Gender Dynamics and Food Security in the Kenyan African Indigenous Vegetables Supply Chain

by Luzia Karin Deißler, Henning Krause, and Ulrike Grote

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Luzia Karin Deißler[1], Henning Krause[2], Ulrike Grote[1]

[1] *Institute for Environmental Economics and World Trade, Leibniz University Hannover, Germany*
[2] *Lower Saxony Chamber of Agriculture, Horticulture Business Devision, Germany*

June 2021

Abstract

In Sub Saharan Africa, producing and selling food crops, such as African Indigenous Vegetables, has traditionally been under the control of women. However, in the last decade food crop production has become more commercialized. The process of commercialization generally results in an increasing engagement of male farmers. At the same time, the bargaining power of women within households may change with commercialization. This paper aims at analyzing the distribution of work among gender in the African Indigenous Vegetables value chain and the intra-household decision-making and bargaining dynamics of small-scale farming, rural households. The analyses are based on 570 small-scale producers of African Indigenous Vegetables in rural and peri-urban Kenya. We investigate factors that are influencing the female intra-household bargaining power and evaluate its impact on household welfare and food security, including numerous indicators. Our results show that most of the work in the African Indigenous Vegetables value chain is still done by women, irrespective of the degree of commercialization. The multidimensional logit regression reveals that female bargaining power is negatively influenced by an increasing farm size, a higher asset score of the household and female off-farm work. A positive impact was observed by tertiary female education, female landownership, male off-farm work, a high share of female income in the overall household income and the location of a household in Nakuru. With Propensity Score Matching, we find that increased female intra-household bargaining power has no significant influence on household expenditure, but some inconsistent influence on the food security of a household.

Key words: Gender Inequality, Intra-Household Dynamics, Decision-Making, Welfare, Food Security

Corresponding Author: Luzia Deißler, Leibniz University Hannover, Institute for Environmental Economics and World Trade, Königsworther Platz 1, 30167 Hannover, Germany, E-mail: deissler@iuw.uni-hannover.de

1. Introduction

Gender inequalities prevail in labor markets and in societies in many parts of the world (Agarwal, 2018; Pearse, 2017). They have immense negative consequences for women and children, as well as for a whole country, because populations do not use their full economic potential, if part of the population is hampered in their development (Agarwal, 2018; Doss, 2013; Heise et al., 2019). Higher female bargaining power within a household increases child health and child education and reduces the share of uneducated work force in an economy (Allendorf, 2007; Bandiera & Natraj, 2013; Rubalcava et al., 2009). Further, women empowerment positively affects the expenditure for food and the food security of households (Asitik & Abu, 2020; Friedberg & Webb, 2006). Equal opportunities, irrespective of gender, are thus very important for the economic development and food security status of a country (Bandiera & Natraj, 2013; Wodon & de la Brière, 2018).

In Sub Saharan Africa, agriculture remains one of the most important sectors for the economies (World Bank, 2021a). In agriculture, women are traditionally responsible for the production of so-called food crops, whereas men are predominantly responsible for the so-called cash crop production (wa Gĩthĩnji et al., 2014; Wayua et al., 2020; Weinberger and Pichop, 2009). This is also true for Kenya, where about 60% of women are employed in the agricultural sector (World Bank, 2021b). In dynamic agricultural markets, so-called food crops sometimes advance to cash crops, so that men may take over the role of production and marketing from women. African indigenous vegetables (AIVs) are such food crops which have steadily gained importance in Kenyan diets. AIVs are full of essential nutrients (Kamga et al., 2013) and can thus play an important role in fighting food insecurity and hidden hunger in Kenya (Krause et al., 2019). However, it is not clear whether and to what extent the allocation of work among gender in AIV value chains changes over time.

While there has been some qualitative research on gender equality in the Kenyan AIV value chain, quantitative evaluation of the role of women, especially within male headed households, is not yet available (Kassie et al., 2014; Colverson & Farnworth, 2015; Wayua et al., 2020). Also, the relationship between intra-household female bargaining power and food security is not clear (Asfaw & Maggio, 2018; Djuikom & van de Walle, 2018; Friedberg & Webb, 2006). Using a unique primary data set from rural and peri-urban AIV producers in Kenya, this study tries to fill this gap by investigating the following three research objectives:

(1) Describing the allocation of tasks carried out by female farmers along the AIV value chain.

(2) Examining factors that determine women's intra-household bargaining power.

(3) Investigating possible impacts of female bargaining power on the household's welfare.

This paper will thus contribute to the literature in three ways: First, we will base our analyses on a unique primary data set collected in the context of the HORTINLEA project. Second, we use advanced methods such as Propensity Score Matching to reduce the potential self-selection bias in the sample. Third, achieving and monitoring the Sustainable Development Goal (SDG) of gender equality and empowerment of all women and girls remains a challenge due to lack of reliable data and analyses (United Nations, 2019; Salvia et al., 2019). Our research provides insights into gender-related issues in households in developing countries, contributing to the monitoring of the fifth SDG on gender equality.

The structure of the paper is as follows: after the introduction, it proceeds with a literature review and presents the underlying conceptual framework. Then we will elaborate on the methodology and present and discuss major findings of the research and derive some conclusions in the last section.

