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https://nbn-resolving.org/urn:nbn:de:0156-1171121

In:
Finger, Anne; Badelt, Ole; Dahmen, Kathleen; Heilen, Lydia; Mai, Nora; Seegers, Ronja; Seewald, Eva; Śnieg, Filip; Wiemer, Leonie (Hrsg.) (2024): Transformationsprozesse in Stadt und Land – Erkenntnisse, Strategien und Zukunftsperspektiven.
Hannover, 164-183. = Forschungsberichte der ARL 23.
https://nbn-resolving.org/urn:nbn:de:0156-11713

Ronja Seegers

WILD FRUIT COLLECTION AND ITS IMPACT ON HOUSEHOLD FOOD SECURITY IN THE LUAPULA PROVINCE, ZAMBIA

Contents

Abstract
In many sub-Saharan African countries, wild fruits offer great potential to serve as a nutritional complement and safety net in times of food shortages. However, their true contribution to food security is still insufficiently investigated. This study, therefore, examines the impact of wild fruits on the food security of 215 households in Northern Zambia. Data were collected through focus group discussions and a census. The Food Consumption Score (FCS) and reduced Coping Strategy Index (rCSI) were calculated as food security indicators. Results of multiple linear regression analysis reveal no relationship between wild fruit collection and the rCSI. However, households with a lower FCS rely more on wild fruit collection to diversify their diets and can significantly improve their food security the more fruits they collect. Thus, households do not consider wild fruit collection as a coping strategy in times of food scarcity but rather use wild fruits as nutritional complements to a regular diet.

Keywords
Wild Fruits – Food Security – Food Consumption Score – Reduced Coping Strategy Index – Zambia

Das Sammeln von Wildfrüchten und seine Auswirkungen auf die Ernährungssicherung von Haushalten in der Provinz Luapula, Sambia

Kurzfassung
In vielen afrikanischen Ländern südlich der Sahara bieten Wildfrüchte großes Potenzial, als Nahrungsergänzung und Sicherheitsnetz in Zeiten von Nahrungsmittelknappheit zu dienen. Ihr tatsächlicher Beitrag zur Ernährungssicherung ist jedoch noch unzureichend erforscht. Diese Studie untersucht daher die Auswirkungen von Wildfrüchten auf die Ernährungssicherung von 215 Haushalten im Norden Sambias. Die Daten wurden durch Fokusgruppendiskussionen und eine Volkszählung erhoben. Der Food Consumption Score (FCS) und der reduced Coping Strategy Index (rCSI) wurden als Indikatoren für die Ernährungssicherung berechnet. Die Ergebnisse der multiplen linearen Regressionsanalyse zeigen keinen Zusammenhang zwischen dem Sammeln von Wildfrüchten und dem rCSI. Haushalte mit einem niedrigeren FCS sind jedoch stärker auf das Sammeln von Wildfrüchten angewiesen, um ihre Ernährung zu diversifizieren, und können ihre Ernährungssicherung deutlich verbessern, je mehr Früchte sie sammeln. Die Haushalte betrachten das Sammeln von Wildfrüchten also nicht als Bewältigungsstrategie in Zeiten der Nahrungsmittelknappheit, sondern nutzen diese vielmehr als Ergänzung zur normalen Ernährung.

Schlüsselwörter
Wildfrüchte – Ernährungssicherung – Food Consumption Score – reduced Coping Strategy Index – Sambia

1 Introduction

Despite global progress, ending hunger and food insecurity remains a challenge. Almost 3.1 billion people worldwide are currently not able to afford a healthy diet (FAO 2022). This is especially true for smallholder farmers in developing countries who depend on their own production (Sibathu/Qaim 2017). Due to changing climate conditions such as rainy and dry seasons, smallholders are vulnerable to seasonal food shortages, resulting in periods of hunger (Chakona/Shackleton 2019; Erskine et al. 2014). Climate change-related, extreme weather events further exacerbate the risk of insufficient food production and harvest loss. In many sub-Saharan African countries, it is not only hunger that poses a serious threat but also malnutrition. As small-scale farming households predominantly cultivate and consume calorie-dense staple crops, they frequently lack important micronutrients that are required to fulfill a diversified, healthy diet (Sibathu/Qaim 2017). This lack of nutrients can severely affect human health, leading for example to stunting, wasting, anemia, and low birth weight. Stunting, the state of children under the age of five being too small relative to their age, is the most common form of malnutrition and affects 32.3% of children in sub-Saharan Africa (FAO et al. 2022).

An important strategy to reduce household food insecurity is the collection of natural forest resources such as wild fruits (Fentahun/Hager 2009; Mahapatra et al. 2012; Shackleton/Shackleton 2004). Previous research has shown that collecting and

consuming wild fruits from surrounding forests and woodlands is common for households in various African countries (Boedecker et al. 2014; Feyssa et al. 2011; Keding et al. 2017; Maseko et al. 2017; Mhuji et al. 2018; Mithöfer/Waibel 2003; Paumgarten/Locatelli/Witkowski 2018; Tebkew et al. 2018; Tebkew/Asfaw/Zewudie 2014). Households particularly use wild fruits as a safety net and coping measure in times of food shortages due to shocks and insufficient crop production (Erskine et al. 2014; Paumgarten/Locatelli/Witkowski 2018). As shown in a study from South Africa, the majority of households increase the frequency of wild food collection during times of food scarcity and hunger. The higher collection frequency, therefore, mitigates the intensity of hunger periods, allows for cost-saving, and prevents the need to pursue other coping measures (Paumgarten/Locatelli/Witkowski 2018).

