Women and men farmer perceptions of economic and health benefits of orange fleshed sweet potato (OFSP) in Phalombe and Chikwawa districts in Malawi

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Abstract Based on a qualitative study conducted in Chikwawa and Phalombe in Malawi, this paper looks at farmers perceived economic, health and social benefits of production, commercialization and consumption of orange fleshed sweet potato (OFSP). Findings demonstrate that perceived health and economic benefits were key determinants in adoption of OFSP varieties. Men and women are receptive to health and nutrition based promotion messages. Health benefits included increased energy to work, for sex, improved health, general wellbeing and cognitive development for children. Economic benefits included ability to invest income from selling of OFSP roots and vines in housing, purchase of livestock, food, and land. Income from OFSP enabled farmers to diversify into other cash crops. Women also mentioned increasing self-esteem due to increased incomes since they no longer needed to ask for money from their husbands to buy household consumables. However, men and women did not have equal access to and control of economic benefits and therefore women could not invest in large assets like cattle, land and agriculture equipment which could contribute to food security and are important to moving out of poverty. Interventions to increase farmer incomes should be designed in ways that allow women to actively participate and benefit. Since livestock are a key investment option and also contribute to food security and diversification, options for making sweet potato based silage for animal feed would be an

important intervention especially for vines that would otherwise go to waste due to lack of markets.

Keywords Sweet potato · Gender · Income · Malawi

Introduction

The link between agriculture, health, nutrition and income for rural households has long been established. It has, however, been suggested that gender is the ‘key element’ in the linkage between nutrition and agriculture (Margolies and Buckingham 2013). If gender inequalities and differences between men and women are not considered in nutrition programming they may negatively impact outcomes (FAO. [nd](#)). Evidence from Sub Saharan Africa (SSA) shows that women and children are the most affected by malnutrition compared to men and that the burden is greatest among poor rural communities (Girard et al. 2012). Another key link between agriculture and nutrition is income. Income from agricultural produce may increase rural farmers’ ability to pay for health care, purchase food and pay for children’s education. Increasing women’s control over assets (especially financial/physical) has been shown to positively impact food security, child nutrition, education and women’s well-being in general (van den Bold et al. 2013). However, women do not always have the ability to access and control income and other benefits from agriculture at the same level as men.

While strategies such as food fortification and micronutrient supplementation are effective at addressing micronutrient deficiencies, emerging evidence shows that biofortified crops such as orange fleshed sweet potato (OFSP) are an effective and sustainable way to address the burden of hidden hunger among vulnerable poor rural households (Birol et al. 2015). Many studies on OFSP and other biofortified crops use

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experimental or quasi-experimental methods, collection of blood samples and biochemical analysis to assess food-based strategies in addressing Vitamin A Deficiency (VAD) (Low et al. 2007; Hotz et al. 2012; Bezner et al. 2011). Other studies have highlighted benefits of agriculture coupled with nutrition education as a potential pathway to nutritional benefits for food based strategies to address micronutrient deficiency among children (Low et al. 2007). It has also been suggested that improved farmer access to markets can improve farm yields, incomes, specialization and consequently living standards (Chamberlin and Jayne 2013). These outcomes, in turn, can contribute significantly to improvements in household food security, poverty reduction, agricultural development, and economy-wide growth and health. However, not many studies have examined farmer perceptions about these benefits. Farmers' acknowledgement of these benefits may lead to sustainable adoption of innovative agricultural technologies. Recent research has shown that non-pecuniary benefits are as important to farmers as pecuniary benefits (Howley 2015). It is therefore important to understand what makes farmers happy and interested in keeping use of a technology and how they perceive benefits from the different array of crops they grow, as these perceptions may also be key in determining whether they adopt biofortified crops or not.

This paper is based on a gender analysis of sweet potato seed systems conducted in Phalombe and Chikwawa districts in Malawi from November 2013 to January 2014. A gender analysis can be described as a study of how "power relations within the household interrelate with those at the national, state, market and community level" (March et al. 1999:18). Phalombe and Chikwawa were chosen because sweet potato is a key food security crop in the two districts. The study used an International Potato Center (CIP)-led Irish Aid funded project on Rooting out Hunger, as an entry point. The Rooting out Hunger project had three major components: agronomic training, nutrition training which included training in processing and value addition as well as training on marketing. The study on which this paper is based was, however, not an evaluation of the Irish Aid funded project as such but aimed to understand gender dimensions of sweet potato seed systems in order to provide input into the development and implementation of gender sensitive interventions.

This paper looks at the perceived economic, health and social benefits of production, commercialization and consumption of OFSP from the point of view of men and women farmers as it is these perceived benefits that may determine adoption of sustainable food based approaches to addressing micronutrient deficiencies. Additionally, most studies that investigate the benefits of OFSP focus on health and nutritional benefits (see Hagenimana and Low 2000), economic benefits in terms of increase in incomes (see Ssemakula and Mwanga 2011) role of OFSP in disaster relief (see Kapinga et al. 2005), or increased yield and productivity attributed to the use of

improved sweet potato varieties, and assume that these advantages will accrue to household members equally. Very few studies have looked at perceived benefits from a gender perspective. It has been noted, however, that the introduction of new technology may shift the balance of power in gender relations and affect the way men and women are able to control resources and benefits (Russell et al. 2015). This study seeks to understand how men and women may benefit differently and the implications on the design of interventions.

