Chapter 11
Gender, Social Equity and Innovations in Smallholder Farming Systems: Pitfalls and Pathways

Tina D. Beuchelt

Abstract Development processes, economic growth and agricultural modernization affect women and men in different ways and have not been gender neutral. Women are highly involved in agriculture, but their contribution tends to be undervalued and overseen. Sustainable agricultural innovations may include trade-offs and negative side-effects for women and men, or different social groups, depending on the intervention type and local context. Promising solutions are often technology-focused and not necessarily developed with consideration of gender and social disparity aspects. This paper presents cases of gender and social equity trade-offs related to the promotion and diffusion of improved technologies for agricultural development.The analysis is followed by a discussion of opportunities and pathways for mitigating potential trade-offs.

Keywords Gender • Marginality • Social disparity • Agricultural technologies • Women farmers

Introduction

Threats to future food security include climate change, overexploitation of natural resources, soil degradation and a change in demand structure for non-food uses of biomass. At the same time, the world is marked by enormous inequities in contemporary living conditions (Anand and Sen 2000). Sustainable development and human development therefore need to go hand in hand given that *"sustainable development can only be achieved when both men and women have the opportunities to achieve the life they choose"* (IISD 2013). However, development processes and economic growth have not been gender neutral; men and women are affected in different ways (Momsen 2010). The modernization of agriculture has changed the division of labour between women and men, often increasing women's dependent

T.D. Beuchelt (✉)
Center for Development Research (ZEF), University of Bonn, Bonn, Germany
e-mail: beuchelt@uni-bonn.de

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status as well as workload. It has displaced women from their traditional productive functions, and diminished the income, power, and status they previously had (Momsen 2010; Moser 1993).

In many Sub-Saharan Africa and South Asian countries, the agricultural sector is underperforming. According to the FAO (2011), one of the key reasons is large gender inequalities in access to and control over resources and opportunities which undermine sustainable and inclusive agricultural development. The inequalities relate to many assets, inputs and services, such as land, livestock, labour, education, extension, financing and technology. This imposes actual costs on the agriculture sector, limits its efficiency, and includes costs for the broader economy and society (FAO 2011). A change in the distribution of inputs and/or control over resources between female and male farmers can not only significantly increase productivity, food and nutrition security, but also positively affect education outcomes (Alderman et al. 1995; Meinzen-Dick et al. 2011; Quisumbing and Maluccio 2000; World Bank 2009). The FAO (2011) estimates that if women had the same access to productive resources as men, total agricultural output could be raised in developing countries, which, in turn, could reduce the number of hungry people in the world by 12–17 %.

The socio-economic and institutional context in which innovations are introduced is key for their adoption (Bayard et al. 2007; Shaw 1987; Umali et al. 1993). Important aspects are the socio-economic status of the household, access to and control over resources and services, and intra-household dynamics (Haque et al. 2010). Gender aspects are often central for the success of agricultural interventions and development because of the specific roles and responsibilities of women and men in the agricultural systems and value chains (Beuchelt and Badstue 2013; Carr 2008). However, solutions to low agricultural productivity often focus on technological innovations, but do not necessarily consider social and gender disparities. Evidence grows that innovations in agriculture can affect women and men differently within households and communities due to differences in power, roles and access rights (Doss 2001). Still, relatively little is known about how agricultural development programs can most effectively deliver outcomes of well-being and higher incomes in ways that acknowledge the differential access to and control over assets and that lead to more equitable outcomes (Meinzen-Dick et al. 2011). Therefore, this chapter aims first to identify differential impacts of technological innovations on women and men and the related reasons. Second, it looks at opportunities and pathways to increase gender and social equity when designing and fostering innovations for sustainable agriculture intensification.

