, food security remains a challenge for farmers in the region. A large proportion of farmers mentioned that food shortages in the household still occur between December and February. The reasons for the shortages are mainly unpredictable rainfall and droughts. Most farmers sell their cattle, use income from selling cotton or ask relatives or neighbors for assistance to buy food during this time.

Positive health impacts. Farmers reported that in the past, after the application of pesticides, their skin was irritated and they had to burn their clothes. Most farmers were not aware of the negative side-effects of agrochemicals on human health and therefore did not use any protective gear during the application of pesticides. As there was no awareness, farmers were also consuming food from sprayed fields. Anyhow, farmers who were aware of the negative effects could not afford any protective gear. As agrochemicals are strictly prohibited in organic agriculture, farmers received training where they learned about the damaging effects of toxic chemicals. Through this training farmers were made aware of the negative impacts and could realize that the elimination of pesticides causes not only positive effects on the environment but also reduces the exposure of farmers to toxic chemicals.

Security net. As there is no insurance possibility for farmers in the Meatu district; livestock is used to fulfill this function; and with no social security system or any other sufficient support by the government, one important aspect for farmers is a security net provided by bioRe. In cases of serious food shortages, heavy losses of harvest through hailstorms and other incidents, not manageable for a lone family, bioRe supports these families. Farmers mentioned the importance of having a reliable partner in case of urgent needs and a permanent contact person through regular supervision by extension workers. In many cases a personal and close relationship between farmer and extension worker was observed. Farmers value this to a high degree, as they do not only receive knowledge but also have the security that somebody is there to assist them.

Improved standard of living. Apart from investments in livestock and land, the additional income through organic farming is mainly invested to improve dwellings. As traditional houses in the region are made out of mud and straw, lots of farmers spend their income to construct modern houses with burnt clay bricks and corrugated sheet roofs. Some, mainly female farmers, indicated that they also slightly improved their furniture and are using the money for clothes or health care. As respiratory problems and diseases are very common in the region due to cooking in small, unventilated rooms, bioRe Tanzania provide subsidized smokeless stoves, through which harmful emissions can be reduced. Another important improvement for farmers and their families is the access to water. bioRe builds water wells in villages where the project is established. This especially benefits women and children, because they are responsible for collecting water. Without water wells, dried-up riverbeds, where one has to dig several meters to reach water, offer the only alternative access to water in the region. Nevertheless, water is still a limiting factor in the region and some families still depend on dried-up riverbeds which are often far away. Some farmers invest their additional income in bicycles or motorcycles, as this offers the only form of transport and saves them from having to cover the often very long distances on foot.

Investments in education. Farmers indicated that they use a certain part of their additional income for the

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education of their children, grandchildren or other relatives. Some farmers also managed to send their children to university through the increased income. bioRe tries to support schools in villages where bioRe is working. In the region it is common for villages to provide teachers with housing. In one village bioRe supported the construction of the teacher's house. A gardening project was started in one school near the bioRe head office. Nevertheless, education of children remains a critical factor, as local schools lack money and offer low-quality education.

Reduction of workload. Bachmann[7] describes that workload increased through organic farming. In this study it can be shown that, under the condition of a constant farm size, the efforts by bioRe are reducing the workload below the previous level of conventional farming, mainly due to two reasons. According to the conducted interviews, previously farmers mainly weeded solely by hand. Farmers can now rent farm implements for free from bioRe or buy their own through the increased cotton income. Also, farming practices like sowing in rows simplified the work, allowing farm implements to be used for weeding.

Empowerment and capacity building. Farmers in the Meatu district are highly vulnerable to environmental influences. Organic farming increases the ability of farmers to deal with challenges mainly through three factors: access to knowledge, the formation of groups and access to loans. For example, through the gained knowledge on organic farming practices, farmers to a certain extent are able to influence local unfavorable conditions, such as poor soils, in a positive way. Through organic farmer groups, farmers have a platform for discussions and can exchange experiences. Farmer groups send information, such as requests or ideas, through a farmer representative to the head office and therefore decide to a certain extent by themselves what they require. Through this possibility for farmer groups to take part in decisions and to formulate common statements, farmers are strengthened. Observations showed that farmers are self-confident and aware of their importance for the project. All farmers described increased cooperation with other farmers. Next to common decisions within farmer groups, they exchange knowledge and experiences. In some farmer groups, members also started to make field visits to each other, even without extension workers. Within these groups, organic farmers encourage each other to stick to the organic principles. This enables an independent and long-lasting development of farmers and farmer groups. Not only members of bioRe can profit from knowledge through organic farming. Some bioRe farmers also share their knowledge with interested neighboring or related conventional farmers. Having learnt from bioRe farmers, some were using certain organic farming methods even before becoming members of bioRe. This shows that, in some cases, the idea of organic farming and knowledge about efficient agricultural practices spreads in villages even without interventions by bioRe.