Context

Malawi is classified as a poor country. Its Human Development Index rank for 2013 was placed at 174 out of 186 countries with close to 49.8% of its population in Multidimensional Poverty and 61.6% of its population living on less than 1.25USD per day (UNDP 2014). The Multidimensional Poverty Index includes income, consumption, health, nutrition, education, skills, livelihood, household conditions and social exclusion as aspects in the calculation of poverty due to the recognition that while income and consumption are important dimensions of poverty they do not provide a complete picture of the multiple deprivations that the poor are subjected to (UNDP 2014:41). Malawi is highly dependent on foreign aid and aid programs. 'Perhaps the defining characteristics of rural areas in Malawi are very low and fragile incomes and consequently market activity based on very small transactions' (Dorward and Kydd 2004:335). Agriculture and remittances and savings from migrant populations have sustained the rural economy (Dorward and Kydd 2004:335). Agriculture in Malawi accounts for 38% of the Gross Domestic Product and 80% of the export earnings while 85% of the country is primarily involved in subsistence agriculture (Mendola and Simtowe 2013). This makes agricultural based strategies for income generation and sustainable livelihoods all the more important.

The Malawi Integrated Household Survey (RoM 2011: 207) alludes to high poverty levels in Malawi with Phalombe and Chikwawa having 64.5 and 81.6% of the populations, respectively, living in poverty. Eighty-five percent of the country's population lives in rural areas (Ellis and Freeman 2004:5) which further worsens the poverty situation through natural resource depletion in the rural areas (Ellis and Mdoe 2003) and further amplifies the need for agricultural strategies to address economic and nutritional deficiencies.

In Malawi, malnutrition is prevalent, with 47% of the country's children under- fives being stunted (Malawi National Statistical Office & ICF Macro 2011). Vitamin A deficiency (VAD) is also a public health problem with a prevalence of 59% among pre-school children (FAO 2008). VAD has severe health consequences, which can lead to blindness, increased morbidity and mortality among children under five (Neumann et al. 2004). Also vulnerable to VAD are pregnant

and lactating women (Akelo et al. 2014). Thus introduction of OFSP, with its high beta-carotene content (beta carotene is a Vitamin A precursor), into Malawi is not only addressing food security but also a major health problem.

In a survey, OFSP (combined with pumpkin) was listed in the top 3 food types produced by households in Malawi (African Center for Biosafety 2014) which may denote relatively high/ increasing levels of consumption of OFSP in Malawi. A survey conducted in Dedza, Zomba, Chikwawa and Phalombe by Sindi et al. (2013) showed that 3% of the total land under crop production was devoted to OFSP, which may also imply its increased consumption. OFSP promotion activities in Malawi started in 2009 with most orange fleshed varieties released in 2011. Although there are no exact figures regarding the consumption of OFSP in Malawi, the importance of sweet potato as a food crop can hardly be overemphasized. Sweet potato is ranked as the 3rd most important food crop in Malawi after maize and cassava (in terms of diets, production and trade) and provides 8% of total caloric intake (Minot et al. 2010).

Methodology

Theoretical framework: social relations approach

The study used a social relations approach (SRA) to collect and analyse data. Perceptions of socio-economic and health benefits may be influenced by a variety of relationships including gender relations, which structure, who benefits and who does not. Kabeer and Subrahmanian (1996:4) state that ‘the concept of gender relations ...shift[s] attention away from looking at women and men as isolated categories to looking at the social relationships through which they...[are] mutually constituted as unequal social categories.’ Looking at the social relationship between men and women, this paper analyses the benefits that both men and women perceived from cultivation and consumption of OFSP leaves and roots. While perceptions may not be an objective measure they provide a window through which to understand how different actors in the system perceive themselves in relation to how they perceive other actors in the system. SRA approaches focus on analyzing the relationship between men and women thus going beyond purely efficiency-focused approach to gender mainstreaming. In other words, SRA goes beyond addressing practical needs only, to challenging gender norms in order to meet empowerment goals related to strategic gender interests (Warren 2007). As a result, while recognizing that male and female farmers are interdependent, this paper acknowledges that gender roles and norms may influence the extent and the ability of men and women to benefit from a crop; as well as the type of benefits they regard as important in influencing their willingness and ability to adopt and continue cultivating a crop like OFSP.

Data collection

The study used sex-disaggregated focus group discussions (FGD) with farmers who participated in the Rooting out Hunger project to understand the perceived benefits of cultivating and consuming OFSP. Two male and two female FGD facilitators were recruited and trained for three days on how to facilitate the FGD. An interview guide was used to ensure that similar questions were asked across groups in order to obtain comparable information. The study Principal Investigator (PI) conducted all the individual interviews with the help of a trained translator. All FGDs and individual interviews were recorded and later transcribed by a Chichewa native speaker.

In total 17 FGDs were conducted with farmers; 9 with men farmers and 8 with women farmers. Each FGD consisted of 10 participants giving a total of 170 participants. Two FGDs were conducted with male extension workers; 5 extension workers participated in one group and 3 in another giving a total of 8 participants. In total 178 people participated in FGDs. Sixteen Decentralised Vine Multipliers (DVMs) participated in individual in-depth interviews (IDIs). Tables 1 and 2 outline the type of respondents targeted by the study:

The sample size for FGD discussions was determined by two criteria. First the study was conducted only in communities where the International Potato Center (CIP)-led Irish Aid funded project on Rooting out Hunger was being implemented. Taking this into account, the study selected a sample size small enough to enable an in-depth qualitative analysis of perception of benefits of OFSP by farmers while large enough to ensure that our data reached saturation point. In qualitative research the saturation point is defined as the point at which the collection of new data ‘does not shed any further light on the issue under investigation’ (Mason 2010) and may even be counter-productive because of the labour intensity associated with collecting qualitative data. Since the study was carried out with relatively homogenous groups of sweet potato farmers, data collection was stopped when it was decided that no new information was emerging (saturation point).