Moreover, wild fruits are important sources of various macro- and micronutrients, such as carbohydrates, fiber, and various vitamins and minerals (Aworh 2015). In India, Mahapatra et al. (2012) found that wild fruits contained a similar or even higher amount of carbohydrates, proteins, sugar, and vitamins compared to cultivated species. In Benin, Boedecker et al. (2014) found that the consumption of wild edible plants (WEPs) can contribute to higher intakes of Vitamin C, riboflavin, copper, iron, folate, and calcium. Wild fruit species are therefore of great relevance to addressing malnutrition among rural populations (Ngome et al. 2017).

Apart from their potential to reduce hunger and malnutrition, wild fruits can also serve as an income source and, therefore, increase households' livelihood (Sardeshpande/Shackleton 2019; Tebkew et al. 2018). Mahapatra/Panda (2012) showed that Indian households generate 15% of their income through the sale of wild fruits. In their study from Murehwa District in Zimbabwe, Mithöfer/Waibel (2003) revealed that, although households sell fewer wild fruits than exotic fruits, they receive similar amounts of cash per unit sold for both types of fruit. Since households frequently use the income obtained through the sale for educational purposes, medical consultations and treatment, and for food from outside their own production, wild fruits also indirectly contribute to food security (Asprilla-Perea/Díaz-Puente 2019).

Poverty and malnutrition are also major challenges in Zambia. In 2021, the prevalence of undernourishment accounted for 30.9%. In addition, an estimated 32.9% of children under the age of five were stunted in 2020 (FAOSTAT 2022). The Miombo woodlands, the predominant vegetation biome in Zambia, include more than 75 indigenous fruit tree species, which are of essential importance for improving household livelihood and food security (Chirwa/Syampungani/Geldenhuys 2008). Ickowitz et al. (2021) estimate that the quantity of wild fruits collected contributes 80% of total household fruit intake in Zambia, which corresponds to 25% of the consumption amount recommended by the WHO. This amount has been shown to be particularly high among households experiencing food security (Steel et al. 2022). However, unsustainable land use and deforestation pose severe threats to the availability of wild fruits in Zambia (FAO 2013). This threat could reinforce the households' risk of suffering from poverty and food insecurity.

Although wild edible fruits could play an important role as a safety net and complementary food, they have been largely overlooked in policy and research analyses in the past (Aworh 2015; Erskine et al. 2014; Keding et al. 2017; Ngome et al. 2017). Researchers from different disciplinary fields have made efforts to include wild foods in nutrition and food security planning, and fill existing knowledge gaps, for example, by conducting studies of ethnobiology, nutritional evaluations, and planting practices (Asprilla-Perea/Díaz-Puente/Martín-Fernández 2022). Despite the increasing number of studies on wild food utilization, their direct impact on household food security is still difficult to confirm and needs greater understanding (Asprilla-Perea/Díaz-Puente 2019). To date, various studies have revealed that households frequently consume wild foods to overcome periods of food shortages (Erskine et al. 2014; Shackleton/Shackleton 2004; Feyssa et al. 2011; Paumgarten/Locatelli/Witkowski 2018), suggesting that wild fruits play an important role in increasing food security. However, fewer studies have empirically investigated the relationship between wild food consumption and household food security by applying thorough food security indicators (Chakona/Shackleton 2019) or nutrient intake assessment measures (Boedecker et al. 2014; Powell et al. 2013; Termote et al. 2012). In addition, the few studies that use food security or nutrient intake assessment indicators have mostly investigated the relation to more general food groups from the forests, such as Non-Timber Forest Products (NTFP), wild foods (Chakona/Shackleton 2019), or Wild Edible Plants (WEPs) (Boedecker et al. 2014; Termote et al. 2012). Indeed, the insufficient differentiation of wild fruits from broader terms leads to limited understanding of the role of wild fruits as an independent category (Keding et al. 2017; Ngome et al. 2017), which might lead to underestimations of their importance to household livelihood.

Moreover, with few exceptions (Steel et al. 2022), hardly any study has examined household food security with regard to the quantity of wild food collected, specifically in Zambia. More studies should therefore investigate the relationship between wild fruit collection and food security (Asprilla-Perea/Díaz-Puente 2019; Chakravarty et al. 2016; Ngome et al. 2017), particularly with regard to both the quantity of wild fruits collected and food security indicators.

To fill these research gaps, this paper investigates the extent of wild fruit collection and its impact on household food security in Zambia. Particularly, the contribution of this study is threefold. First, it specifically considers the collection of wild fruits instead of more general terms such as NTFP, wild food, or WEPs. Second, this paper not only takes into account the decision of households to collect wild fruits but also investigates the linkage between the quantity of wild fruits collected and food security among Zambian households. Third, the study uses two widely used food security indicators to investigate the role of wild fruit collection on household food security. The calculation of food security indicators allows this investigation to more precisely analyze the true impact of wild fruit collection on household food security, which might help to draw policy implications. In addition, since the literature analyzing the influencing factors of food security among Zambian households is still limited (Nkomoki/Bavorová/Banout 2019), this study also investigates other potential determinants of their food security status.

The paper is structured as follows. Section 2 first provides a conceptual framework explaining the impact of wild fruit collection on household food security. Section 3 describes the data and methods used for this study, including information on the study area, data collection process, description and calculation of the two food security indicators, and data analysis. Section 4 reports the descriptive and econometric results and discusses the findings. Section 5 summarizes the results and concludes with an outlook for future research and policy recommendations, before Section 6 closes with a discussion of the limitations of this study.