Challenges and future perspectives

Although many positive impacts could be revealed, there are still challenges facing farmers and organic cotton production in general in Meatu district.

Challenges for farmers

Low quality of basic education and poor access to health care. Through insufficient payment of teachers and poor facilities of schools, the quality of basic education in the region is low. Although schools are supported in different ways by bioRe, the quality of basic education remains unsatisfactory. This is hampering a lot of possible development in the region. Also modern health care is limited in the area. For many farmers, sickness of family members is a crucial challenge as there is low governmental support. Although increased income through organic farming enables farmers and their families to cover medical costs to a higher extent, high treatment expenses are still challenging for farmers' families. This is one reason why farmers in the region still turn to traditional healers.

Environmental conditions and land pressure hinder further development. Limited natural resources and environmental conditions are one of the biggest challenges for people in the region and one important trigger of poverty. The lack of fertile soils, deforestation, water shortages and extreme weather phenomena such as heavy rainfall and drought, hinder improvements to people's livelihoods. Although farmers can increase their ability to cope with these circumstances through organic farming practices and higher resilience, the situation is still challenging.

For cotton yields, weather conditions are very important and farmers are highly vulnerable, as there is no insurance against losses of harvest. Some farmers mentioned unpredictable rainfall and droughts, which caused lower cotton yields and losses of food crops to occur more frequently. Additionally, hail storms regularly destroy cotton fields.

Although bioRe builds water wells, water remains limited and walking distances to fetch water are still great.

Limited land area, restricted natural resources and rapid population growth—birth rates are very high in the region—lead to land pressure and overstrained resources. The high demand for firewood, for example, causes clearance of trees, which results in further environmental problems. Additionally, droughts, poor access to water and the fact that the region is one of the poorest in the country make life burdensome, which causes migration of people to neighboring regions.

Low empowerment of female farmers. Women are important adapters of organic farming[29]. bioRe data show that registered female bioRe farmers are less likely to

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be excluded from the project than men. Within farmer groups nearly all farmers insisted that the cooperation between male and female farmers is good. Furthermore, registered female farmers stated that they can participate in decisions of farmer groups and give their views. Female farmers nevertheless account for only around 15% of the registered bioRe farmers. Women register only if they are unmarried, widowed or their husband has more than one wife on different farms.

According to farmers there are always few women participating in training and meetings, as usually the husband attends farmer training and meetings, while female farmers remain at home, limiting their input to discussions, which fails to strengthen female farmers and their position. Interviews revealed that for female farmers; registered or not; it is more difficult to attend training, because of their responsibilities at home and the traditional role assigned to women. Therefore they profit to a lower degree from training and the reduced workload, as their time is also assigned to other duties.

Men are traditionally the heads of households and the interviews showed that male farmers, to a large extent, still decide by themselves on the use of the income. Hence it can be assumed that women profit less directly from the increased income.

In the Sukuma tribe, polygamy is allowed and a high number of wives and children symbolizes a high economic status. As the gained income is mainly used to purchase land and livestock, the total workload for farmers' families can increase. This can be used as an argument why the farmer requires a greater number of wives. The increased income also enables the farmers to provide for a greater number of wives. A greater number of wives results in a smaller workload for each wife, which is in turn used as an argument as to why also women benefit from polygamy. This means that an increased income can lead to an increase in the number of wives.

Nevertheless organic farming opens different possibilities for women, as bioRe offers special support, such as tailoring groups to earn an independent income and, as mentioned before, the provision of wells in the villages which benefits mainly women and children.

Dependency of farmers. bioRe has a monopoly position for organic cotton production in the region. Therefore organic farmers rely on bioRe to a high degree in different aspects. For example, marketing of organic cotton is only possible through bioRe. The alternative is to sell without an organic price premium. Additionally farmers only get organic price premiums for cotton due to the lack of local markets for other organic products. Thus, if bioRe could not continue with organic farming, organic production in the region would be in peril.