This chapter is based on a comprehensive literature review. While the focus of the chapter is on gender, we also address social equity aspects, since they are often interlinked. The next section introduces concepts around gender and the adoption of agricultural innovations, as well as analytical categories in which trade-offs and opportunities for innovation may occur. The third section addresses trade-offs in technological innovations from gender and social equity perspectives, using the case of conservation agriculture and decentralized bioenergy production. The fourth section identifies opportunities and pathways to enhance gender and social equity with sustainable intensification processes; the last section concludes.

Gender and the Adoption of Agricultural Innovations

Concepts

Many research projects and development programs around technological and institutional innovations for sustainable agricultural intensification are built on the assumption that by targeting the "household", all members will (equally) benefit from the intervention. Typically, households are perceived as quite homogenous in terms of family structure, with the man as the household head who adequately represents the needs and preferences of all household members (Moser 1993). Empirical evidence, however, shows that households do not have a joint utility function or practice joint decision-making; unequal exchange, power imbalances and inequality exist within households and between husbands and wives (Quisumbing 2003). In smallholder and marginalized farming systems, limited resources are typically allocated according to the priority of the household and/or to the most powerful household member, who is usually a man (Ponniah et al. 2008).

Gender[1] is a determining factor in defining who does which activity, who owns a good or resource, who decides, and who has power (UNICEF 2011). Gender aspects relate directly to men's and women's roles and responsibilities in the farming household and to decisions about allocating resources or adopting technologies in farming systems. For example, in Africa, wide gender disparities exist over ownership and management of land, trees and other resources; certain crops, trees, or parts of them, or necessary management activities, are often specifically attributed to or used by either women or men (Carr 2008; Doss 2002; Kiptot and Franzel 2011; Schroeder 1993).

In Africa, female farmers, compared to male farmers, often show lower adoption rates of sustainable intensification practices such as high-yielding varieties and improved management systems (Doss 2001; Ragasa 2012). Ndiritu et al. (2014) find for Kenya that women have similar adoption rates of intensification practices such as soil and water conservation measures, improved seeds, chemical fertilizers, and maize-legume intercropping, but are less likely to adopt minimum tillage and animal manure for crops. They relate the observed adoption differences to gender differences in access to these technological innovations and to required inputs, resources or information, as well as other socio-economic inequalities and barriers for women.

Successful interventions are usually transformative, whether through creating opportunities, new commodities and services or through changing the ways people

[1] Following Beuchelt and Badstue (2013), the term gender is used to refer to the socially constructed roles, rights, and responsibilities of women and men and the relations between them. Men and women, and their relations, are defined in different ways in different societies and, influenced by historical, religious, economic, and cultural realities, the roles and relations between women and men change over time (Doss 2001).

do things (Meinzen-Dick et al. 2011). Also, the gender roles and responsibilities are dynamic and get renegotiated, reflecting the changes in socio-economic circumstances; it is thus difficult to predict a priori what the adoption effects will be within households and communities (Doss 2001). For example, after innovating, women farmers face difficulties in maintaining profitable market niches and risk losing control over resources such as land, as men often take over production and marketing when it becomes financially lucrative (Momsen 2010; World Bank 2009). Since there have been several detailed literature reviews on gendered constraints and opportunities in relation to the adoption of new agricultural practices and technological innovations (Doss 2003, 2001; Peterman et al. 2010; Ragasa 2012; World Bank 2009), this section will not deal with it further, but will concentrate on how to categorize opportunities and trade-offs in agricultural innovations.

Analytical Categories for Identifying Opportunities and Trade-Offs in Innovations

From a gender and social equity perspective, opportunities and trade-offs in innovations around sustainable agricultural intensification typically occur in several areas of the farming and food system (Fig. 11.1). These can be grouped into five analytical categories: food and nutrition security as well as diversity; resources and labour; information and technology; and income, marketing and value chains, as well as health aspects (Beuchelt and Badstue 2013). The identification of the categories is derived from a review of the literature on human rights-based approaches to development, particularly for agriculture, nutrition and women (Anderson 2008; Cornwall and Nyamu-Musembi 2004; Doss 2001; FAO 1998; Lemke and Bellows 2011; Rae 2008; Socorro Diokno 2013).