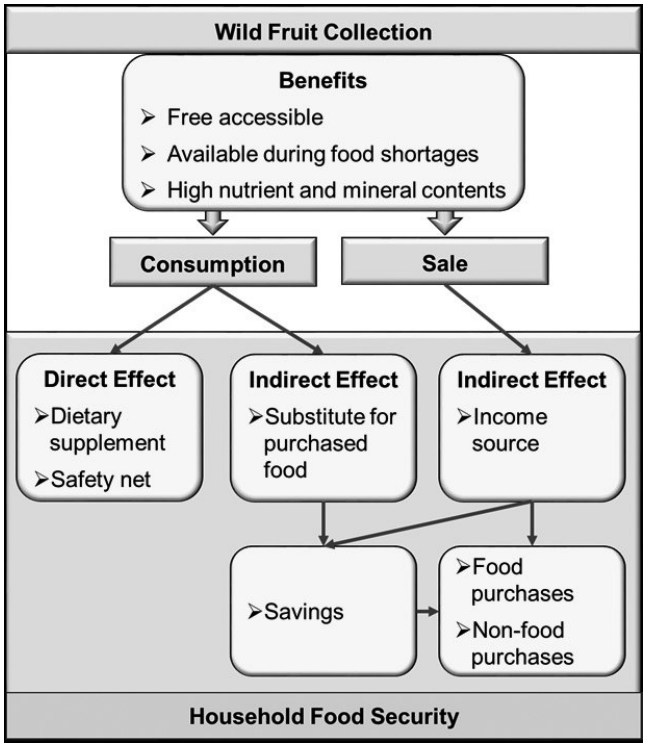

Figure 1: Conceptual Framework / Source: the author

2 Conceptual Framework

The collection of wild fruits offers important benefits to poor rural households of developing countries who only have limited access to markets and diverse food apart from their own production. Figure 1 represents the conceptual framework of this study, which highlights the most meaningful advantages of wild fruits and their importance for rural household food security. Since wild fruit trees occur spontaneously and are self-propagating plants that are neither domesticated nor cultivated (Heywood 1999), households can easily access them with no costs other than labor opportunity costs (Shackleton/Shackleton 2004). Existing literature has already shown that the availability of wild fruits is particularly important in times of low crop

yield and insufficient food production, implying that the consumption of wild fruits can help to overcome periods of hunger (Gumbo et al. 2018; Paumgarten/Shackleton 2011; Feyssa et al. 2011). Due to their high nutritional value, they are also considered a nutrient-rich supplement to the typical unbalanced, carbohydrate-heavy diet and, thus, play a critical role in reducing malnutrition (Vinceti et al. 2013). Through their function as a safety net and nutritional supplement, it is expected that wild fruits have a direct positive impact on household food security. In addition, collecting fruits from surrounding forests provides a cost-saving strategy, as households can substitute purchased food with collected wild fruits and, therefore, reduce their food expenditures (Chakona/Shackleton 2019; Paumgarten/Shackleton 2011). Another indirect way to improve household food security is through the sale of wild fruits. The cash income generated from fruit sales enables households to buy other important food products, which again contributes to food and nutrition security (Ngome et al. 2017). Alternatively, the income obtained from fruit sales and the savings through lower food purchases may be used for investments in agriculture, education, or other non-food commodities (Ngome et al. 2017; Shackleton/Shackleton 2004). The collection of wild fruits can thus increase household food security through various direct and indirect pathways.

3 Data and Methods

3.1 Study Area

The study area is located in Mantapala in the Nchelenge District, which is part of the Luapula Province in northern Zambia (Figure 2). Among all provinces in Zambia, the under-five mortality rate is highest in the Luapula Province (Zambia Statistics Agency/ Ministry of Health (MOH) Zambia/ ICF 2018). In addition, it is one of the provinces with the largest prevalence of stunting and wasting rates for children under the age of five (Bellack/Richards 2016), accounting for 45% and 6%, respectively (USAID 2018; Zambia Statistics Agency/ Ministry of Health (MOH) Zambia/ ICF 2018).

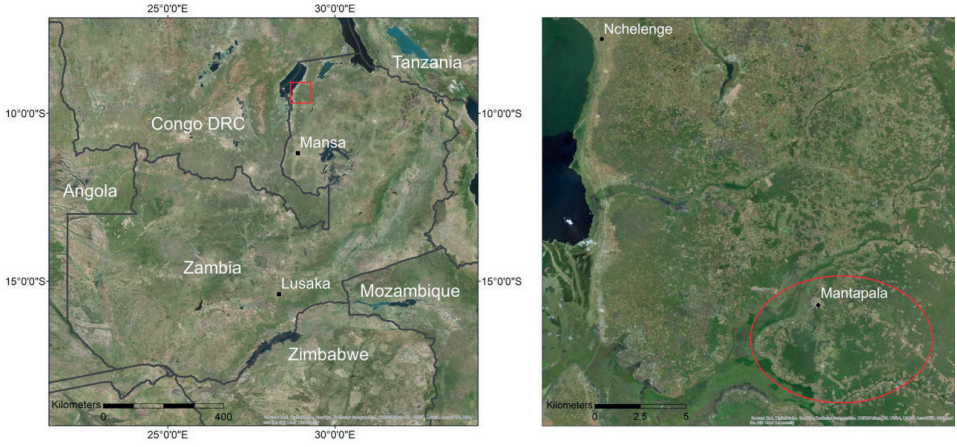

Figure 2: Location of the study area Mantapala in the Luapula Province, Zambia / Source: Gronau/ Winter/Grote (2018)