As bioRe has been working in the region for several years, farmers have high expectations regarding different concerns and believe that bioRe can solve all problems. This creates a sense of security, but also dependency and lethargy.

Another aspect is dependency regarding information. Farmers in the region have, on average, access to two radio channels (one governmental and one private channel). Overall this is the main source of information, except for village meetings and informal exchange within villages and farmer groups. Therefore knowledge from bioRe has a big influence and farmers depend to a high degree on bioRe regarding new information, though this may change as nearly all farmers interviewed have a mobile phone. A big change for rural farmers can be access to information through mobile phones[55].

Challenges for organic cotton production in Meatu district

Limitations due to restrictions in the application of organic farming practices. Although most farmers reported the positive impacts through the application of organic farming practices, observations showed barriers that did not allow for the full application of some of the mentioned practices.

Nearly all farmers stated that crop rotation is an important technique to improve soil fertility. But some mentioned that for them it is difficult to set this into practice, as there is limited land, with additional family members claiming parts of the land. Field visits confirmed these statements and showed that every year some farmers use their same 'good', fertile fields to grow cotton. Also the availability of farmyard manure is limited and is mostly applied only on cotton fields. A further constraint is that in Tanzania intercropping is not desired by the government as, traditionally, farmers intercrop cotton only with maize, which impoverishes soils. Intercropping is done by farmers, but utilized to a lower extent than recommended.

A further governmental recommendation is contradictory to organic principles. Burning of crop residues, although prohibited according to the National Organic Product (NOP) Standard, is encouraged through national radio to avoid persistence of pests in harvest residues.

An extension service is crucial for the application of organic principles. Especially when there is pest infestation, extension workers have to support farmers and assist them, for example during the application of botanical pesticides to avoid misuse. Some extension workers are young and have little experience with organic farming. This and the high fluctuation of extension workers harm the efforts to keep the quality of extension service high. Additionally, the continuously growing number of farmers to be visited is challenging for extension workers.

This shows that certain preconditions (limited land, lack of manure and contradicting governmental advice), but also the attitude of farmers (adherence to old habits) and quality of extension service influence the level of application of organic farming practices.

Environmental restrictions. As water stays the limiting factor in the region, large-scale irrigation systems, which

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could highly increase cotton yields, are not possible. On the other hand, in these semi-arid conditions fewer insects are attracted to cotton fields, due to smaller cotton fruits, and therefore a lower use of pesticides is needed in general. This favors organic farming, as farmers are less tempted to use forbidden chemical pesticides.

Land is an important limiting factor for farmers. As organic farmers have to rotate crops, fallow land also has to be cultivated. Additionally, the organic price premium motivates farmers to use more land in total for cotton cultivation, which increases land pressure. The use of income from organic farming mainly for land and livestock further enhances this development.

Inequitable inter-household distribution of wealth. A minimum of 3.6 ha of land is needed to join bioRe. This is necessary to enable crop rotation and to avoid overuse of soils. The farmers, who have less land than required to become members of bioRe, do not have the possibility to profit from organic farming and are excluded from positive impacts through organic cotton production. This is critical as farmers who can join bioRe, use the additional income through organic farming mainly to add even more land and livestock, widening the difference in the economic status of farmers.

Threat through transgenic cotton. Transgenic cotton, mainly Bt-cotton, is grown on about 70% of the 35.52 M ha under cotton cultivation worldwide[16]. Transgenic Bt-cotton ('Bt' expresses an insecticide from the *Bacillus thuringiensis* bacterium) is one of the most widespread biotechnologies and, along with herbicide resistance, the most common transgenic trait in cotton[56].

In countries, where Bt-cotton was introduced, the access to non-transgenic seeds is the main challenge for organic cotton farmers. Due to the lack of good-quality non-transgenic seeds, organic cotton production decreased in these countries, in some cases to a high degree[17].