For each category, innovations can have different effects on women and men from different social groups which may also stretch out to other categories. The effects of technologies and interventions are likely to vary between individuals in a household or between different social groups, depending on the socio-cultural context, age, sex, skills, abilities, religion, social relations, including kinship ties, and economic status. It is important to ask who benefits, who loses and what the potential consequences are. There is an enormous heterogeneity and complexity among African and Asian households, including in regard to gender roles, therefore generalizations are not possible (Doss 2001).

Identifying potential gender or social equity trade-offs in itself may lead to opportunities to address them straight away in the research for and implementation of innovations. It also may lead to the discovery of complementary measures that can enhance the overall potential for positive human development impacts of the particular intervention.

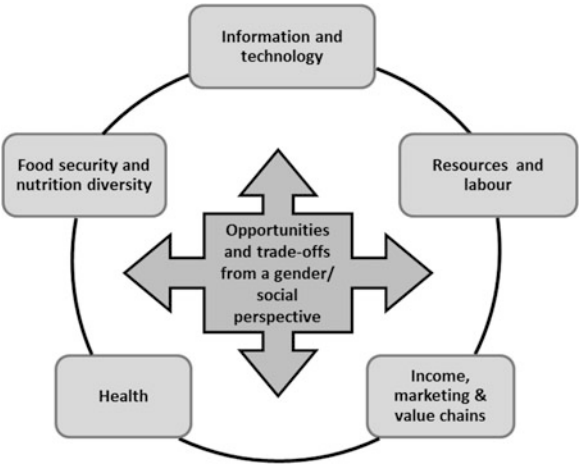

Fig. 11.1 Analytical categories for identifying potential gender and social equity trade-offs or opportunities related to agricultural technologies (Source: Adapted from Beuchelt and Badstue (2013))

Technological Innovations in Agriculture from a Gender and Social Perspective

Several research studies have shown that women's labour burden can increase with new agricultural technologies and innovations. This happens when women take on additional tasks, or when their current tasks become more burdensome, for instance, when fertilizer application requires more weeding, or more output to be processed – both tasks often done by women (Doss 2001). Along similar lines, it is pointed out that *"an intervention that increases the amount of time women work in the field without considering childcare may improve food availability and diet, but hurt child welfare"* (Berti et al. 2004, p. 605).

A study by Paris and Pingali (1996) shows that the gender and equity impacts of a new labour-saving technology depend on the cultural and social characteristics of the local context. The introduction of a mechanical thresher in the Philippines reduced labour for both men and women, since threshing was much faster. Farmers were thus able to grow a second rice crop, which benefitted women, as it increased their employment opportunities in transplanting, weeding, and harvesting. The benefits outweighed the reduced labour demand for threshing. Contrarily, in Bangladesh, the introduction of a mechanical thresher affected poor and landless women negatively, because it replaced their work as a thresher. As cultural restrictions prevented these women from leaving their homestead, they could not look for alternative employment opportunities, and thus lost an important income source (Paris and Pingali 1996). Similar effects occurred in Vietnam, where new seeder technologies were promoted for rice production. As a consequence of adoption, more than half of the women from poor farming households, who previously worked as agricultural wage labourers in rice transplanting, lost this important income opportunity (Paris and Truong Thi Ngoc Chi 2005).

Palmer-Jones and Jackson (1997) report on treadle pumps and their gender effects in Bangladesh. The pumps were introduced as a pro-poor technology so that poor farmers could irrigate their fields. Though this often lead to an increase in production, food security and income, negative effects also occurred. Women living on small farms did the pumping in addition to their other household responsibilities, which not only raised their total labour burden but also its intensity. Although the treadling affected the women's ability to perform their other household tasks or reduced breast milk production, only in some cases did they receive support from their husbands. In other cases, poor women employed by better-off households had to use the treadle pumps as part of their employment activity. Women frequently suffered pain and exhaustion from the pump, even months after the work was finished. In general, more women than men used the treadle pump, especially those from poorer and female-headed households; however, the pump was clearly designed for the average weight and strength of a man and not of a woman (Palmer-Jones and Jackson 1997).