Table 1 Type of FGD respondents by sex

Group/Respondent characteristic	# of men FGDs	#Men participants in FGDs	# of women FGDs	# of women participants in FGD
Project beneficiaries (FGDs)	7	70	6	60
Extension workers (Government & NGO)	2	8	-	-
Non project beneficiaries	2	20	2	20
Total FGD participants (178)		98		80

Table 2 Type of participants in Individual Interviews

Group/Respondent characteristic	Men individual in-depth interview (IDI)	Women individual in-depth interview (IDI)
Decentralized Vine Multipliers (DVM)	6	1 DVM 2 wives of DVMs
Decentralized vine multiplier dropouts	3	1
Extension workers (Government & NGO)	2	1
Total participants (16)	11	5

Decentralized Vine Multipliers (DVMs) refers to farmers who were identified and trained by the Rooting out Hunger project to multiply clean OFSP planting material for sale to organisations and other farmers on a cash basis or through a voucher system operated by the project and other NGOs. While some of the DVMs produced OFSP roots, all of the other project beneficiaries were sweet potato root producers. Study participants who were also project beneficiaries were recruited through sweet potato farmer groups that had benefited from the project. Recruitment was done through announcements at community meetings as well as by word of mouth from members of sweet potato farmer groups and vine multipliers. Farmers were informed that participation was voluntary and refusing to participate in the study would not result in them being penalized.

The study adopted qualitative approaches because according to Quisumbing and Pandolfelli (2009:21) they may ‘provide critical insights into beneficiaries’ perspectives, the value of programs to beneficiaries, the processes that may have affected outcomes, and a deeper interpretation of results observed in quantitative analysis.’ Since the aim of this study was to capture men and women’s perceptions and experiences of changes and benefits accrued as a result of project interventions, qualitative methods were the best way of capturing this.

Data analysis

Interviews were conducted in Chichewa, recorded, transcribed, and translated into English. The PI created a coding tree, identifying different themes that were used to manually code the data in Excel, ensuring that all data from both FGDs and IDIs were coded in a sex-disaggregated way and then analyzed. The codes used for the perceived benefits components included: Health benefits of OFSP roots and vines, Economic Benefits of OFSP roots and vines and most significant (socio-economic) changes as a results of growing OFSP roots and vines. Cross-cutting themes included gender roles and norms that influence perceptions of benefits as well as the ability to benefit. The data were analyzed to understand the

interaction between men and women, between farmers and institutions as well as to understand how male and female farmers perceived benefits from OFSP. Quantitative analysis involving frequency counts was also conducted. Results presented in this paper include findings from both FGDs and IDIs.

Results

The results section is divided into three broad sub-sections. The first sub-section looks at why men and women adopted OFSP cultivation. This section focuses on factors that promoted adoption of OFSP by men and women in the study area. The second sub-section focuses on the economic benefits perceived by men and women; while the third sub-section focuses on the perceived health and social benefits. We offer an analysis of these benefits showing how social structures and social relations influenced men and women’s experiences and perceptions of benefits. The last section looks at gender related barriers, which deter access to benefits. Factors that shaped the opportunity structure for men and women benefits are also discussed.

Why men women adopted OFSP root production and vine multiplication

The link between adoption and perceived or anticipated economic benefits that accrue to the farmer after adoption of a crop cannot be over emphasized. For example in FGDs, men and women stated that they had adopted OFSP because of the anticipated economic benefits. Several farmers also noted that whilst in the beginning other farmers in the village were not willing to adopt OFSP farming, they eventually did so because of the changes they observed in the homes of farmers that had adopted the crop. What was most attractive to late adopters were higher incomes that early adopters made from OFSP and the various investments they made leading to visible changes in their lives. When asked about the acceptability of planting OFSP in their village a woman FGD participant mentioned that:

Participant: Yes they are [beginning to plant OFSP]. They are just looking at our achievements, because ... when they saw that I had managed to build a house, many people are seeing that the orange fleshed sweet potato can help improve homes. (A woman FGD participant, Phalombe)

Participant: we built this house so it seems many people have seen what we have done and they are joining. ... when others saw that we were benefiting [from multiplying OFSP vines] that is when they started joining

(growing OFSP) after seeing that there are benefits. (A man FGD participant Phalombe)

Thus perceived economic changes that farmers can link directly to a specific crop may encourage them to adopt it too. The above testimonies also show that farmers are willing to adopt and try new crops when the perceived benefits outweigh the opportunity costs. Farmers depend on agriculture for their livelihoods and interventions that improve the chances of sustainability are likely to be more attractive. In another FGD women who belonged to a group that cultivated OFSP shared that after receiving training, they proceeded to plant the crop and obtained huge benefits in terms of increased root yields and incomes from sale of the roots and consequently continued cultivating the crop. This shows that economic benefits particularly those related to higher incomes were critical to the adoption of OFSP cultivation and vine multiplication.

Health benefits were also mentioned as a key reason why men and women adopted OFSP. In a village where women had mentioned that traditionally men used to plant sweet potato, women shared that they were increasingly making decisions about OFSP because of perceived health benefits. Women cited health benefits related to better pregnancy outcomes, and better health and nutritional status for infants and toddlers, which encouraged women to be involved in OFSP production. Women also stated that they were willing to invest in sweet potato vines even paying cash for them because of the perceived health benefits of consuming OFSP. Those with no money mentioned that they could do 'piece jobs' (casual work) in the community in return for vines as payment. From this perspective perceived health benefits can motivate people to adopt and continue to grow OFSP. Below we dig deeper into the investments arising out of economic and health benefits that farmers perceived from OFSP.