On average, people only have less than 1.90 US$ per capita per day to live on, which reveals the severe state of poverty in the Luapula Province (Mofya-Mukuka/Mofu 2016). To secure their livelihood, households rely on subsistence farming and the use of forest resources. They mainly cultivate cassava and maize, but sweet potatoes, rice, millet, groundnuts, and beans are also grown to a lower extent (Gronau/Winter/Grote 2018). Due to a lack of income and infrastructure, households are unable to buy nutritious foods such as fruits. Therefore, wild fruit collection is considered an important strategy to improve household food and nutrition security (Gronau/Winter/Grote 2018).

3.2 Data Collection

The data of this study originated from the project Food Security in Rural Zambia (FoSeZa), which was funded by the German Federal Ministry of Food and Agriculture (Bundesministerium für Ernährung und Landwirtschaft – BMEL). Within this project, a census was conducted in April 2018, including 215 households from eight villages within Mantapala. In addition, five focus group discussions (FGDs) with six randomly selected participants were conducted to gather in-depth knowledge on wild fruit collection.

3.3 Data Analysis

3.3.1 Food Security Indicators

According to the definition by the World Food Summit from 1996 "Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life". Following this definition, food security captures four different dimensions, namely food availability, food access, utilization, and stability. The first dimension refers to the existence of a sufficient quantity and quality of food, whereas the second dimension means that the available food products should be accessible to every individual to enable a nutritious diet. The third dimension captures non-food inputs like healthcare, clean water, and sanitation, which constitute important components for assuring food security. The last dimension of food security refers to the long-term stability of food availability, access, and utilization (FAO 2006).

This study applies the Food Consumption Score (FCS) and the reduced Coping Strategy Index (rCSI). Both indicators measure the food access dimension of household food security and are based on a seven-day recall period (Carletto/Zezza/Banerjee 2013; Vaitla/Coates/Maxwell 2015). While the FCS refers to dietary diversity, food consumption frequency, and the nutritional importance of food groups, the rCSI focuses on the coping behavior of people in times of food shortages (Maxwell/Caldwell 2008, WFP 2008). For further information on calculations, see for example WFP (2008) and Vaitla/Coates/Maxwell (2015). The three final categories of the FCS are "poor", "borderline", and "acceptable". The corresponding scores of these categories range from 0 to 21, from 21.5 to 35, and from 35.5 to 112, respectively, with higher

scores representing greater food security (WFP 2008). In contrast, higher scores of the rCSI imply lower food security. For the rCSI, households are classified as "food secure" for values between 0 and 4, "moderately food insecure" for values between 5 and 10, and "severely food insecure" for values ranging from 11 to 63 (Vaitla/Coates/Maxwell 2015).

3.3.2 Econometric Analysis

For data analysis, the dataset was separated into households that collect wild fruits and households that do not. To investigate the impact of wild fruit collection on food security, four different multiple linear regression models were applied, which all follow equation (1):

$$y_i = \beta_0 + \beta_1 x_{1i} + \beta_2 x_{2i} + \cdots + \beta_n x_{ki} + u_i, i = 1, \ldots, n, \quad (1)$$

In this equation, y_i represents the i^{th} of the n observations on the dependent variable, $x_{1i}, x_{2i} \ldots x_{ki}$ constitute a set of k independent variables x_{ki} for the i^{th} observations, and u_i refers to the error term. While y_i and x_{ki} are examined based on the corresponding dataset, the intercept β_0 and the slope coefficients β_n of the regression line are the unknown parameters that have to be estimated (Stock/Watson 2020).

In the models of this study, y_i is the food security indicator as a continuous variable, ranging from 0 to 112 for the FCS and from 0 to 63 for the rCSI. As mentioned in Section 3.3.1 on Food Security Indicators, a higher FCS implies greater food security, whereas a higher rCSI denotes lower food security – this should be taken into account when interpreting the results. For each indicator, two regressions were conducted. The first one includes a dummy variable for wild fruit collection as an independent variable and the second one includes a continuous variable on the quantity of wild fruits collected by households. In the second model, only households that collect wild fruits are included.

Other independent variables refer to characteristics of the household head, such as age, sex, and education; general household information like family size, cropland size, annual income, and whether the household's main income source is agriculture. Two additional variables were added which relate to intra-household decision-making. These variables are dummy variables that take the value 1 if a household's woman decides about food allocation and family planning. This study furthermore includes a dummy variable that takes the value 1 if at least one person in the household is a member of any group (e.g. agriculture producer group, livestock producer group, health group, credit or microfinance group). Data were analyzed using Stata 14.2. However, responses from two households were missing for some sections. Therefore, these households could not be included in the econometric analysis.

4 Results and Discussion

4.1 General Household Information

Of all households from the study area, a majority of about 79% collect wild fruits (Table 1). Most of these households are headed by men, with female-headed households only accounting for 16%. The share of female household heads is slightly significantly higher for non-collecting households than for fruit-collecting households. Household heads of both groups are, on average, 44 years old and spent 7 years in schooling. Both groups are also similar in terms of average yearly income, household size, and the share of family members who cannot work due to their age or diseases. Approximately 87% of households use the outcome of agricultural activities as their main income source, which does not significantly differ between the groups. The only significant difference between the two groups exists in terms of land size. On average, households that collect wild fruit have three hectares less land than households that do not collect fruits. However, the area used for crop cultivation does not differ between the two groups.