A positive example of unexpected gender effects is the case of the improved dual-purpose cowpea, which was developed to address problems of low productivity in northern Nigeria. As a result, productivity increased and with it the availability of food, fodder, and household income. Though cowpea production and sale is a male activity, additional income from the grain sales was also forwarded to the wives. The women saved the money, bought household goods or food, and invested in petty trading. Though it was not expected, the social and economic status of the wives from male adopters were improved (Tipilda et al. 2008).

Gender differences may also exist in regard to male and female farmers' crop preferences and varieties. Women and men rate maize characteristics differently and prefer different combinations of traits because of the intended maize consumption objectives, e.g., for markets, their own consumption, special dishes, feed (Bellon et al. 2003; Hellin et al. 2010). Whereas men often prefer high-yielding varieties to sell surplus production, women's reproductive roles often mean that they focus on food security and/or varieties that are palatable, nutritious and meet processing and storing requirements (Badstue 2006; Bellon et al. 2003). Improved maize varieties may also require longer cooking times, thus requiring more firewood and more female labour, and consequently are less preferable to women (Hellin et al. 2010). In Mexico and southern Africa, women's varietal preferences are also linked to their productive roles and income generation from the artisanal processing and sale of traditional maize products (Badstue 2006; Bellon et al. 2003; Doss 2001).

In the following section, two case studies are presented which describe in more detail the differential impacts of technological innovations regarding gender and social equity using the five analytical categories from section "Gender and the Adoption of Agricultural Innovations".

The Case of Conservation Agriculture

Conservation agriculture (CA) is globally promoted as a sustainable innovation for small and large farms (Derpsch et al. 2010; Hobbs 2007; Hobbs et al. 2008; Kassam et al. 2009; Valbuena et al. 2012). There are three key components to conservation agriculture: (i) Maintaining a permanent organic soil cover (through cover crops, intercrops and/or mulch); (ii) minimizing soil disturbance by tillage and other cultural operations; and (iii) diversifying crop rotations, sequences and associations (Kassam et al. 2009).

Evidence shows that CA can enhance soil quality and health, contribute to higher, more stable yields, and reduce production costs (Govaerts et al. 2005; Kassam et al. 2009). Depending on the local context, there are several constraints, including the cost of moving to and adapting CA practices for the specific farming system, the need to have access to inputs, markets, machinery, credit, and information, the availability of labour, the increases in weeds and pests (Baudron et al. 2007; Erenstein et al. 2012; Nyanga et al. 2012) and the competing uses of crop residues in smallholder systems for fuel, livestock fodder, and thatching (Hellin et al. 2013, Beuchelt et al. 2015).

Table 11.1 lists the effects of CA on women and men in smallholder agricultural systems. CA can imply diverse trade-offs from a gender and social perspective. The impacts of CA on certain social actors depend, among other things, on the specific context, the farming system, and local gender norms, and can be entirely different for other social actors or in a distinct context (Beuchelt and Badstue 2013).

The Case of Small-Scale Biomass Production for Decentralized Bio-energy

A lack of secure, sustainable and affordable energy is a big development constraint in developing countries (Amigun et al. 2011; Wiskerke et al. 2010) and has a disproportionate impact on rural women (Karlsson and Banda 2009). Though it bears a large potential for Africa, little research attention is directed to decentralized, local, small-to-medium-scale energy production based on local biomass (Ewing and Msangi 2009; Mangoyana et al. 2013). More research around the gender and equity impacts of decentralized energy schemes is certainly needed. The following analysis concentrates on smallholder biomass production for decentralized energy schemes, such as a small-to-medium-scale biodiesel plant located close to an agricultural area and oil mill (Amigun et al. 2011) or small-scale short rotation woodlots for fuelwood production (Wiskerke et al. 2010). The directions of effects depend highly on the local situation, for example, whether it is a biomass rich or dryland area, which technologies are used, and how large the dependence on local biomass is. Table 11.2 indicates potential effects of