As in other African countries, in Tanzania transgenic crops and the introduction of Bt-cotton are topics of polarized debate. Different stakeholders and NGOs who oppose the cultivation of Bt-cotton are engaged in discussions[16]. Until now no Bt-cotton crops are being planted on farmers' fields in Tanzania, as regulations state that companies that bring in new technologies are responsible for possible damage through these new technologies. Nevertheless, Tanzania is researching and running trials on transgenic cotton[16] and a committee with different stakeholders was set up to find a common position at the national level. Although different studies indicate that there are low rates of cross-pollination between cotton fields[57], Niranjan Pattni from bioRe Tanzania and Bernd Jauch from bio.inspecta expect that Bt-cotton in Tanzania could be a serious threat to organic cotton production. As experienced in other countries, the domination of Bt-seeds on the seed market makes the access to non-Bt-seeds difficult for organic cotton farmers. At the time of the interviews, none of the farmers had information about transgenic cotton. This shows that there is no public discussion integrating or informing farmers. This lack of elucidation and integration of farmers can be an important risk for organic farming.

Organic price premium as an incentive. External incentives (like subsidy payments) might replace internal motives, such as environmental attitudes[58], if the incentives are higher than the comparative level of losses through changes of the cultivation system would be[28]. Therefore an organic price premium once granted can also be a challenge for organic cotton projects, especially when it goes beyond closing the gap caused by the higher cost of organic over conventional farming. As nearly all farmers reported increased yields and no harvest losses, the organic price premium is an additional external incentive. This price premium also attracts farmers with foreground financial motives. In the case of stopped payments of price premiums—a lack of markets for organic cotton can make it difficult for organic cotton projects to pay price premiums—farmers are induced to consider stopping organic cultivation. For organic cotton projects this would cause the loss of organic farmers and their investments in farmers' education.

In interviews, farmers indicated that they would continue organic farming, even if there was no organic price premium. Farmers mentioned access to knowledge, training and services of bioRe as reasons to stick to organic farming, even without continued subsidy payments. Observed side-selling to conventional purchasers, when prices are temporarily higher, contradicts this and shows that prices are an important factor for farmers.

Breach of organic principles. Once a year, inspections are carried out according to the ICS. During these inspections, in the season 2013, around 20% of bioRe farmers had to be excluded from the project due to the use of prohibited treated seeds, the application of forbidden chemicals or parallel production of organic and conventional cotton. Farmers—although aware of the advantages of being a member of bioRe—breached organic principles for different reasons.

The use of treated seeds happened partly because farmers have to register for non-treated seeds before the season starts. If farmers have a higher than expected demand, they are tempted to use prohibited treated seeds from other sources instead of registering again, especially in the case of long distances to bioRe offices.

The use of forbidden chemicals happened especially when there was high pest infestation—cotton bollworms, such as the African bollworm (*Helicoverpa armigera*), spiny bollworm (*Earias* spp.) and the pink bollworm (*Pectinophora gossypiella*), as well as pests such as cotton aphid (*Aphis gossypii*), cotton stainer (*Dysdercus* spp.), cotton jassid (*Empoasca* spp.), cotton leaf worm (*Spodoptera littoralis*) and cotton leaf roller (*Haritalodes (Sylepta) derogata*) are a problem in the area—and farmers were afraid of losing their harvest. Normally organic farmers have to inform extension workers when

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pest infestation is discovered, to get assistance with the application of botanical pesticides, such as pyrethrum. As farmers are not allowed to keep their own spraying pumps or to spray without extension workers, farmers sometimes have to wait, especially when fields of more bioRe farmers are affected. As for most farmers, cotton is the only source of income, they fear yield losses if they wait too long. Therefore some farmers used chemical pesticides, such as permethrin, Karate® or a pyrethroid, and then were excluded from the project. Another reason for the use of forbidden pesticides is that farmers see the effects of chemical pesticides immediately after application and therefore are sure to have efficiently combated pests.

Parallel production of conventional cotton is mainly done through family producers. On most farms, family members of the registered bioRe farmer, such as brothers, uncles or sons, have the right to cultivate a certain part of the land. As some family producers do not follow organic principles, this also causes exclusions of registered farmers, as the whole acreage has to be cultivated organically.

Further reasons for the breach of organic principles can be poor attendance of training—more frequent when bioRe offices are distant—together with a low level of knowledge of farmers and frequent change or low dedication of extension workers.

Summary and Conclusions

Farmers in the Meatu region in Tanzania are facing various challenges, such as water scarcity, deforestation, poor soils, low yields and limited access to external inputs due to low capitalization. Also social circumstances are challenging, such as high birth rates, gender disparities, low education level, insufficient health care and poor access to information, as it is a very remote region.