	Total sample (n=215)	Wild fruit-collecting households (n=170)	Non-fruit collecting households (n=45)
Female-headed households (%)	16.28	14.12	24.44 *
Age of household head (years)	44.37 (14.80)	44.28 (14.47)	44.71 (16.18)
Education of household head (years)	6.94 (2.94)	6.99 (3.01)	6.73 (2.64)
Annual income (Zambian Kwacha)	6,167 (6,483)	6,417 (6,836)	5,224 (4,879)
Household size	6.28 (2.42)	6.36 (2.37)	5.93 (2.61)
Agriculture as main income source (%)	86.98	85.29	93.33
Land size (ha)	9.12 (9.43)	8.46 (8.84)	11.59 ** (11.15)
Cultivated land size (ha)	2.12 (1.66)	2.08 (1.64)	2.26 (1.75)

Note: Wilcoxon rank-sum test and two-sample test of proportions. *p<0.1 **p<0.05 ***p<0.01.
Source: the author.

Table 1: General household characteristics of wild-fruit-collecting and non-collecting households / Source: the author

4.2 Wild Fruit Collection

The three most preferred wild fruit species by households from the study area are *Uapaca kirkiana*, *Anisophyllea boehmii,* and *Aframomum africanum*. Other preferred fruits include Landolphia species, *Vangueria infausta*, *Strychnos cocculoides,* and *Parinari curatellifolia*.

During the harvest season, households pick the ripe fruits mainly from the ground or, if they are at a reachable height, directly from trees. Most households spend less than one hour per week collecting wild fruits, whereas one-third collect fruits for one to three hours weekly. Over the ripening period between the months of October and March, households collect about 112 kg of wild fruits, which consist almost entirely of *Uapaca kirkiana* and *Anisophyllea boehmii* fruits. Households consume about 90% of the fresh fruits directly after collecting. From the total quantity collected, 4% of fruits are lost due to perishability or pests and diseases, and almost no fruits are further processed into other products. This is in line with study results from other countries such as Ethiopia (Fentahun/Hager 2009; Tebkew et al. 2018) and Botswana (Garekae/Lepetu/Thakadu 2020), where households consume dominantly fresh wild fruits. Only 11 households from the study area sell wild fruits, on average 79.45 kg per year. These households receive a return of 108.924 Zambian Kwacha, accounting for approximately 1% of their total annual income. The low share of marketed fruits in the study region implies that wild fruits play a subordinate role in income generation, but constitute important food for home consumption. Similar findings were made by Leßmeister et al. (2018) in Burkina-Faso, where households collect wild fruits exclusively for their own consumption. Seyoum et al. (2015) argue that the limited sale of wild fruits is associated with insufficient marketing experience, the low market value of wild fruits, and insufficient return. In addition, people do not recognize wild fruits as a regular food source and perceive their consumption as a sign of poverty. This negative perception further reinforces the neglect of wild fruits as marketable goods (Seyoum et al. 2015).

Figure 3 and Figure 4 show the food security level of wild-fruit-collecting and non-collecting households, as measured by the FCS and rCSI. According to the FCS, a majority of 60% have an acceptable food security status, whereas the remaining households are characterized by borderline or poor food security in equal proportions. Households who do not collect wild fruits are more frequently in the acceptable food security status than fruit-collecting households ($p=0.0205$). This result indicates that households who collect wild fruits are slightly less food secure in terms of dietary quality and diversity than non-collecting households.

In terms of the rCSI, about one-fourth of all households are classified as food secure, another 32% as moderately food insecure, and the remaining 42% as severely food insecure. In contrast to the FCS, the rCSI does not significantly differ between fruit-collecting and non-collecting households. This could imply that households might not necessarily consider the decision to collect wild fruits as a coping strategy to reduce food insecurity.

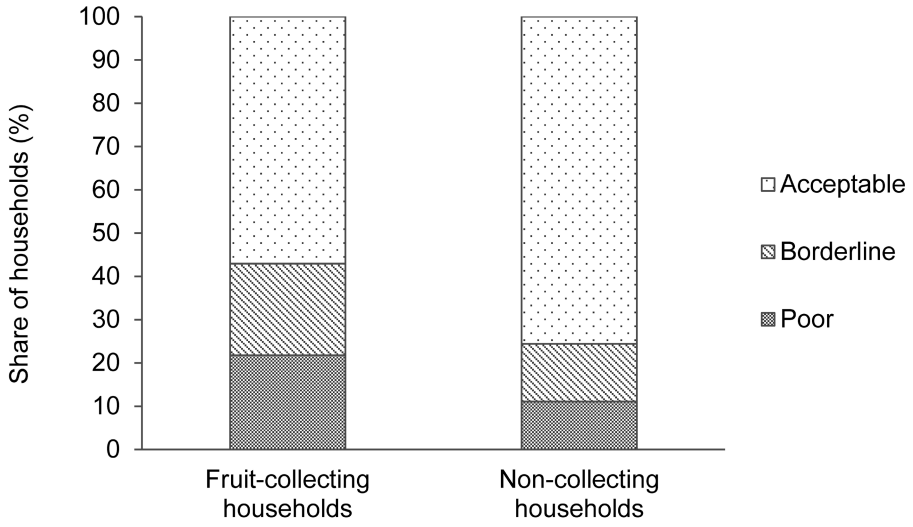

Figure 3: Food Consumption Score (FCS) of fruit-collecting households and non-collecting households / Source: the author