Table 11.1 Potential effects of CA on women and men in smallholder agricultural systems

Categories	Potential equity effects of CA
Food security and nutrition diversity	+ Increased and more stable yields in 4–5 (10–12 at the outset) years and reduction of hunger period, benefits whole household + Crop rotation/intercropping increase nutrition diversity and food security when using food crops, helping women to fulfill their reproductive role − Herbicides and mulch layer may negatively affect traditional intercropping patterns and suppress use of wild vegetables typically managed by women → lower nutrition diversity and food security, esp. in hunger season; women often suffer disproportionately − Fewer residues available for feeding livestock – can also affect small livestock managed by women. If livestock is reduced, nutrition diversity is lowered or risks are increased − Food security may decrease if cash crops are used and income not spent (by men) on food
Health	+ Potential for better health, esp. of women, due to improved nutrition once higher yields appear amd due to rotation/intercropping, esp. with food crops and legumes (when not practiced before) + Reduced physical stress due to less land preparation (particularly benefiting men) and use of herbicides (particularly benefiting women) − Herbicides may contaminate ground water, wells, and ponds → risk for drinking water; women may have to walk further to get decent water − Herbicides may be a direct health hazard to household (HH) members, esp. to children, due to faulty application and storage of herbicides
Information & technology	+ Once technology is mastered, increased understanding of agricultural management − Highly knowledge intensive; may take women with lower education levels longer to learn, but projects/extension often do not account for this − Threat of male bias in decision-making when extension service/projects are gender blind and do not include women − Tendency to overlook womens' needs and constraints, especially when it comes to introducing machinery or working in mechanized systems − Mechanization may exclude women from its use (depending on gender norms)
Resources & labour	+ Mechanization reduces drudgery in land preparation and reduces land preparation in the long run, mainly benefits men but also women + Herbicides reduce work load, esp. for women, who usually do the weeding − Women and marginalized farmers often have insecure land title or rent land → land improvement due to CA can lead to risk of losing their plot − Crop rotation/intercropping may include putting "male" crops on female plots → women risk losing control over plot/harvest when growing "male" crops due to gender norms

(continued)

Table 11.1 (continued)

Categories	Potential equity effects of CA
	− Less residues/weeds available for livestock or fuel → increased labour burden for women to obtain alternative sources − Without herbicide use and/or using planting basins, increased labour burden to HH members, especially women and girls → mothers may neglect their children's welfare or nutrition to keep up with work − If herbicide applications are incompatible with intercrops, typically planted by women, gender disparities increase − Planting basins increase labour burden, esp. of women − Mechanization reduces need for hired, casual labour, eliminating an important income source for marginalized farmers, landless people
Income, marketing & value chains	+/− Higher potential income due to higher yields and lower production costs in mechanized systems, but when men alone make decisions about income, gender disparities can increase − In case of herbicide use, potential income loss when wild plants are sold for income − If herbicides/mechanization replaces rural workers, income loss of day labourers, especially women, due to limited employment opportunities in the rural sector − If crop residues become private property, poor landless shepherds/marginalized livestock owners may not be able to maintain their herds and lose their income source

Sources: Ackerman (2007), Berti et al. (2004), Beuchelt and Badstue (2013), Doss (2001), Giller et al. (2009), Govaerts et al. (2005), H. Nyanga (2012), Hellin et al. (2013), Kettles et al. (1997), Nyanga et al. (2012), Ramírez-López et al. (2013), Valbuena et al. (2012), World Bank (2009), Beuchelt et al. 2015

decentralized bioenergy production based on biomass which can serve as an analytical input for estimating impacts of new investments.