Perceived economic benefits and investments

This section discusses economic benefits that farmers perceived as possible gains from cultivating OFSP. Figure 1 below summarizes perceived economic benefits of OFSP roots and vines by sex:

Building a house

Both men and women in FGDs and Individual Interviews mentioned that increased incomes from vine production and marketing had helped them build or renovate houses that they were already staying in. However benefits from sweet potato have to be understood from a systems perspective, where farmers used income from different agricultural sources to invest in developments around the home. For example farmers mentioned combining money from potato and sweet potato, or

sweet potato and maize or livestock sales to invest in housing improvement and other investments around the home. This complementarity amongst agricultural enterprises is seen not only to augment income and wellbeing in the household, but also provides insurance against crop and market failure. The ability to build 'something that people can see' was often mentioned in group discussions, and can be seen as a change in 'status' symbol. Farmers regarded building a better house as a key benefit and priority investment from agricultural incomes. Extension workers in Phalombe also mentioned that both men and women farmers, who multiplied vines, used the money to build houses and in one case to install electricity in the house. The focus on housing construction may be related to the low housing standards in both Phalombe and Chikwawa which made it a priority investment for farmers. For example a study done by Kirimi et al. (2013) found that 72.3% and 67.7% of houses in Chikwawa and Phalombe have thatch for roofing, while close to 10% of the houses in Phalombe had mud walls. The new houses that farmers built from agriculture income often had iron /zinc roofs, brick walls and windows.

High yields and high market demands

More money and higher yields from a small piece of land was regarded as one of the benefits of OFSP. OFSP was regarded as having much higher yields as compared to other crops while linkage to markets made it financially more rewarding than other crops.

Participant: for me and my family... we had tried to farm rice and many other crops but we never got anything in return but when we decided to try this OFSP, that year we had big returns and that is how we built this house (Man FGD participant, Phalombe)

Respondent: The benefit that I have seen [from vines] is that from a small piece of land you can get a higher yield and more money and it surpasses the yields you get when you grow cotton on the same piece of land. Like in a quarter acre of cotton you can get 2 bales and when you sell the bales of cotton you can get maybe 30 – 40 thousand kwacha but if you use the same size of land for OFSP and all goes well you can get 100 000 kwacha or even 200 000 kwacha or even more (Individual Interview with Male DVM, Chikwawa).

Some farmers also mentioned that money from selling OFSP vines and roots could also be invested in the production of other crops. High demand for OFSP roots and vines was mentioned as a benefit since they sell fast (the aroma and smoothness of OFSP was preferred) and sometimes for a better price than their white fleshed counterparts. Farmers perceived that demand for OFSP was higher than for white

Fig. 1 Perceived economic benefits of OFSP Roots and Vines by sex

fleshed sweet potato given the additional knowledge that people had about the health benefits of consuming OFSP.

Enough food

Farmers mentioned that food availability improved because OFSP was available in the lean months. This meant that there was always enough food to eat. Linkages to markets also meant that farmers could purchase other types of food such as meat and milk, using their income from sweet potato.

Respondent: Mostly we were always having food shortages in our household. This was a problem because the maize yield was low due to inadequate rains. The maize was too little and it wasn't enough for the family to last the whole season. We could not get extra to sell. So when we discussed we saw that if we start vine multiplication we will get enough food and we will be able to earn money, which we can use in our household (Individual Interview with Female DVM, Phalombe).

Access to food in ample quantities was mentioned by both men and women as one of the key benefits of cultivating OFSP roots and vines. For example the short maturity time of OFSP was mentioned in one FGD as a benefit, which ensured that farmers always had access to food. Additionally, due to climate variability, farmers were not always assured of a good maize harvest and therefore sweet potato could be used to augment their diets.

Barter trade practised in the communities under study also meant that those with sweet potato could exchange it for other food items leading to dietary diversity within families. It was mentioned that after harvesting roots in July and August, farmers could exchange them for maize. It was also noted, however, that women dominated the barter trade system, which often consisted of smaller quantities traded in exchange

for food crops such as rice, maize, soybean and chicken. Women dominated barter trade because of their role in food provision in the household, while men, as household heads, dominated all cash sales. Women often complained that when men sold crops they did not bring the money home or did not consult them on expenditure. Barter trade within communities meant that women could gain access to food items that they lacked in their homes, thus improving household diets. When asked about three significant changes that had happened in their lives because of OFSP one group of women mentioned the ability to have access to enough food. They further stated that they now had enough food in their homes since they could buy food, using money from the sale of sweet potato, or exchange sweet potato for other food items. Availability of more food in the house also had other unexpected benefits for women. For example, in some discussions women mentioned that they now depended less on offering labour to other farmers in exchange for food as was the norm in the past.

In one group, men mentioned that in their sweet potato field they allocated a larger portion of their land to OFSP production as compared to other sweet potato varieties, because they could get cash and food from OFSP. Additionally cooked OFSP leaves tasted better than other sweet potato leaves.

Participant: The leaves taste better than any other sweet potato and people are using OFSP to make jam, chips and make different things from OFSP. But the other sweet potato we just eat just to fill our stomachs because it has no vitamins (Man FGD participant, Mitore Chikwawa).

Thus, in addition to the good taste of OFSP, roots and leaves could be processed into different products including jam and chips. The consumption of leaves and also being able to mix the sweet potato with other local foods such as cowpeas was regarded as a good addition to the food basket.

Buying livestock and investing in other business enterprises

Both men and women mentioned using money from the sale of sweet potato roots and vines to purchase livestock as a key economic benefit from cultivating OFSP roots and vines. Women however mentioned that animals like goats were really good to buy since, in addition to producing milk which could be sold or consumed by the household, they could sell goats to pay school fees or buy clothes for the children. Thus livestock is key to both food nutrition and income security and also serve as an emergency fund and a way for both men and women farmers to save their money. When asked about three significant changes; a woman who belonged to a club that multiplied vines mentioned that she never had livestock in the past but after cultivating and selling OFSP roots she was able to buy a goat, maize and a pot. This she said had changed her life. Buying livestock often consistently ranked in the top three significant changes in men and women farmers' lives. However it has to be noted that only male DVMs who multiplied vines and were linked to institutional markets were able to buy large livestock such as cows. Since the majority of DVMs were men, none of the women mentioned buying cattle. This may in itself indicate that women are less integrated in vine markets than men are and are not able to benefit to the same level as men.