2. Literature review and conceptual framework

2.1 Commercialization of African Indigenous Vegetables

AIVs are vegetables that originate from the African continent and play an important role in traditional diets in many African countries (Ambrose-Oji, 2009; Smith & Eyzaguirre, 2008; Towns & Shackleton, 2018). The mineral content of these leafy vegetables is even higher than that of many other vegetables (Kamga et al., 2013). But AIVs are also most important for smallholder farmers' livelihoods as a potential income source. This is especially true for amaranth (*Amaranthus spp.*), vegetable cowpea (*Vigna unguiculata*), African nightshade (*Solanum scabrum, S. villosum, S. nigrum, S. americanum*), jute mallow (*Corchorus olitorius*), pumpkin leafs (*Cucurbita moschata*) and Crotalaria (*Crotalaria ochroleuca*) (Weinberger & Pichop, 2009). In Kenya, due to continuous urbanization and the rising influence of supermarkets in agricultural value chains, commercially produced AIVs are becoming an increasingly interesting income alternative for smallholder farmers (Cernansky, 2015; Krause et al., 2019; Trienekens, 2011). With respect to AIVs, women have been traditionally farmers, intermediaries and retailers (Weinberger & Pichop, 2009), whereas the production and marketing of cash crops have been dominated by males (wa Gĩthĩnji et al., 2014). Sugarcane, tea, coffee, wheat, maize and beans belong to these cash crops in Kenya (Kumela et al., 2019; Ochola & Kosura, 2007; Odero-Waitituh, 2017). However, the commercialization of former

food crops and their changed status into cash crops usually results in male farmers taking over production (Francis, 1998; wa Gĩthĩnji et al., 2014).

Literature suggests that AIV commercialization has positive impacts on income and food security (Krause et al., 2019). There is also evidence that the commercialization of crop production is linked to farm and plot size, since a household is able to diversify its crop production and to dedicate higher shares to commercial production (Martey et al., 2012). However, it is not clear how commercialization of AIVs affect women, their bargaining power and their involvement in production and marketing.

2.2 Gender inequality and intra-household bargaining power

Persisting gender differences in societal norms are not only affecting economic outcomes at the national level (Carlana, 2019; Giuliano, 2020; Wodon & de la Brière, 2018), but also contribute to differences in women's bargaining power within households (Galván & García-Peñalosa, 2018; Giuliano, 2020). These differences in gender roles are also present in agriculture in Sub-Saharan African countries (Colverson & Farnworth, 2015; Holden et al., 2001), which rank very low regarding the Gender Inequality Index (UNDP, 2020). A case study from the Ethiopian highlands shows for example significantly higher productivity for land operated by male-headed households than by female-headed households (Holden et al., 2001). This is mainly due to women's limited access to input markets including credits as well as to education and training, and the constraints they face by institutions and cultural norms that affect the intra-household allocation of marketing and management duties (Kilic et al., 2015). Societal norms tend to allocate the reproductive work to women, and the productive work, such as off-farm work, to men. Furthermore, women do most of the farm work (Dodoo & Tempenis, 2002; Kes & Swaminathan, 2006; Saito et al., 1994). Colverson and Farnworth (2015) describe the gender-specific allocation of tasks by pointing out that women are considered to be primarily interested in feeding their households by doing farm work, while men have a primary interest in commercial production. Subsequently, women have to divide their time between reproductive work and farming tasks (Kes & Swaminathan, 2006). Especially in the context of increasing trade opportunities for AIVs in Kenya, gender inequality carries more weight than ever, as female productivity cannot increase without proper resources (Colverson & Farnworth, 2015; Irungu et al., 2006).

Earlier studies have demonstrated a positive effect of female bargaining-power on the well-being of households (Annan et al., 2019; Asitik & Abu, 2020; Friedberg & Webb, 2006). The expenditure on food consumption and the food security of a household are stated to increase

significantly with higher female bargaining power, which should go along with an improvement of the food security status (Asitik & Abu, 2020; Friedberg & Webb, 2006).

2.3 Conceptual framework

Intra-household bargaining power has an impact on various household outcomes including well-being (Asitik & Abu, 2020; Friedberg & Webb, 2006). Also the production of AIVs can increase household welfare, making AIVs an important aspect for smallholder farming households in Kenya (Cernansky, 2015; Gotor & Irungu, 2010). In order to determine the factors that are influencing female bargaining power, we need to conceptualize the situation of female farmers within a household. To account for the complex dynamics within a household (Kilic et al., 2015), we base our framework on the Collective Model of the household (Fafchamps, 2001; Himmelweit et al., 2013). The model is described by Himmelweit et al. (2013) as a generalization of cooperative bargaining models, which considers more aspects and characteristics of individual household members (Figure 1). Bargaining power of an individual is determined by the threat point, or *fall-back position*, describing the level of utility, which each individual would have without the cooperation in the household (Agarwal, 1997; Himmelweit et al., 2013). The *fall-back position* is determined by so-called distribution factors including specific intrinsic and extrinsic aspects that influence the household members (Himmelweit et al., 2013).