Fighting these problems, farmers profit to a high degree from the transition to organic agriculture and services from bioRe Tanzania. Although for farmers the price premium is an important incentive, access to training and advisory services are even more important for conversion to organic, as no other sufficient agriculture extension service is available in the region.

As the level of poverty in the region is high, general ecological concerns beyond technical environmental improvements to increase yields, such as improvement of soil fertility and soil erosion control, are not primary reasons to convert. After becoming organic farmers this is changing and farmers are becoming more aware of environmental effects and ecological concerns.

Nevertheless the conversion period contains various obstacles, as farmers do not yet get subsidy payments and still have knowledge gaps about organic farming practices. Therefore it is a critical time, when the supervision through extension workers is especially important. Thus, the quality of extension services is decisive for the successful adaption of organic farming.

Knowledge through training, technical advice and exchange of experiences in organic farmer groups enables members to combat soil erosion, improve soil fertility and increase yields. Results of other studies[29,59] describing decreasing harvest quantities during conversion could not be verified. Concrete data about yield developments are missing, but interviewees clearly stated observing a rising trend in yields. Preconditions, such as a low level of knowledge, low yields and missing external inputs in the region before conversion, can be a reason for these results.

Higher yields and organic price premiums could boost the economic status of farmers to a high extent. The access to loans and other services also contributes to this development.

Although there are considerable environmental improvements and more sustainable cotton cultivation, unfavorable natural environmental conditions, such as water scarcity, cannot be compensated by organic farming. Organic cultivation can also lead to a higher use of land for cotton cultivation as the production gets more profitable and, together with investments in land and livestock, to even more land pressure.

Next to this possible negative effect, the conversion had decisive positive social impacts on farmers. The additional income, mainly invested in land and livestock, is also used to improve dwellings and education of children. In contrast to other studies about the impact of organic cotton cultivation, which show an increased workload for farmers in organic cotton production[7], this investigation shows that the workload could be decreased compared to conventional farming through access to farm implements and new farming techniques. The prohibition of agrochemicals has not only positive impacts on the environment, but—as farmers were usually unprotected during the application—also on farmers' health.

Projects at the community level, such as construction of water wells and the support of schools, as well as the provision of smokeless stoves and sewing machines for female farmers, could further contribute to social improvements. Additionally, through bioRe Tanzania farmers have a contact person during difficult times and therefore, to a certain extent, a type of social security system. One key topic of social aspects of organic farming is the empowerment of farmers through the possibility to participate actively in decisions of farmer groups. This empowerment of farmers can be further increased through more involvement in decisions at project level. Active exchange of experience and knowledge in farmer groups contributes to the construction of long-lasting social changes and capacity building.

Next to these achievements the inter-household distribution of wealth must be critically reviewed. Farmers with a small acreage do not have the same potential to profit from organic agriculture, which is causing an increasing gap between farming households.

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Gender disparities are also still challenging, as only a few female farmers are registered at bioRe and, due to huge responsibilities at home (the main duties for women are child care and domestic work), female attendance at meetings and training is lower. As men control household earnings, women benefit directly from the increased economic status to a smaller extent, although they benefit indirectly through a higher household income. A higher economic wealth can also lead to polygamy and further children, as this is a symbol of status. Although positive effects on female farmers were recognized, to a certain extent cultural preconditions hinder efforts to strengthen women in the region.

Although an empowerment of farmers was recognized, there is still a high dependency on global trading schemes and volatile world market prices. Since liberalization, cotton prices in Tanzania have followed world prices relatively closely and therefore are subject to wide fluctuations[60]. Estimations indicate that through subsidies for cotton production in the USA, the world price for cotton is reduced by 10%[3]. Thus, although organic farmers receive around 15% more compared to local conventional cotton growers, prices are still dictated by unequal trading regimes where small-scale farmers working manually have to compete with big mechanized industries. Furthermore, a decreasing consumer demand for organic textiles threatens the future of organic cotton projects[16].

The study clearly shows that organic farming can contribute to the improvement of livelihoods in the region to a high extent, but cannot change and fully balance global trading schemes, social problems (such as high birth rates, gender gaps, poor education system and missing health care) as well as environmental restrictions, (such as water scarcity and extreme weather conditions), which trigger food insecurity and burdensome lives. Nevertheless, the example of bioRe revealed that, despite these preconditions, another type of business cooperation is possible, which triggers a more sustainable development.

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