Farmers also mentioned being able to invest in land and other agricultural equipment such as irrigation pumps from selling sweet potato vines. However, the ability to invest in larger equipment and land from OFSP farming should not be over rated. For example, in the study, only one farmer who was also a DVM selling vines through the Rooting out Hunger Project operated voucher system had been able to make these big investments. However, extension officers also corroborated that when men and women are able to access high agricultural incomes they diversify their investment portfolios. For instance farmers invested in small enterprises such as local restaurants and also livestock as mentioned earlier when their income increased. Farmers made major investments in housing, agriculture and other non-agriculture based enterprises. However it seemed from the study that it was mostly men who were able to make major investments as well as diversify their income sources mainly because they had access to vine markets.

Buying clothes, household utensils and paying school fees

Many farmers depend on agricultural incomes for most household expenditure including purchasing clothing, household utensils as well as paying school fees for children. However, while men mostly mentioned buying clothes for themselves

and their children, it was mentioned that women benefited more in terms of buying kitchen utensils. Men regarded women being able to buy kitchen and other household utensils as a benefit that the women enjoyed from increased incomes as a result of OFSP. One woman mentioned being able to buy a pot as a major benefit from OFSP.

Some women mentioned that having money that they could control independently of their husbands was a huge benefit from cultivating OFSP roots and vines because it gave them autonomy as well as the ability to purchase household needs without having to ask their husbands for support. For instance, while women did not have full control over money from the sale of vines, one female Vine Multiplier mentioned that she had become independent and self-reliant and that was a big benefit for her. She could use money from the selling of vines and roots to buy the things she wanted without consulting her husband:

Respondent: The thing is before, everything that I wanted to buy for the household I had to ask. I had to ask for money from my husband for everything, be it soap, salt, the child needs this at school. Since I started growing and selling orange fleshed sweet potato vines and roots, now I have my own money. I don't have to ask for money from my husband even if he has money. *I no longer have to kneel to ask for money for small things like salt* (Individual Interview with woman DVM, Phalombe).

Thus even though women may not at the moment be able to invest in large items, their ability to make independent decision on small items within the household using some of their earnings from sweet potato was empowering for them.

Health and social benefits of OFSP roots and vines

This section looks at farmer perceived health benefits of consuming OFSP. Figure 2 summarizes the perceived health and social benefits of consuming OFSP Roots and leaves by sex. Some of the mentioned health benefits such as improved eyesight, better cognitive development for children as well as general bodily well-being (such as good skin) are benefits farmers stated they had been told about during some of the OFSP nutrition training campaigns and awareness raising. These may have influenced what the farmers mentioned as health benefits. However, when group participants mentioned these benefits, FGD facilitators were trained to probe further to ascertain whether some of the participants had experienced the benefits themselves or whether they were repeating what they had been taught during training. Included in this section are benefits that FGD participants stated that they or members of their families had experienced.

Fig. 2 Perceived health and social benefits of consuming OFSP Roots and leaves by sex

Below we discuss in detail the perceived health benefits:

Increased Energy for sex and work

A key perceived benefit of consuming OFSP that was mentioned by men's groups was increased energy for sex. Both men and women groups mentioned improved sex lives as a result of men consuming OFSP. Men often mentioned 'power' to have sex and ability to please their wives in bed as a major benefit of sweet potato roots:

Participant: Before this sweet potato came we were very weak. But when we were given these sweet potato vines and grew them it's like we have been given medicine or injections. I am old but I have just had 2 children - twins, (Group laughter)

Participant: For me before we had other sweet potato and we were also eating vine leaves but we were not getting the power that we have now. My wife is testifying on how I am performing [in bed]. She likes to cook the vine leaves and she knows when she cooks leaves in the afternoon, that night there will be work to be done (Men FGD participants, Chikwawa)

Men sometimes mentioned not feeling like old men anymore but like young men as a result of the energy which they got from eating OFSP. In several FGDs women also supported men's views regarding improved sex lives as a result of OFSP consumption. Women mentioned that OFSP was like 'medicine' as it had improved the energy levels and sexual performance of their husbands, which made the women happy. The perceived improved sex life was tied to increased energy for men who were being described as weak in the past but had improved their performance after consuming OFSP roots and leaves. There was also a belief mentioned twice that eating raw OFSP gave more energy than eating cooked roots. Some women groups in Chikwawa also mentioned that men in the past had not been interested in growing sweet potato as they regarded it as a woman's job. However after seeing the

benefits of increased energy and improved sex lives some men now helped their wives in the sweet potato fields.

In addition to sexual energy as illustrated in Fig. 2, farmers also mentioned that they felt that consuming OFSP roots and leaves also in general gave them more energy to work in their homes and fields. Women mentioned waking up with a lot of energy after eating sweet potato for supper. They also stated that once they consumed OFSP they did not feel hungry the whole day. Men respondents also supported the notion that sweet potato was filling and when you ate it you would not feel like eating for the rest of the day. Higher energy content was related to higher energy density in sweet potato as both men and women mentioned that when they ate OFSP they ate less but had more energy through-out the day.

Eyesight

Both men and women mentioned improved eyesight particularly for children as a benefit they had observed from consuming OFSP. In some cases raw OFSP was regarded as more potent than cooked OFSP.