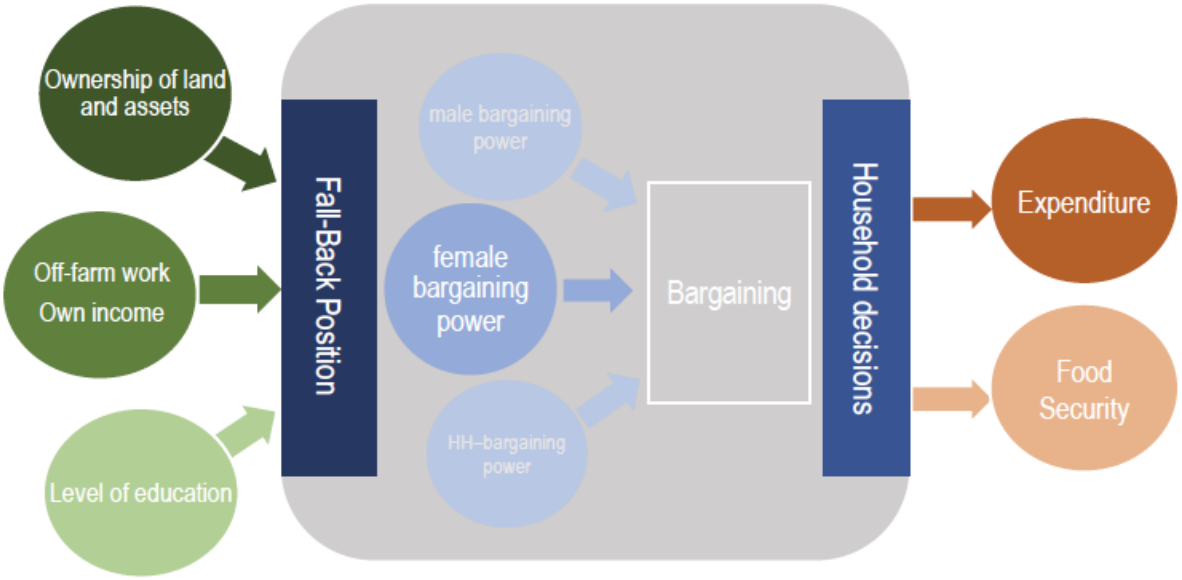

Figure 1. Conceptual Framework on the intra-household dynamics with the extra and intra-household factors influencing the female bargaining position and welfare aspects. Notes: HH = household. Source: Own compilation based on Doss, 2013; Fafchamps, 2001; Fischer & Qaim, 2012; Himmelweit et al., 2013

Financial resources, and even potential own income, can directly support a female's options outside the household (Agarwal, 1997; Doss, 2013). Own income provides control over resources within the household and can be directly linked to outcomes that must be purchased (Fafchamps, 2001; Fischer & Qaim, 2012). In addition, access to off-farm employment can increase bargaining power as it serves as a source for income, as well as social and other skills (Fafchamps, 2001; Hilliard et al., 2016). Moreover, control over household resources such as land and assets, as well as higher education have the potential of improving a female's bargaining position within a household (Doss, 2013; Doss et al., 2015; Quisumbing & Maluccio, 2003). These aspects affect a woman's intra-household bargaining power by giving her opportunities to cope without the household and making her able to threat or bargain.

However, the intra-household bargaining power is difficult to measure, as it is a rather intangible concept. Since decisions are mostly made in favor of the participant with the highest bargaining power (Agarwal, 2018; Quisumbing & Maluccio, 2003), we use the ability of a woman to achieve outputs in her favor as a proxy for her bargaining power (Alkire et al., 2012). Hence, we examine the participation in the decision-making process (Alkire et al., 2012; Doss, 2013). The bargaining power of every household member also influences the outcomes of decisions made in the household (Doss, 2013) (Figure 1). Thus, we examine the impact of female decision-making on household welfare, measured in food and non-food expenditure, as well as the household's food security status.

3. Data and methodology

3.1 Data

The data used for this project was collected in the context of the project *Horticultural Innovation and Learning for Improved Nutrition and Livelihood in East Africa* (HORTINLEA) with the objective of improving food security in Kenya. The survey was conducted in 2015 in two rural areas in Western Kenya, Kisii and Kakamega, in two peri-urban areas in South-Western Kenya, Kiambu and Nakuru, as well as in the urban county of Nairobi. Those sites were chosen according to main AIV production and consumption. In the regions, households were randomly chosen for the surveys which were carried out through direct interviews with producers, traders and consumers (Kebede et al., 2018).

The total survey covers 706 households. In order to investigate the female intra-household bargaining power, the sample was reduced to the households with a complete household head couple. This reduction leaves a sample of 570 households. The questionnaire depicts the socio-economic characteristics of actors involved in the value chain of AIVs. It includes sections on

general household characteristics, consumption, income and expenditure, agricultural production and shocks.

3.2 Methodology

3.2.1 Value chain mapping

In order to examine the allocation of tasks carried out by female farmers, a mapping of the AIV value chain based on the household data of the HORTINLEA project is conducted. As the AIV value chains differ with respect to location of households and types of AIVs, we separate the sample into rural and peri-urban households (Abel et al., 2019) and focus on the most important AIVs, namely Spiderplant, Ethiopian Kale, Slenderleaf, Murere and Indian Spinach. Furthermore, we differentiate between AIVs and other crops with the latter including all crops that are considered cash crops in Kenya, i.e. tea, sugarcane, maize, beans, coffee and wheat.

3.2.2 Multinomial logistic regression

First, we proxy female bargaining power as participation in two household decisions directly affecting the welfare of the household. One will be the decision over the production of crops and the other one will be the decision over the income deriving from the sales of AIVs. Second, we estimate the determinants of female bargaining power with a multinomial multivariate logistic regression based on Friedberg and Webb (2006). It consists of two separate regressions being conducted for the two different decision-making processes.

The statistical model is derived from a simple linear regression term (Cramer, 2007) and describes the outcome variable Y_i^*:

$$\text{with} \qquad Y_i^* = 0;1;2 \qquad \text{female decision; male decision; co-decision}$$

$$Y_i^* = \beta_0^* + \beta_1^* X_{1i} + \beta_2^* X_{2i} + \beta_3^* X_{3i} + \varepsilon_i^* \qquad \text{Eq. 1}$$

whereas X_i is the set of variables that are assumed to determine the outcome variable, ε_i^* is the error term, and β^* is a vector of unknown parameters. The choice of independent variables X_{ji} included in the model is based on the literature review and the conceptual framework. The variables we use in the statistical model cover general household and village characteristics, as well as gender specific attributes of the household head couple (Table 1).