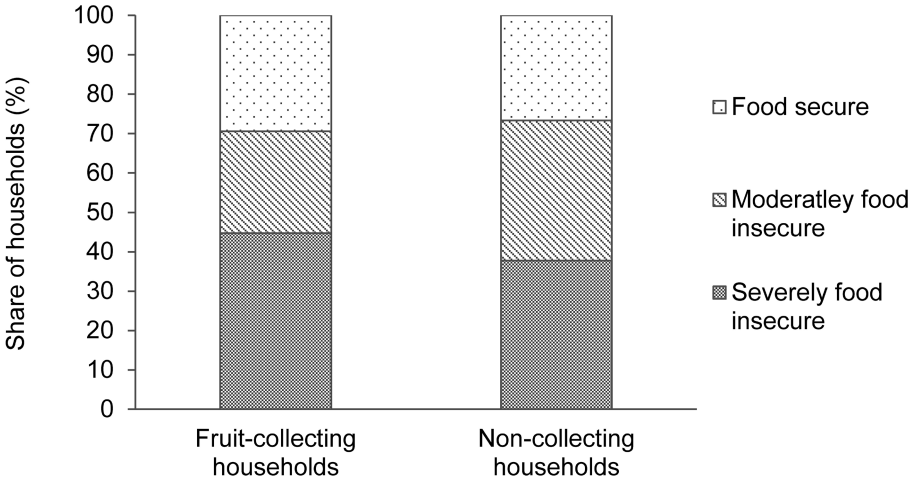

Figure 4: Reduced Coping Strategy Index (rCSI) of fruit-collecting households and non-collecting households / Source: the author

Although there is a negative association between food security based on the FCS and wild fruit collection, the opposite is true for the quantity of fruits collected. As shown in Figure 5, households with an acceptable FCS collect three times more fruits than households in the poor FCS category. This indicates a positive relation between high

collection amounts of wild fruits and household food security with regard to their dietary quality and diversity. In contrast, there is no relation between the quantity of fruit collection and household food security based on the rCSI.

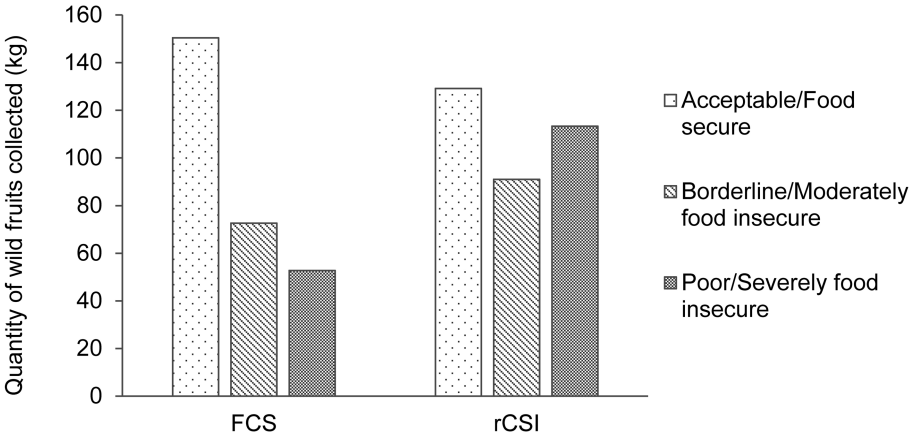

Figure 5: Average quantity of wild fruits collected by households with different levels of food security / Source: the author

4.3 Impact of Wild Fruit Collection on Food Security

Impact on the FCS

Results of the regression analyses show that the impact of wild fruit collection and other influencing factors highly differ depending on the indicator used to measure food security (Table 2). For the FCS, the effects of both wild fruit collection variables are significant. However, the impact of the wild fruit dummy is negative, which indicates that the decision of households to collect wild fruits would reduce their food security status.

This is somehow implausible and it is therefore suspected that the effect is exactly the opposite, namely that food-insecure households are more likely to collect wild fruits than food-secure households. This would be in line with previous studies that revealed a higher dependence on wild food consumption among food-insecure households (Erskine et al. 2014; Shumsky et al. 2014).

In contrast to the dummy variable, the continuous variable significantly and positively affects the FCS. If households increase the annual amount of wild fruits collected by 100 kg per year, they improve their FCS by 2.49 points. This indicates that wild fruits serve as a nutritional complement and help households to improve their dietary diversity. Similar findings were made by Boedecker et al. (2014), who investigated the impact of WEPs on women's diets in Benin. They found higher nutrient intakes, especially of copper and iron, and higher dietary diversity for women who consume WEPs than for women who do not.