Opportunities and Pathways to Enhance Gender and Social Equity Through Sustainable Intensification

The ways and processes by which innovations are generated, adapted and disseminated are complex, given the many direct and indirect interactions between stakeholders (Aw-Hassan 2008). As the above-mentioned cases illustrate, it is not necessarily possible to predict how the introduction of new technologies may affect the patterns of labour, resource and land allocation between men and women, or how this, in turn, may influence who benefits and loses. Having highlighted potential trade-offs around agricultural innovations, the question remains as to how anticipated or emerging trade-offs can be converted into opportunities and pathways for making agricultural innovations more equitable and gender responsive, and thus, to expand the overall human development impact. In part, the

Table 11.2 Potential effects of smallholder biomass production for decentralized bio-energy on women and men

Categories	Potential equity effects of smallholder biomass production
Food security & nutrition diversity	+/− Food security should be little or unaffected, since not much feedstock is needed for a small bioenergy plant, but in case of competition, local food prices could somewhat increase → increased food insecurity could hit the most marginalized, esp. women
Health	+ In case of improved stoves, less burden to carry wood and less indoor air pollution, respiratory infections, and eye problems, benefiting mainly women and girls + (Maternal) health benefits from clinics with improved facilities from electrification
Information & technology	+ Potential for small-scale mechanization of laborious household tasks through decentralized energy – benefitting women, e.g., through mechanization of food processing (grinding), powering water pumps (no longer tiresome water fetching) + Access to electricity → e.g., improved school performance of children and enrollment of girls; less dependency of women on men, e.g., to recharge mobile phones + Women could be targeted in technology training, for supervision and plant management → increase in knowledge − Literacy constraints of smallholders, esp. of women; due to lack of technical know-how related to feedstock, its conversion may lead to their exclusion in decision-making and participation − Energy produced may be insufficient for whole village; only the better-off households might get energy or have money to pay for it → negligible benefits for marginalized HH − Tendency to overlook women's energy needs and constraints, esp. when it comes to introducing machinery → threat of male bias in projects
Resources & labour	+ Frees female labour/time when wood is no longer required or laborious household tasks, typically done by women, are mechanized, e.g., pumping water, grinding − Land scarcity / biomass scarcity → land previously given to women may be taken away → affecting their food security, income, status − Land insecurity may prevent investments in tree crops, esp. for women; having insecure land rights and land tenure system may inhibit access to biomass fuel for women − When using slow-growing crops like jatropha or oil palm, better-off farmers tend to benefit more than poorer farmers, and men more than women, due to land rights and available liquidity − Increased labour burden (for women) to procure biomass for the plant − Lack of willingness to pay for electricity/fuel generated by energy scheme – female labour is "for free" and women are often not very involved in decision-making in regard to energy
Income, marketing & value chains	+/−When feedstock sold to plant, income opportunities for both sexes; however, men tend to take over activities from women once profitable and invest less in food security + Women could be targeted to be involved in management of

(continued)

Table 11.2 (continued)

Categories	Potential equity effects of smallholder biomass production
	plants → employment/income opportunities + Electricity can provide business opportunities for women and men, e.g., many small retail businesses, such as phone charging or tailoring, are run by women − Commercial biomass activities such as charcoal and firewood trading are often male activities; income may not benefit women

Sources: FAO (2008), Farioli and Dafrallah (2012), Hunsberger et al. (2014), Karlsson and Banda (2009), UNDESA (2007)

response depends on the kind of impacts an innovation or development programme aims to have on women and men, as well as on social equity and whether explicit gender and equity goals were defined (Skutsch 2005).