Table 1. Variables used for multinomial logistic regression

VARIABLE		Exp. Sign.	Reference
household decision-making			
decision on production	HH member that decides over the production of crops: 0 = female decision, 1 = male decision, 2 = co-decision		Alkire et al., 2012; Doss, 2013
decision on money from AIVs	HH member that decides over the money derived from sold AIV: 0 = female decision, 1 = male decision		Alkire et al., 2012; Doss, 2013
household characteristics			
hh size	number of members in the HH: continuous	+/-	
hh head age	age of HH head: continuous	+/-	
land (ha)	size of farm in hectare: continuous	-	Francis, 1998; Martey et al., 2012
asset score	value of weighted number of assets a HH owns: continuous	+/-	
share other income sources	share of income generated by sources other than agriculture and livestock: continuous	+/-	
male and female characteristics			
education female	highest degree of education obtained by female HH head: 1 = primary, 2 = secondary, 3 = tertiary	+	Doss et al., 2015; Doss, 2013
education male	highest degree of education obtained by male HH head: 1 = primary, 2 = secondary, 3 = tertiary	+/-	
landownership female	binary: 1 = female HH head holds formal title over the parcels in the HH	+	Quisumbing & Maluccio, 2003
landownership male	binary: 1 = male HH head holds formal title over the parcels in the HH	+/-	
off-farm work female	binary: 1 = female HH head works off the HH farm	+	Fafchamps, 2011; Hilliard et al., 2016
off-farm work male	binary: 1 = male HH head works off the HH farm	+/-	
share female income	share of income generated by female HH head: continuous	+	Agarwal, 1997; Doss, 2013
geographic location			
County	location of the HH (county): 1 = HH located in Nakuru, 2 = HH located in Kakamega, 3 = HH located in Kisii, 4 = HH located in Kiambu	+/-	Dodoo & Tempenis, 2002; Mungai & Ogot, 2012

Notes: HH = household

3.2.3 Propensity score matching

To evaluate the impact of female bargaining power on household welfare, we use the Propensity Score Matching (PSM) method. This method controls for possible bias due to endogeneity, which we expect in our analysis, because treatment and control are not randomly assigned (Ahmed et al., 2016; Asfaw & Shiferaw, 2010). As there are numerous factors that are influencing the welfare of a household, besides the treatment variable of interest, PSM matches for each treated individual a suitable counterfactual amongst the control group, controlling for

all other (partly unobserved) aspects and thereby allowing the observation of only the treatment effect (Jena et al., 2012). In our impact analysis, the case of co-decision is neglected, as the number of observations is not sufficient for this statistical model. The advantage of PSM is its independence of random experimental setups, because it minimizes the bias due to the non-randomized data collection (Rosenbaum & Rubin, 1983). It controls for differences between households by matching them based on observable characteristics and therefore, makes them comparable for observing the treatment effect of interest (Ahmed et al., 2016). Since we can only observe one treatment per household, either male or female decision, we have a missing data bias in the analysis, which is accounted for by the balancing and matching with suitable counterfactuals (Rosenbaum & Rubin, 1983). Later on, we transfer the treatment effect into the average treatment effect on the treated (ATE), by calculating the difference between the treated and non-treated groups, based on the propensity scores.

In order to apply this methodology on the stated objective, the treatment will be the female decision-making, with the woman as the main decision-maker ($G_i = 1$) and the man as main decision-maker ($G_i = 0$). Effects on the welfare outcomes can be computed as the average of the primary treatment effect of interest for the treatment group (Ahmed et al., 2016):

$$\tau_{ATT} = E(\tau) = E(Y_i[1|G_i = 1] - [Y_i[0|G_i = 1]) \quad \text{Eq. 2}$$

With τ_{ATT} as the treatment effect of female decision-making on the individual households from the treated group, Y being the welfare outcome measured as food security status and with D_i as the household i that either has male or female decision in the respective questions.

In order to find suitable counterfactuals for each group of treatment and control, propensity scores will be computed following a logit model, as the treatment variable is binary. By applying the propensity scores, the differences between the subjects within treatment and control group should be as small as possible (Caliendo and Kopeinig, 2008). Those scores are based on a set of variables X, chosen according to the conditional-independence assumption and the common support condition (Heinrich et al., 2010; Rosenbaum & Rubin, 1983). To ensure robustness of the results, we use three matching methods: nearest neighbor matching (NN), kernel matching (KM) and radius matching (RM). The variables chosen as X for the propensity scores were chosen according to the previous choice model. See Appendix B for robustness checks.

3.2.4 Measuring household welfare and food security

Table A1 in the Appendix A provides an overview of the welfare indicators we use. We measure household's welfare by food and non-food expenditure since the expenditure pattern of a household counts as the more reliable welfare measure in developing countries (Haughton and Khandker, 2009). The food security status of a household is proxied by four different indicators. This allows to check for the robustness of the results. Additionally, the indicators cover the access, stability and utilization dimension of food security (FAO, 2008). These are three of the main aspects necessary for food security (FAO, 2008).

First, the Household Dietary Diversity Score (HDDS) accounts for the diversity and quality of a household's diet (Swindale & Bilinsky, 2006). For the HDDS, the frequencies of consumption of food within the household are grouped into categories and added up (Swindale & Bilinsky, 2006). This indicator is referring to the last seven days. Second, the Food Consumption Score (FCS) is calculated which depicts the diversity of the diet a household consumes with a score on the frequency a household consumes different food groups. The frequency is referring to the last seven days (Kebede et al., 2018). The indicator adequately represents the actual caloric intake of the household, by depicting the general consumption of rather nutritional or less nutritional food (WFP, 2008). Third, the Months of Adequate Household Food Provisioning indicator (MAHFP) identifies the months a household stated that they had enough food in the last year (Swindale & Bilinsky, 2010). The expenditure of the households was measured in Kenyan Shilling (KSH) and refers to the last month. The total household expenditure is composed of the food and non-food expenditure. Lastly, the Coping Strategies Index (CSI) is a measure of food insecurity and depicts the strategies households implement in order to cope with no or low access to food. The score shows the frequency and severity of the cases in which the household needs to fall back on such coping strategies (Maxwell & Caldwell, 2008).