'I had a child who had problems with her eyesight so I told her eat raw OFSP, morning afternoon and evening and I see it is helping her' (Individual interview with a woman DVM dropout, Chikwawa)

After observing this improvement in her child, this respondent mentioned that she was now reserving some OFSP for family consumption instead of selling it all as she used to do in the past. Study participants also linked improved eyesight to better performance of children in school. Linked to that, cognitive improvements among children were also perceived

Participant: The sweet potato is good because I have a son who is in school. The time we started eating OFSP I saw he changed even in school. His thinking has improved he is small but is now in the higher class. It is because when he eats the OFSP he is full and is able to

understand more in class. It has improved his interaction as he can think quicker (Man FGD participant, Phalombe)

Perceived changes in the health and mental capacities of children who consumed OFSP was regularly mentioned in several FGDs and farmers stated that this motivated them to keep cultivating OFSP.

Good for our bodies/Healthy bodies

More women's groups than men's groups stated that OFSP was good for bodies. Women often mentioned that since they started to eat OFSP their bodies (particularly skin and bodies of their children) had improved and looked healthy. This could be related to the fact that more nutrition education was targeted towards women or may simply be a result of women consuming most of what they cultivated as they had limited access to expensive markets. Women were more likely to mention improvement in birth outcomes for pregnant women or improved weight for HIV positive people than men, who were more likely to mention improvement in the intake of vitamins.

Women also mentioned other social impacts of the project especially related to improved relations within households. For example, they said that because they learnt to make new and tasty sweet potato dishes their husbands appreciated them more and treated them better. There may be a need for further investigation in order to understand how social relations within households have improved or worsened as a result of introduction of new crops and technologies such as OFSP.

Determinants to accessing benefits

Men controlled income and expenditure from vines

While both men and women derived some economic and social benefits from OFSP root and vine cultivation, women who belonged to households where men were selected as the DVMs often mentioned that they did not benefit directly from the vines but from the roots. This was because men controlled the income from the vines and left women to deal with the roots. In fact one male respondent mentioned that men were not interested in OFSP roots because they produced small roots but were instead interested in the vines, which gave them higher incomes as NGOs bought the vines. An extension officer also corroborated this assertion by mentioning that most of those who cultivated the vines were not OFSP root farmers. Because women did not control the vine income, they sometimes worried that the yield of roots was not enough for them to obtain higher incomes.

In some cases women could not afford to cultivate OFSP vines because they lacked equipment such as watering cans and

had other domestic chores to attend to. For instance some men's groups mentioned that OFSP vine multiplication was only possible for people with access to irrigation equipment, the time to water the vines as well as the ability to construct nurseries. This made it difficult for women to be involved in vine multiplication because they had neither the time nor the resources to invest in vine multiplication. Instead they chose crops that were less demanding and also where they would be able to control the benefits. In general, they preferred crops where they had more control over benefits. For example, maize was less demanding and it was perceived that women preferred to cultivate rice because when they sold it they could control the money to buy what they wanted, which was different from incomes received from the sale of vines for example.

It was often assumed by project implementers and men that when men benefitted, women would automatically benefit too. For example extension workers mentioned that when men bought livestock or invested in businesses using agricultural incomes, their wives also benefited from the investments. While it may be true that investments that men make may benefit the entire family, one female respondent who belonged to a male headed DVM household stated that she was not involved in making decisions on income from sweet potato vines. For example, she had wanted her husband to purchase a goat from the proceeds of vine sales but he refused and the wife did not know what the money was eventually used for. She therefore felt that she did not benefit although her husband claimed that his investments benefited the entire family. Men and women may have different investments priorities but men's decisions often prevailed over women's. As a result it cannot be always be claimed that men and women benefit equally from increased agricultural incomes.

Type of marital union

The social systems related to marriage patterns in the two communities also determined who could benefit from the OFSP roots and vines. For example in Nakondwe in Chikwawa, women mentioned that in the event of divorce, society expected that men and women would share equally any livestock they had acquired together. Also, if they had built a house the husband was supposed to build a similar house for the wife at her parents' home. In other communities FGD participants mentioned that in patrilineal societies men remained with the property whilst in matrilineal communities women remained with the property. However in those matrilineal systems while the woman could remain with the house, land, kitchen utensils, if the house was built in the woman's natal home and property like motorbikes belonged to men. This may explain why in some communities, women preferred to invest in livestock since they could legitimately claim the livestock in case of dissolution of marriage. Depending on whether the society is matrilineal or patrilineal, men and

women would benefit differently in the event of divorce. It is not clear, however, whether these systems influenced investment choices as well as control of income from sweet potato.

While there have been suggestions that women in matrilineal communities are more independent and can make independent decisions regarding disposal of income and are therefore better able to enjoy benefits from agriculture than women from patrilineal communities, the study showed that this was not always the case. Even in matrilineal unions, men were regarded as household heads and this gave them greater decision making powers and more access to and control of benefits from agricultural investments. When asked about women's ability to benefit from agricultural endeavours one woman from a matrilineal community mentioned that men controlled the money and did not share it with women claiming that because they were household heads they should keep the money and decide on its use. Thus even the ability of women in matrilineal communities to control benefits was limited by norms related to household headship.

Nature of vine markets

Women mentioned lack of markets as a major limitation for them to participate in and benefit from OFSP vine multiplication and also limited the amount of roots they could produce. When farmers are assured of markets and there is less risk of market failure, their confidence to cultivate a particular crop, in this case OFSP, is raised. Women perceived themselves as having potential to produce vines but lack of markets and exclusion from vine markets were perceived as major limiting factors in vine multiplication.