Different dimensions of marginalized and smallholder lives, such as livelihood assets, institutions, food system activities, and food system outcomes, affect agricultural innovations and are affected by them, and all can imply equity issues. Equity issues in the 'livelihood assets' dimension relate to access and control over the natural, physical, financial, human and social capital (DFID 1999) needed for agricultural biomass production, processing and marketing. In the 'food system activities' dimension, they are connected to the food-related activities undertaken in the farming system and value chains by women and men of different social groups. In the 'institutions' component, they refer to formal institutions, such as legislative frameworks and policies, as well as informal institutions – social relations, values, and norms that shape beliefs and behaviours. All, but especially the norms, influence relationships between men and women. In the 'food system outcomes' dimension, equity issues arise due to differences in the actual situation and potential project or policy outcomes regarding food and nutrition security, health, poverty reduction and natural resource sustainability between women and men and different social strata. Mainstreaming equity issues entails the inclusion of a gender and social equity perspective for each dimension and requires strategies, as well as tactics, that take into account the power difference within and between female and male members of various groups, integrate advocacy to have open spaces for voices to be heard and enable people to recognize and use their agency (Cornwall 2003).

Though gender mainstreaming is commonly known and promoted, it is seldom fully practiced. To overcome trade-offs and use opportunities, gender and equity aspects need to be integrated into the project cycle, i.e., to be included in all stages of a project, programme or policy from the planning and design stage, during the implementation, in the progress monitoring and in the final evaluation (Arenas and Lentisco 2011; Aw-Hassan 2008).

At the planning and design stage, it is important to explicitly define whether an innovation/project (also) aims to improve women's welfare, increase the economic productivity of women and/or marginalized farmers or contribute to their empowerment (Skutsch 2005). These goals should ideally be defined together with the concerned stakeholders; however, this is often not feasible. Possible opportunities

and trade-offs in agricultural innovations and interventions need to be carefully assessed for women and men of different social strata and age groups before the project starts. This implies a sound gender and social analysis of the specific intervention and the related target context, with particular focus on the analytical categories listed in Fig. 11.1. It is essential to know whether women or men are the direct users of a technology, who is considered responsible for different aspects of the innovative technology, who will make the investment and labour decisions and who will benefit from it, since this will have a bearing on who will be involved with and affected by the new technology. It is a good business practice to utilize a marketing survey in order to know the customers, their needs and priorities, before the project starts (Skutsch 2005). *"If it turns out that all such investment decisions are made by men, and if it is likely that this will result in decisions which are not in women's interests, then a strategy may have to be developed to counter this as far as possible"* (Skutsch 2005, p. 48). For real project success, it is key to do this as early as possible in the research and development process, and explicitly address the critical issues, ideally in a participatory process together with the relevant stakeholders of both sexes. A stakeholder analysis is very useful for understanding power issues and the impact of the innovation on the stakeholders, as well as the impact of the various stakeholders on the project or innovation. This provides opportunity to identify joint priorities, adjust research targeting and project design, and devise context specific alternatives or ways to mitigate negative trade-offs. It can include the combination of various technologies or approaches which, when used together, can compensate for trade-offs or enhance overall development impacts. The identification of non-traditional research and development partners with comparative advantages for addressing specific trade-offs can play an important role. For example, in a situation in which CA mechanization holds great promise for individual farm households to reduce labour input, but may happen at the cost of offsetting rural landless workers, collaboration with alternative partners with expertise in income-generating activities could be considered.

Before and during implementation, an analysis of the capacity of the implementing organizations to be aware of and handle gender and equity issues is helpful, as some organizations do not possess experience in this field, but are rather "technical focused" (Skutsch 2005). During implementation, a gender and social perspective can be incorporated into the activities through gender-responsive and gender transformative approaches, as well as a focus on empowerment of marginalized farmers.

Gender transformative approaches seek to address and eventually change gender norms, roles and imbalances of power when inequities are large and can easily be combined with agricultural extension. They raise awareness of gender roles and relations between women and men; foster – at a local pace – more gender-equitable relationships between both sexes while challenging the unequal distribution of resources and allocation of duties between men and women. They can also address the power relationships between different stakeholders and social actors (Consortium International Agropolis 2012; USAID and IGWG 2011). They, thus, are a complementing means to achieve agricultural intensification, improve

livelihoods and gender equity, especially where current extension and technological approaches alone have had limited effect with regards to adoption of the promoted technologies, or an equitable benefit sharing between men and women. A successful example of gender transformative approaches regarding sustainable agricultural intensification is summarized by Beuchelt and Badstue (2013), based on experiences in Zambia (Bishop-Sambrook and Wonani 2008; Klos 2000).