4. Results and discussion

4.1 Gender-specific allocation of tasks in the AIV value chain and bargaining power

Our value chain mapping shows that women carry out more than two thirds of the work along the AIV value chain (Table 2). With respect to the production, in over 60 % of the households, women are responsible. In Kisii and Nakuru the share is even higher with over 70 % and 80 %. This further increases to 88 % for Nakuru and up to 94 % for Kisii for the selling and marketing. This finding goes along with earlier findings (Weinberger & Pichop, 2009), showing that the allocation of tasks in the AIV value chain has not yet changed substantially from women to men as it is expected to happen with increasing commercialization (wa Gĩthĩnji et al., 2014).

However, only 50 households are selling their AIVs to supermarkets or retailers, whereas 250 households are selling directly to consumers, implying that most households from our sample are not commercially producing AIVs, and thus the responsibility was not expected to shift.

Table 2. Percentage shares and total number of women involved in producing and selling AIVs and other crops

Tasks along the value chain		Kisii	Kakamega	Nakuru	Kiambu
Production	AIVs	78 / 120	65 / 112	86 / 97	62 / 71
	other crops	51 / 79	38 / 66	67 / 78	50 / 57
Selling	AIVs	94 / 91	78 / 105	88 / 52	71 / 65
	other crops	69 / 85	55 / 64	84 / 58	64 / 63

Notes: The numbers represent percentage share of females / total number of females. Source: Own compilation

Only in 40-50 % of all households, females are responsible for the production of other crops, with the exception of households located in Nakuru with a share of 67 %. In more than half of all households in every county, females are also responsible for the selling of other crops. Kes and Swaminathan (2006) point out that females on average spend more time on farm work than males. Yet, it is stated that women are not involved in the production of cash crops to a great extent (Kes & Swaminathan, 2006; wa Gĩthĩnji et al., 2014). This is opposed to our findings; there seems to be differences in the participation of males and females in those tasks, but the traditional separation into food and cash crops is less distinct. However, the participation of female farmers is higher in the value chain of AIVs than other crops.

Table 3 shows the distribution of decisions made by female, male and both (meaning co-decision) along the location of the households. The decision over the income from selling AIVs is dominated by females with female decision-making in approximately 70 % of the households. In contrast, the decision over crop production is predominantly made by males with a share of 50 %; one exception is Nakuru with a share of only 37 % of male decisions and 50 % of female decisions. Nakuru shows the highest female participation in crop value chains and also has the highest share of households with female decision-making, indicating that Nakuru must be a special case regarding female bargaining power.

Nakuru's population mostly consists of Kikuyus (Lynch, 2014; Mathenge et al., 2010). Earlier research demonstrates that the Kikuyu culture shows a comparably clear orientation towards femininity (opposite of clear gender roles), in comparison with other ethnicities (Ketter & Arfsten, 2015). Furthermore, they are less risk averse than other cultures and rather short-term oriented. Nevertheless, the Kikuyu culture remains a rather patriarchal system (Abbott, 1997; Presley, 1992). Therefore, it is convincing that, besides the comparably clear orientation towards femininity in the prevailing ethnicity in Nakuru, also the changing family structures

and the resulting changes in gender roles in favor of women have an influence on the high number of female decision-makers in households in Nakuru (Manyara et al., 2016). These culture and county specific characteristic can explain the unique female predominance, compared to other ethnicities, in the two decisions under consideration.

Table 3. Overview of the percentage share of decision-making of females, males and both (meaning co-decision) within the households

Gender of decision-maker	Kisii	Kakamega	Nakuru	Kiambu	total
Decision on the production of crops					
Female	33.77	31.67	50.86	34.19	36.68
Male	51.95	51.67	37.07	57.26	49.91
Both	14.29	16.67	12.07	8.55	13.40
Number of Obs.	154	180	116	117	567
Decision on income derived from selling AIVs					
Female	77.36	66.90	80.65	60.42	70.20
Male	21.70	33.10	19.35	38.54	29.31
Both	0.94	0.00	0.00	1.04	0.49
Number of Obs.	106	142	62	96	406

Source: Own compilation

4.2 Determinants of female bargaining power

Table 4 depicts the results from the regressions conducted to determine factors that are influencing the decision-making process within a household. The age of the household head slightly increases the chance of female decision-making over crop production, whereas the increase in land size seems to have a negative impact. Households with larger land size tend to commercialize their agricultural production (Francis, 1998; Martey et al., 2012; wa Gĩthĩnji et al., 2014). Since commercialization is also associated with higher male involvement, this might explain the negative correlation between the land size and female decision-making. This further indicates that females are still disadvantaged within commercial crop production in Kenya (Kilic et al., 2015; Martey et al., 2012). Additionally, a higher asset score decreases the chance of female decision-making over the crop production. A study from Kenya finds a positive correlation between commercialization of the smallholder farm and the asset score of a household (Murathi, 2018). This confirms that numerous aspects of commercialization can lead to disempowerment of women (wa Gĩthĩnji et al., 2014; Weinberger & Pichop, 2009). Thus, it might be one reason for the continuous allocation of women to subsistent farming.