Figure 3 shows the different sweet potato vine clients that men and women sweet potato vine multipliers sold to:

Figure 3 demonstrates that women farmers were excluded from a number of markets as they were only present in barter and cash sales markets; usually for small amounts within villages. Institutional buyers such as NGOs, government, research organizations and church organizations often bought

Fig. 3 Sweet potato vine clients

in bulk and paid a higher price for vines than that paid by local individual buyers. However, women mentioned that these institutions only bought vines from project registered vine multipliers who were mostly men. Lack of access to resources militated against women's participation as vine multipliers and extension workers interpreted cultural norms as also preventing some women from participating. When a male extension officer in Phalombe was asked why men dominated among DVMs even though women owned the land in some matrilineal communities, he mentioned that the selection criteria focused on whether or not the household to which the individual having access to land belonged to was regarded as owning the land. Therefore how extension workers and research organisations defined eligibility to participate in vine multiplication and therefore vine markets by focusing on household heads meant that women were left out of vine markets even when they owned land. There is need to raise awareness of extension workers of their own selection biases in order for them to make concerted efforts to involve women as vine multipliers and involvement in vine markets.

Discussion

Economic and health benefits: interlinkages

Hoddinott (2012: 13) states that 'Agriculture is the primary source of calories and essential nutrients and is a major source of income for the world's poor'. Findings from this study clearly demonstrate the agriculture, nutrition and health linkages. For example from OFSP farmers could obtain food directly from the crop, barter it in exchange for food items, use cash income from sales to purchase food as well as to diversify their investment portfolio by purchasing livestock, which would diversify their diets through meat and milk products. Consumption of diverse food items as well as Vitamin A rich OFSP was also linked to perceived improvements in energy levels, sexual performance, skin health, and cognitive capacities. These perceived benefits are not implausible because they can be linked directly to the functions of vitamin A in the body. Vitamin A is an essential nutrient required for the development of the reproductive systems (Hogarth and Griswold 2013) maintenance of epithelial cells in skin (Byrnes 2014), and brain development (Wongsirirotj and Blaner 2015). Health benefits are also important particularly for women who mentioned a number of health benefits related to pregnancy outcomes derived from consumption of OFSP roots. Perceived health benefits were also an important driver of adoption and continued cultivation of OFSP.

Various studies have demonstrated that extra nutrients in OFSP can improve micronutrient status (Hagenimana et al. 1999); that biofortification is a cost-effective dietary micronutrient provision strategy (Bouis et al. 2011; Birol et al. 2015)

and that OFSP is a source of energy (293 to 460 kJ/100 g) (Low et al. 2007:1321). In Malawi, farmers in the study area often perceived improvement in their health status after consuming OFSP. They mentioned improved eyesight, body energy or simply improved wellbeing and appearance of children and adults as some of the health elements attributed to OFSP. While more objective measures (e.g. changes in serum levels of Vitamin A) are needed to assess farmer perception in terms of micro-nutrient levels and other health indicators, it seemed that qualitatively farmers were confident that the benefits should be attributed to OFSP. However, farmer perception that OFSP improved men's sexual performance may need to be examined further. This was a pervasive comment in many group discussions and was the most frequently mentioned health benefit.

Findings from the study suggest that perceived economic and health benefits influence farmer adoption of OFSP. For instance where farmers were guaranteed a market for their roots and vines they were more willing to adopt OFSP compared to where they had limited market access. Economic benefits are an important consideration for farmers before they decide to grow OFSP roots and or vines. For example, the men mentioned that they were interested in planting OFSP vines because there was a ready market. On the other hand, they were not interested in cultivating OFSP roots because the yield was low and markets were not always assured.

However it is important to note that, although economic benefits were important, men and women did not have equal access to them. For example, it was clear that women did not control higher incomes obtained from sweet potato vines and therefore could not invest in large assets like cattle, land and agriculture equipment. While it is clear that farmers considered the health benefits of OFSP as a reason to adopt the crop, in many cases these benefits were also tied to the ability to make cash incomes and earn a living. As mentioned earlier, cash incomes also led to household food diversification as farmers could use the cash to buy other food items that they did not have.

Where farmers regarded OFSP as a better option compared to other crops because of changes in weather patterns, they were more open to cultivating OFSP. This may mean that future promotions of OFSP should also focus on regions with marginal climatic conditions or other limitations since OFSP would offer a better option compared to other crops in terms of food as well as income, more especially in the face of climate change.

OFSP incomes leading to diversified farmer portfolios: a systems approach to OFSP interventions

What is also clear is that sweet potato forms an integral part of a farming system that includes other crops as well as livestock.

For example, in many cases farmers mentioned using money from sweet potato to invest in production of other crops like maize as well as investments in livestock. Thus while OFSP is mostly a nutritional intervention, improvements that go beyond nutrition may need to be captured and considered for such projects. Households in Malawi invested income from OFSP vines and roots in livestock which they could use as a source of emergency funds for example to pay school fees as well as to diversify their diets through consumption of meat and milk products from goats, pigs and cows. This is in line with the observation of Ibrahim et al. (2013) that livestock are a major component of improving rural livelihoods. Diversification, such as buying livestock and investing in other agricultural crops according to Shackleton et al. (2000) 'not only enhance household income but also food security, health, social networks and savings'. However, it is interesting to note that diversification opportunities were gendered. For example, while all women participants mentioned that they could invest in small animals such as goats and pigs, and a few were able to buy cattle and production equipment, such as irrigation pumps, the main difference between those who bought cattle and small animals depended on whether the source of income was roots or vines and whether they had access to more lucrative markets. Since mostly men had access to higher paying vine markets they were the ones able to make the big investments.