In agricultural development, empowerment efforts are often viewed as an advanced form of participation that will improve project effectiveness through farmers making their own decisions, rather than only adopting recommendations. However, a large focus is still on an ex-ante decision of what is supposed to happen in the project and how rural people are supposed to live their lives, which is found in statements such as "30 % of farm households will use improved varieties" or "CA will be practiced on 20,000 hectares". Instead of controlling the development process, projects may go one step further and become entry points for empowerment through enhancing the means for and facilitating the process of intrinsic empowerment (Bartlett 2008). This requires a change in power relations not among the different social groups, but with the project planners and managers. Research and extension can support changes in knowledge, behaviour, and social relationships with the aim that poorer people are taking control of their lives, thus transforming the way they live their lives (Bartlett 2008).

Emerging trade-offs and negative effects, which were not anticipated in the planning stage, also need to be identified and addressed – a task of the monitoring process. Corrective measures may include new alliances with project partners who can help to mitigate trade-offs or embark on the opportunities. Sufficient time buffers for these unexpected events should be integrated into the planning phase. Reflection and joint learning processes, especially through participatory approaches, regarding effects on gender and social equity are crucial during monitoring, but also in the evaluation phase in which the project's success is assessed. This can be combined with disaggregated qualitative and quantitative data which also distinguishes for sex, age, economic and social strata, to describe and explain the observed changes and project effects among men and women in different groups of society. Gender separation during data-gathering phases in planning, implementation, monitoring and evaluation is suggested to obtain reliable information on gendered uses, constraints, opportunities and trade-offs around innovations (Skutsch 2005).

Conclusions

In summary, research and development for sustainable intensification face the challenges of (i) enhancing the food and nutrition security of poor men and women of all age groups; (ii) increasing gender and social equity and decreasing poverty and (iii) being environmentally and socio-economically sustainable. Development processes and agricultural modernization have affected men and women in

different ways and have often increased gender and social disparities. Given the complexity of gender and social dynamics and their embeddedness in the agricultural and socio-economic contexts, innovations for sustainable intensification need to address these in order to reach desired development impacts.

There are many positive characteristics of agricultural innovations for sustainable intensification, including yield increases, crop diversification and labour savings. The global or overall effects of an innovation are often positive, but the resulting benefits may be shared in different ways by different social groups, between men and women, and, in extreme cases, even increase gender and social inequalities. The evidence presented suggests that it is critical to address the different needs and constraints of both female and male marginalized farmers in the processes and systems through which agricultural intensification innovations are developed, disseminated and promoted.

Gendered trade-offs need to be considered and assessed in relation to the other expected human and sustainable development impacts of the agricultural innovation in question. There are several pathways to mitigating trade-offs and building on opportunities to enhance gender and social equity. The incorporation of gender-transformative and general empowerment approaches in agricultural research and development interventions can be helpful in this respect. Decisions as to which pathway is chosen should be developed together with male and female stakeholders – of different social groups – and can include engagement with non-traditional partners with the necessary skills and abilities to work at the levels where trade-offs occur. The promoted institutional or technological innovation can also be combined with other technologies which are able to compensate or mitigate trade-offs created by the promoted main technology. In addition, policy interventions can contribute to the stimulation of inclusive development and the reduction of gender constraints related to specific interventions.

Aiming at positive, equity-enhancing development impacts through technology development and innovation diffusion, a holistic farming and food systems approach is recommended which is gender-sensitive and social transformative. Further evidence of the potential but also specific challenges hereof, especially scientifically accompanied case studies, is needed to build broader support for mainstreaming social and equity approaches in agricultural research and development projects.

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