Education of the female household head was expected to have a positive correlation with female decision-making, as a higher educational degree might increase a female's outside options and subsequently her *fall-back position* (Quisumbing & Maluccio, 2003). The results show that tertiary education has a positive impact on the chance of female decision-making over the income derived from AIVs. However, only 9.7 % of all females in Kenya were enrolled in tertiary education in 2017 (World Bank, 2020b). Therefore, the threshold of this level of education for higher bargaining power is relatively high. The share of females being enrolled in secondary education is significantly higher with 53.6 %, but this apparently has no great influence (World Bank, 2020a). Furthermore, owning land, as it is an important asset in developing countries, is highly associated with bargaining power (Allendorf, 2007; Doss, 2013; Quisumbing & Maluccio, 2003). Subsequently, the raise in the chances for female decision-making over the crop production was as we expected. However, this can only increase general female bargaining power if some gender gaps can be overcome. Land rights in Sub-Saharan Africa remain rather unfavorable for women and formally owned land is not always controlled by women as well (Doss et al., 2015).

Interestingly, having work outside of the farm decreases the woman's probability of participating in the decision-making process for production and money handling. This is going against earlier findings indicating a positive impact resulting from increased social and other (job related) skills (Fafchamps, 2001; Hilliard et al., 2016). The opposing value might result from less time the female household head spends on the farm and subsequently with the production and selling of crops. Women in Sub-Saharan Africa face severe time poverty due to the need of splitting their time between formal or informal off-farm work, and reproductive tasks. Work outside of the farm can increase the time pressure on them and thus, might lower their bargaining position (Colverson & Farnworth, 2015; Dodoo & Tempenis, 2002; Kes & Swaminathan, 2006). Further, the financial resources from employment were expected to increase a woman's bargaining power (Agarwal, 1997; Doss, 2013). However, this is only backed by our finding that a higher share of the female income in total household income increases the chances of female decision-making in the household (s. Table 4). Male off-farm employment increases the chance of female decision-making significantly. This can possibly be explained by the fact that the woman spends more time on farm work to compensate for the absence of the male.

Women living in the counties of Kakamega, Kisii and Kiambu have a lower chance of being part of the decision-making process, as the prevailing culture of Kikuyu seems to be a special case of gender norms. As described before, the Kikuyu culture shows rather low masculinity,

indicating overlapping responsibilities of men and women (Ketter & Arfsten, 2015). Moreover, currently changing social structures tend to shift the gender roles further towards equality (Manyara et al., 2016).

Table 4. Determinants of female bargaining power – results of the multinomial logit model

	(2) Decision: production				(1) Decision: AIV income	
VARIABLES	female		both		female	
	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
hh size	-0.0201	(0.0470)	0.0332	(0.0689)	0.0953	(0.0867)
hh head age	0.0113**	(0.00495)	0.00822	(0.0126)	0.0120	(0.0123)
land	-0.0698*	(0.0388)	-0.245**	(0.107)	-0.0965	(0.0644)
ln (asset score)	-0.189***	(0.0241)	0.421	(0.301)	0.0601	(0.342)
other income sources	-0.128	(0.266)	-1.126***	(0.328)	0.0541	(0.393)
educ female: Sec	0.248	(0.281)	-0.115	(0.260)	0.119	(0.398)
educ female: Tert	0.553	(-1.102)	0.236	(1.132)	0.954*	(0.551)
educ male: Sec	-0.138	(0.299)	0.0524	(0.151)	-0.345	(0.346)
educ male: Tert	-0.386	(0.453)	0.517	(0.691)	0.782	(1.066)
landownership female	1.413*	(0.766)	0.497	(1.452)	0.507	(0.905)
landownership male	0.227	(0.497)	-0.123	(0.180)	0.229	(0.457)
off-farm work female	-0.746***	(0.248)	-0.753	(0.476)	-1.235***	(0.163)
off-farm work male	1.718***	(0.204)	0.332	(0.247)	1.160***	(0.210)
share female income	1.120**	(0.468)	-0.728	(1.128)	3.244***	(0.769)
Kakamega	-0.523***	(0.150)	-0.139	(0.162)	-0.656***	(0.189)
Kisii	-0.447**	(0.174)	-0.356***	(0.0735)	-0.126	(0.214)
Kiambu	-0.580***	(0.0842)	-1.074***	(0.163)	-0.816***	(0.0787)
Constant	0.319	(0.518)	-4.048*	(2.424)	-0.557	(2.740)
Observations	566		566		404	
R^2	0.1074		0.1074		0.1148	

Notes: The numbers in brackets are standard errors. Significance at the 10, 5, and 1 % levels is indicated by *, **, and *** respectively. (1) with the dependent variable: decision about the money coming from selling the AIV. (2) with the dependent variable: decision over the production of crops. Source: Own compilation

4.3 Impact of Female Bargaining Power on Welfare

The impact of female bargaining power on the welfare and food security status of a household is shown in Table 5. The results are the average treatment effect on the treated (ATT) and derive from the propensity score matching using different matching algorithms. The ATT on the HDDS caused by female decision-making in production decisions is about -0.35 to -0.60. Consequently, female bargaining power seems to decrease this food security indicator, opposed to the findings from the literature (Duflo & Udry, 2004; Haughton & Khandker, 2009). As the HDDS reflects the food access of a household, it seems as female bargaining power has a negative impact on the household's ability to access a variety of food (Kennedy et al., 2011).

Regarding the decision over the income from selling AIVs, the PSM on the FCS and MAHFP resulted in significant treatment effects, showing opposing directions. A female decision over the money from sold AIV increases the FCS of the respective household by 3.25 to 3.46, whereas it decreases the MAHFP by about 1.17 to 1.34, meaning a household had about one more month without adequate food supply. The differences in signs and values might result from the different calculations of the indicator, however, both indicators depict a proportional relation between food security and their scores. While the FCS depicts the diversity of the household's diet, reported on a weekly basis, the MAHFP reports the availability of an adequate amount of food in one year (Lovon & Mathiassen, 2014; Swindale & Bilinsky, 2010).