Ellis and Mdoe (2003: 1372) notes that 'Current understandings of poverty place considerable emphasis on the ownership or access to assets that can be put to productive use as the building blocks by which the poor can construct their own routes out of poverty'. In this respect, successful asset accumulation is often observed to involve trading-up assets in sequence, for example, chickens to goats to cattle to land; or, cash from nonfarm income to farm inputs to higher farm income to land or to livestock'. Accordingly, measuring whether people are moving in and out of poverty also depends on the extent of trading up assets. In a study in Malawi, Freeman et al. (2008) state that 'livestock farming was the second most important livelihood activity after crop production and sale' and that livestock formed a safety net function as they could be sold to meet emergency cash needs within households. He noted that 'The acquisition of hardy goats, resistant to many common diseases, were also used as an important risk management strategy by food insecure households' and that food secure households also had a lot of livestock including cattle, sheep, goats and pigs whilst food insecure households owned no cattle' (Freeman et al. 2008). Since livestock are a key investment option for both men and women, making sweet potato based silage for animal feed would be an interesting intervention, especially for vines that would otherwise go to waste due to lack of markets, or during the rains when there is greater vegetative growth.

In terms of livestock it would seem that women farmers preferred goats and pigs whilst men also included cattle in their investment portfolio wherever possible. Choice of investment options when it came to livestock depended on gender and amount of agricultural income that one had. For example, while some women preferred goats because they could get milk, ease of disposal to meet other cash demands from the household, men preferred to invest in cattle. While it is not clear from the study why this was the case, what was obvious was that male vine multipliers (men dominated among decentralized vine multipliers in terms of numbers) are the ones who managed to purchase cattle compared to men and women who did not multiply vines. There are two possible explanations: either that if women had access to profitable roots or vine markets they might also be able to invest in large animals like cattle. The second explanation could be that women do not have the same level of control over cattle and ability to manage them as they have over small livestock. So even when they have higher incomes they will still continue to invest in small ruminants. If the second option is the case, this may challenge development paradigms such as that outlined by Ellis on trading up when it comes to livestock. This is because trading up may essentially mean that women are also trading themselves out of being able to have access to and control of emergency sources of cash in buying cattle, which they would not control. A study by Mudege (2008) also revealed a case of a farmer wife who took her husband to the village court because although they were farming together he was always buying cattle which the wife could not own, or make decisions over and in the event of his death his brothers would take over. This may have implications for studies looking at women's economic empowerment in Malawi as they may need to understand who has control over animals and what impact this could have on women's economic independence. For example while a household that owns many cattle may have a better economic status or rank, women within those households may not have a level of financial security if the household does not also own small ruminants, which they can control. What women are able to invest in and are willing to invest in, may also have implications on their ability to move out of poverty. Restrictive gender norms such as those related to control of certain resources within the home may make it harder for women to climb out of poverty. Ownership of cattle could also be a status symbol, especially for men.

In the rural areas, for instance, farmers may diversify their portfolio to include both on farm and off farm income generating enterprises. For example, as noted in this paper, farmers could invest in small businesses

and restaurants or in their children's education and also livestock. However, investments in most off-farm activities, especially related to small businesses and restaurants, was a field mostly dominated by men, also because of lower incomes that women received from roots as compared to the higher incomes men made from vines. This may show that while the markets for vines exists (especially institutional markets), root markets may need to be developed further so as to increase the income earning capacity and benefits thereof for women and men who depend largely on income from root markets. However this needs to be carefully managed to guard against the risk of men taking over the roots trade once it becomes lucrative hence pushing women out of this market segment (see Fischer and Qaim 2012).

Gender and control over income

Girard et al. (2012) suggests that when agricultural strategies include gender considerations they 'have documented impacts on households and women's income and livelihoods, gender relations and health seeking'. This was clearly illustrated in this paper. For example because women were not included in the project as primary DVMs, they did not have control over how income from selling of sweet potato vines was spent. However, they had more say and control on components of the project that clearly targeted them such as root marketing, consumption and processing. Women mentioned an improvement in their income from the selling of roots and also increase in self-esteem and self-respect because they no longer had to ask for money from their husbands to buy household consumables. Building self-esteem among women has been regarded as important in interventions that seek to empower them (Farnworth and Colverson 2015).

Conclusion and study limitations

This paper has demonstrated that Malawian men and women's perceptions of what the benefits of adopting biofortified OFSP are and their perception about their ability to benefit from these technologies may depend on gender roles as well as access to and control of resources. This study showed that the link between agriculture and nutrition is not only related to farmers' ability to cultivate and consume nutritious food but also to the ability of the men and women farmers to use cultivated crops to generate an income, control that income and use it in different ways to promote dietary diversification. Institutional arrangements in development organizations may also influence the ability of men and women to benefit from new technologies. This paper illustrates that involvement of women in projects depends on awareness of extension officers and their ability to engage with them since women's lack of

involvement in sweet potato seed multiplication was in some cases due to how extension officers interpreted the recruitment criteria during project implementation. Therefore, interventions to increase food security and farmers' incomes, should be designed in ways that allow women to actively participate and benefit.

The study depended on farmer perceptions and did not collect numbers and figures for example to confirm if farmer perceptions about benefits are in line with reality. Additionally, while the small sample size enabled us to have a more in-depth analysis of farmer perception, we are not able to generalize these to the rest of Malawi.

Compliance with ethical standards

Conflict of interest The study was funded by Roots Tubers and Bananas a CGIAR Research program as well as by Irish AID through the Rooting out hunger using orange fleshed sweet potato in Malawi project. All the authors are also employed by the International Potato Center, which is also engaged in promotion of orange fleshed sweet potato in Malawi.

I warrant that our manuscript is original work and has not been accepted for publication by another periodical. I further warrant that my work (including tables, figures, photographs, and other illustrative material) does not infringe on the copyright or statutory rights of others and does not contain libelous statements.

Informed consent Informed consent was obtained from all individual participants included in the study. In line with the informed consent agreement all information that could potentially identify participants has been removed and responses anonymised.

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