Variable	(1) FCS	(2) FCS	(3) rCSI	(4) rCSI
Fruit dummy	-8.552** (3.461)		1.025 (1.588)	
Fruit quantity (kg)		0.027** (0.012)		-0.003 (0.006)
Age household head	-0.113 (0.097)	-0.091 (0.111)	0.031 (0.046)	-0.02 (0.053)
Education household head	0.089 (0.504)	0.030 (0.564)	-0.115 (0.237)	-0.019 (0.277)
Cropland size	2.002** (0.882)	2.502** (0.989)	-0.822** (0.405)	-1.017** (0.467)
Household size	0.402 (0.589)	-0.104 (0.703)	-0.112 (0.270)	0.199 (0.328)
Female-headed household	7.087 (4.409)	5.598 (5.034)	0.479 (1.857)	1.824 (2.258)
Log annual income (Zambian Kwacha)	2.720*** (0.770)	2.897*** (1.037)	-1.562*** (0.355)	-0.611 (0.486)
Agriculture dummy	-13.730*** (4.290)	-13.973*** (4.536)	-0.945 (1.919)	1.245 (2.086)
Decision dummy food allocation	16.361*** (3.045)	15.354*** (3.455)		
Decision dummy family planning	-11.337*** (4.027)	-11.203*** (4.531)		
Group dummy			-3.517** (1.389)	-3.709** (1.634)
Constant	30.71*** (10.33)	19.49* (11.75)	27.220*** (4.715)	19.163*** (5.465)
Observations	213	168	213	168
R-squared	0.301	0.332	0.208	0.121
Adj R-squared	0.266	0.230	0.173	0.071

Note: *p<0.1 **p<0.05 ***p<0.01. Source: the author.

Table 2: Econometric results on the impact of wild fruit collection on food security / Source: the author

Since households from the study area hardly grow any fruit trees, the consumption of wild edible fruits from the surrounding forests is of particular relevance for diminishing micronutrient deficiencies. In this context, it is important to note that the calculation of fruit quantity is based on a time period of over one year, whereas the FCS reflects only a short period of one week during the time of data collection in April. While households harvested most fruit species in October, November, and December, only a few species, such as *Aframomum africanum* were ripe in April. Thus, households probably consumed considerably lower amounts of wild fruits at the time of data collection than at the main harvest time, especially since they hardly process or store any fruits. The true effect of wild fruit consumption on household food security might therefore be underestimated in these study results.

In both models of the FCS, other variables apart from wild fruit collection significantly influence household food security. For example, a larger area of cropland is significantly associated with higher food security. This finding coincides with the results of other studies that found a positive relationship between size of land and food security, implying that households with more land can produce more food (Mbwana et al. 2016; Muraoka/Jin/Jayne 2018; Nkomoki/Bavorová/Banout 2019; Rammohan/Pritchard 2014; Tefera/Tefera 2014).

Another highly significant factor that positively affects the FCS is annual household income. This result is also confirmed by previous studies that identified income as an important determinant of household food security, meaning that households with higher income can acquire more food and thus improve their diet (Asmelash 2014; Mbwana et al. 2016; Sekhampu 2013).

However, if households generate their main income through agricultural activities, their FCS significantly decreases by approximately 14 points in both models. This finding is in line with previous studies that reveal a positive effect of non-farm work on food security. For example, Zereyesus et al. (2017) identified a lower vulnerability to food poverty in Ghana for households engaging in non-farm work. In their study from Nigeria, Babatunde/Qaim (2010) found that generating off-farm income increases household calorie consumption, dietary quality, and micronutrient supply. They argue that off-farm income can help to compensate for a lack of farm capital and enhance food production. In addition, off-farm income improves household resilience by mitigating the negative effects of shocks that jeopardize food security (Ansah/Gardebroek/Ihle 2019; Kassie/Ndiritu/Shiferaw 2012). Another highly relevant predictor of household food security refers to female decision-making. If women decide about intra-household food allocation, the FCS significantly increases by 16 points. It is well known that women play a vital role in food production and intra-household distribution. Nevertheless, they often face inequities and constraints such as insufficient access to education, employment, and production assets, which leads to low bargaining power and food and nutrition insecurity (ADB/ FAO 2013). According to findings from Sraboni et al. (2014), increasing women's empowerment can enhance household food security regarding calorie availability and dietary diversity.

Impact on the rCSI

Regarding both models of the rCSI, wild fruit collection was not a significant predictor of food security, neither as a dummy variable nor as a continuous variable of the quantity collected. These insignificant effects could imply that households do not consider wild fruit collection as a coping strategy to reduce hunger in times of insufficient food availability. It can therefore be concluded that households are aware of the positive benefits of wild fruits and use them as dietary supplements, regardless of the availability of other foods. This result is in line with the conclusions of Boedecker et al. (2014), who revealed that in Benin, WEPs are used as a dietary complement rather than as a substitute for other food. However, the findings contrast with various studies that identified the consumption of wild fruits as a means to overcome shock-related and seasonal food shortages (Agyei/Asumadu 2018; Erskine et al. 2014; Fentahun/Hager 2009).

Similar to the FCS, the results of the rCSI should be interpreted with caution due to the inconsistencies between the reference time of the rCSI and the harvesting period of wild fruits. On the other hand, if households had been able to collect fruits, this might have had an impact on alternative coping strategies. For example, if households had the opportunity to collect and consume wild fruits during times of insufficient food or money to buy food, they would probably less frequently rely on borrowing food, reducing the number of meals, or restricting consumption by adults to provide enough food for children.

Concerning other influencing factors of household food security, cropland size has the same effect on the rCSI as on the FCS, meaning that holding more cropland leads to significantly higher food security. Similar to the findings of the FCS, higher household income results in greater food security based on the rCSI. However, this effect is only significant for the first model that includes the entire sample, but not if only fruit-collecting households are included. This change in the result could be due to a correlation between household income and the amount of wild fruits collected, which proved to be positive and significant. Another variable that significantly affects the rCSI in both models is group membership. Farmers who participate in social networks or groups can greatly benefit from interaction with other members, which is defined as social capital. In their literature review on the impact of social capital on food security, Nosratabadi et al. (2020) have shown that social capital increases the share of food products within communities and the exchange of knowledge and information among farmers. Through these interactions, households can enhance the availability of food and access to food products. Hence, social capital is particularly relevant for households, allowing them to increase their food security and resilience to shocks, as highlighted by the positive impact of group membership on the rCSI.