Table 5. Impact of female bargaining power on welfare and food security

		Decision over Production		Decision over Income from AIVs	
VARIABLE		ATT	S.E.	ATT	S.E.
Food Security					
HDDS	NN	-0.601***	0.197	-0.145	0.249
	RM	-0.311**	0.153	-0.061	0.162
	KM	-0.352**	0.169	-0.882	0.181
FCS	NN	-2.229	2.280	2.627	2.552
	RM	-0.835	1.618	3.457*	1.892
	KM	-1.123	1.882	3.248*	1.780
MAHFP	NN	-0.246	0.597	-1.174***	0.441
	RM	-0.330	0.341	-1.308***	0.329
	KM	-0.313	0.390	-1.338***	0.327
CSI	NN	-2.117	3.943	-6.733*	3.828
	RM	-0.535	2.786	0.590	3.081
	KM	0.055	2.874	0.538	3.253
Expenditure					
food expenditure	NN	-153.4	245.9	-279.4	265.5
	RM	-28.84	190.4	-81.54	203.8
	KM	-38.16	211.9	-152.8	224.3
total expenditure	NN	-247.6	317.9	-378.9	306.6
	RM	-28.82	216.9	-112.6	200.1
	KM	-50.31	191.4	-214.9	217.9

Notes: The numbers in brackets are standard errors. Significance at the 10, 5, and 1 % levels is indicated by *, **, and *** respectively. ATT: Average Treatment Effect on the Treated, NN: Nearest Neighbor Matching, RM: Radius Matching, KM: Kernel Matching, HDDS: Household Dietary Diversity Score, FCS: Food Consumption Score, MAHFP: Months of Adequate Household Food Provisioning indicator, CSI: Coping Strategies Index. Source: Own compilation

The FCS depicts the access dimension of food security and refers to one week within the household, whereas the MAHFP reflects the stability dimension and refers to one year (FAO, 2008; Krause et al., 2019). The food security within the one week reported by the respondents

might have been different to the complete past year. This could also be a reason for the opposing effects of female bargaining power on the two indicators. Women in Kenya are mainly responsible for the food choice and preparation (Musotsi et al., 2018; Venkatramanan & Shah, 2020). The positive results on the FCS may indicate that female bargaining power has a positive impact on the diversity of the household's diet, possibly by providing more control over resources.

The ATT regarding the CSI is also statistically significant, however, only for the nearest neighbor matching algorithm. The negative value of 6.7 indicates a reduction in food insecurity. Households with female decision-making show a lower frequency and severity of occasions in which the household needs to cope with an inadequate access to food (Maxwell & Caldwell, 2008). Opposed to our expectations (Asfaw & Shiferaw, 2010), we do not find statistically significant effects of female decision-making on the expenditure of a household.

5. Summary and Conclusion

We examined gender inequalities within Kenyan AIV value chains, the determinants of female bargaining power and the consequences of this power on the welfare of smallholder farming households. In more than 70 % of the sampled households, females are responsible for the production and sale of AIVs. The production of commercial crops is almost evenly distributed, but even with increasing commercialization, women remain the major actors in the AIV value chains. The decisions regarding the income from AIV sales are still dominated by females, but the female bargaining power regarding the general crop production is still low. Concerning the evaluation of determinants of female bargaining power, women on larger farms with high asset scores are found to have lower bargaining power, indicating a continuous disadvantage regarding diversified and commercial crop production. Higher education increases a woman's bargaining power, however, only a small fraction of women in Kenya actually obtains tertiary education, providing an important intervention point for policy makers. Our results also show a decrease in female bargaining power by female off-farm work and an increase by male off-farm work.

Lastly, significant impacts of female bargaining power are found on the welfare of a household. The HDDS and MAHFP are decreased, opposed to the expectations. Only the FCS and thus the access dimension of food security increase with higher female bargaining power. In contrast to earlier findings, the expenditure of the households is not altered by high female bargaining power in our case.

Our study shows the continued importance of women in the Kenyan supply chain of AIVs. It is of great interest to examine further parts of the decision-making process to gain more detailed insights in this complex matter and the possibilities of empowering women in smallholder farming households. Policy makers should aim at improving women's education and income in order to increase their bargaining power. This is also of great relevance for the economic potential of the country, which is highly depending on the agricultural sector.

It must be noted that the decisions over crop production and the income from the AIVs are carefully taken as representative for the decision-making process within the household, as they may not reflect the intra-household dynamics completely and precisely (Alkire et al., 2012; IFPRI, 2012). Thus, further research in this field is necessary to understand the effect of intra-household bargaining power on household welfare in Kenya. After all, the data represents the current state of the households for 2015 only. Future research may also want to analyse changes over time. With respect to the statistical models, a reversed relationship between bargaining power and asset ownership might influence the statistical methods as it could lead to biases due to endogeneity. This would be interesting for future investigations. Also, PSM was chosen to control for self-selection and endogeneity bias, but some critique on the matching mechanisms of PSM suggest a verification of results by conducting other models as well. Finally, a study specifically focusing on the intra-household decision making including, e.g. games and role-plays, could shed light on how the factors found in this study influence intra-household bargaining power.

Acknowledgments

This publication is a product of the HORTINLEA project (http://www.hortinlea.org/) funded by the German Federal Ministry of Education and Research (BMBF) and co-financed by the German Federal Ministry of Economic Cooperation and Development (BMZ). The views expressed are purely those of the authors and may not under any circumstances be regarded as stating an official position of the BMBF and BMZ.

Funding

The authors received no direct funding for this research.

Competing Interest

The authors declare no competing interest.

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Appendix A

Table A1. Welfare indicators used for assessing the impact of female bargaining power on the household's welfare.

VARIABLE	Obs.	Mean	Std. Dev.	Reference
Household Dietary Diversity Score (HDDS)	570	8.951	1.478	Friedberg and Webb, 2006; Haughton and Khandker, 2009
Food Consumption Score (FCS)	570	70.56	15.80	Friedberg and Webb, 2006; Haughton and Khandker, 2009
Months of Adequate Household Food Provisioning indicator (MAHFP)	570	9.411	3.891	Friedberg and Webb, 2006; Haughton and Khandker, 2009
Coping Strategies Index (CSI)	570	20.56	25.28	Friedberg and Webb, 2006; Haughton and Khandker, 2009
food expenditure (KSH)	567	2,414	1,722	Ahmed et al., 2016; Asfaw and Shiferaw, 2010
total expenditure (KSH)	563	174.9	185.2	Ahmed et al., 2016; Asfaw and Shiferaw, 2010

Source: Own compilation

Appendix B

In order to optimize the bias reduction, three different matching algorithms were used. The nearest neighbor matching (NN), the radius matching (RM) and the kernel matching (KM). Radius and kernel matching can adjust for non-optimal matches by including specifications. For the RM the caliper was set to 0.1. The bandwidth for the KM was set at 0.06.

Concerning the common support condition (Heinrich et al., 2010), the region of common support was determined by the rimming procedure (J. A. Smith & Todd, 2005). Seven observations were excluded regarding the decision over production and eight observations regarding the decision over the money from AIV (s.

	B			**A**		
Sample	Off Support	On Support	Total	Off Support	On Support	Total
Untreated	2	281	283	1	118	119
Treated	5	203	208	7	278	285
Total	7	484	491	8	396	404

Notes: **A** decision over production, **B** decision over the money from sold AIV. Source: Own compilation

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Table B2 shows the standardized bias tests, t-tests and F-tests for the different matching algorithms and treatment variables. The mean biases of RM and KM are below 5 %, only slightly higher for KM for the decision over the money from AIV, and the t-test statistics indicate no significant differences between the groups after the balancing (Caliendo & Kopeining, 2008; Rosenbaum & Rubin, 1985).

For a detailed description of the robustness checks of the PSM see Krause et al. (2019) and Caliendo & Kopeinig (2008).

Table B1. Imposition of common support

	B			**A**		
Sample	Off Support	On Support	Total	Off Support	On Support	Total
Untreated	2	281	283	1	118	119
Treated	5	203	208	7	278	285
Total	7	484	491	8	396	404

Notes: **A** decision over production, **B** decision over the money from sold AIV. Source: Own compilation

Table B2. Overall bias reduction and F-test after matching

B	Sample	Pseudo-R2	LR chi2	p>chi2	MeanBias	MedBias
	Unmatched	0.132	88.16	0.000	14.7	8.7
	NNM	0.017	9.74	0.914	5.6	5.3
	RM	0.007	4.05	0.999	3.7	2.6
	KM	0.006	3.14	1.000	3.3	2.6
A	Sample	Pseudo-R2	LR chi2	p>chi2	MeanBias	MedBias
	Unmatched	0.115	56.37	0.000	16.2	15.4
	NNM	0.019	14.33	0.574	6.4	5.7
	RM	0.012	9.54	0.992	4.3	3.3
	KM	0.017	13.00	0.736	5.3	4.9

Notes: **A** decision over production, **B** decision over the money from sold AIV. Source: Own compilation

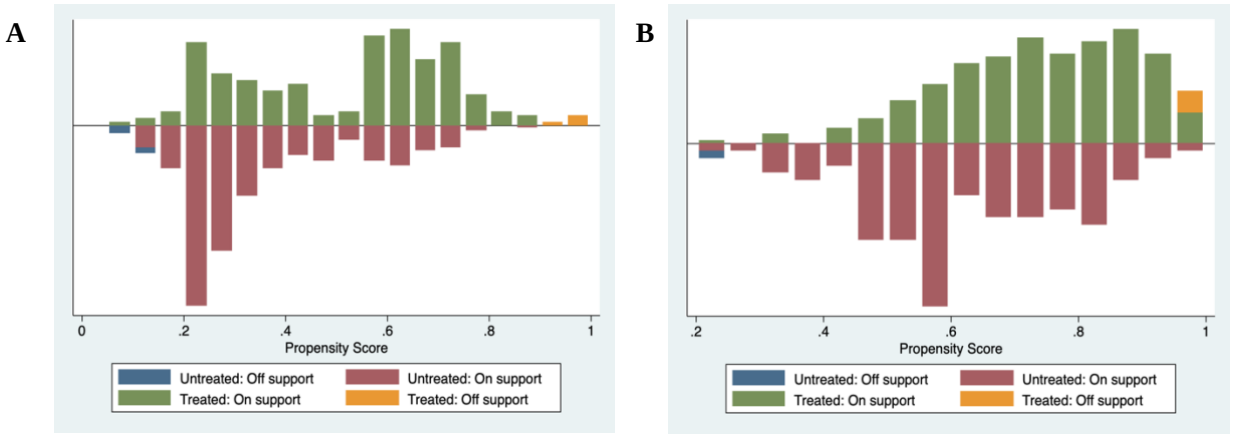

Figure B1. Distribution of propensity scores

Notes: **A** decision over production, **B** decision over the money from sold AIV. Source: Own compilation