4.4 Threats to the Availability of Wild Fruits

Participants of the FGDs emphasized various risks that lead to a decline in the availability of wild fruits. For example, deforestation was said to be one major factor influencing the availability of wild fruit trees. Due to increasing population growth, there is a greater need to clear land for expanding agricultural areas and to extract

natural forest resources for building and heating. During the FGDs, participants mentioned that they also use wood from some wild fruit trees such as *Uapaca kirkiana* as building material, which leads to a decreased abundance of wild fruits. According to the participants, some main collection spots with a great variety of wild fruit species had already been completely cleared. Thus, households nowadays have to walk longer distances to reach collection spots than in the past.

At the same time, participants expressed concerns that an increase in population growth will reinforce the competition between collectors and result in overharvesting of fruits. They furthermore declared that bushfires led to decreased availability of fruits, as they destroy parts of or even entire wild fruit plants. Another threat mentioned is climate change, which amplifies the decline in wild fruit availability. Heavy rain, wind, and hail during the preceding season led to damaged buds and flowers, which in turn reduced fruit development in the following season. Furthermore, they observed a rising trend among younger generations to ignore wild fruits, as they rather prefer the increasingly popular exotic fruits.

5 Conclusion

The collection of wild fruits is considered an important strategy for rural households in developing countries to overcome periods of hunger. However, the true contribution of wild fruits to household food security in Zambia remains unknown. This paper uses census data from 215 households and FGDs from the Luapula Province in Zambia to investigate the impact of wild fruit collection on household food security. Multiple linear regression models are applied to examine the impact of households' decision to collect fruits and the quantity of fruits collected on the FCS and rCSI as food security indicators.

The results show that a large proportion of households from the study area are classified as food insecure and a vast majority collect wild fruits from surrounding forests. This study did not find a link between wild fruit collection and the rCSI as a food security indicator. Turning to the FCS, the results show that households who are food insecure are more engaged in wild fruit collection, but increasing the collection quantity significantly reduces household food insecurity. Other factors that significantly affect food security are cropland size, household income, off-farm work, group membership, and female decision-making.

The findings of this study lead to several implications regarding household food security and wild fruit consumption. The high prevalence of food-insecure households in the study region highlights the need to support farmers in improving their food security. This can be done by fostering the consumption of wild fruits, since they constitute important supplements for rural households' diets. However, increasing demand and decreasing availability may lead to unsustainable harvesting, threatening the role of wild fruits as a safety net and turning them into a poverty trap (Levang/Dounias/Sitorus 2005; Paumgarten/Locatelli/Witkowski 2018). To ensure their long-term availability and safety net function, cultivation of wild fruit species is recommended. Thus, NGOs and government agencies should provide tree seedlings and

training to farmers. Moreover, introducing storage facilities and value-added processing is advisable. This would extend the availability of fruit products beyond the harvest season and ensure consumption at all times. Enhancing access to markets and improving commercialization of fruits would be useful to generate additional income, which, in turn, can reduce food insecurity. Increasing awareness about the nutritional benefits of wild fruits and making consumption more attractive is particularly important among younger generations who tend to neglect wild fruits. This can be done by organizing public information campaigns and increasing the demand by introducing effective marketing strategies.

Besides promoting wild fruit consumption, strengthening female empowerment, providing off-farm opportunities, enabling group participation, and increasing access to productive resources can be considered important measures to increase household food security.

6 Limitations

Although this study provides important insights, it is subject to three major limitations. First, the two food security indicators are calculated on a 7-day recall period, which could imply the risk of recall bias if respondents cannot accurately remember their coping behavior and the type of food consumed. The period of 7 days only represents a snapshot of household food security during the time of the data collection process. However, household food security status can change over the course of a year, depending on the availability of food. In accordance with Maxwell/Caldwell (2008), repeated measurements over various time periods to receive more powerful data are recommended.

Second, the FCS excludes food that was consumed outside the home (WFP 2012). If household members consume wild fruits directly after harvest, for example during other livelihood activities such as collecting firewood and during fieldwork, wild fruits are not included in the calculation of the FCS. In addition, the consumption frequency only refers to the entire household. To receive a broader picture of intra-household food allocation and individual food security levels, not only the household head but also other household members should be interviewed.

Third, reverse causality is suspected to be present in the data. As discussed earlier, collecting wild fruits could, on the one hand, increase household food security, while, on the other hand, households who are already food insecure may be more dependent on consuming wild fruits and therefore more inclined to collect them. This is probably the most relevant limitation of this study, which is why the results should be interpreted with caution. By using panel data rather than cross-sectional data, researchers are more likely to address the issue of reverse causality and thus examine the relationship between wild fruit collection and food security.

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Author

Ronja Seegers *(*1992), studied Horticultural Science in Hannover and is now a research assistant and PhD student at the Institute for Environmental Economics and World Trade at the Leibniz University Hannover, Germany. She is also a member of the interdisciplinary TRUST-/ARL doctoral college working on the topic of "Transformative Processes in Urban and Rural Areas". Seegers' research focuses on farmers' decision-making, food security, land-use, and natural resources. Within projects in Sub-Saharan Africa, she has gained experience in participatory research and role-playing games.*