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Wild Foods: Safety Net or Poverty Trap? A South African Case Study

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Abstract
Wild foods contribute towards the food security of an estimated one billion people. In light of expectations of the contribution of wild foods to sustainable and climate-resilient livelihoods and widespread evidence of their consumption, their contribution to households' diets requires a more nuanced understanding, specifically with respect to their safety net function during food shortages. Data were collected from two villages in Venda, South Africa, selected due to differences in mean annual precipitation. Semi-structured interviews were administered to 170 households and a Participatory Rural Appraisal was conducted to assess the influence of multiple variables, including household characteristics and site, on wild food use. Household archetypes were defined based on the frequency of consumption in response to increasing food scarcity. Our findings suggest limitations to the safety net function of wild foods including seasonal fluctuations in availability and decreased availability during extreme events, with dependent households decreasing their consumption frequency in response to food scarcity. Given this potential poverty trap, further research is required, particularly in terms of when the safety net function of wild foods may be weak or detrimental to the livelihoods of the vulnerable.

Keywords Climate · Food security · Seasonal availability fluctuations · Vulnerability · Wild foods · Participatory rural appraisal · South Africa

Introduction

Wild foods contribute towards the diets of an estimated one billion people (Pimentel *et al.* 1997; Burlingame 2000). While seldom the primary share of the household food basket, they complement other food sources, provide dietary and nutritional diversity, and offer a 'safety net' for households experiencing seasonal or shock-related food shortages (Addis *et al.* 2005; Shackleton and Shackleton 2004; Powell *et al.* 2015). Studies have noted the consumption of a diversity of species, arguing this adds a robustness to the daily- and safety net function of wild foods and provides important micronutrients (Sunderland 2011; Powell *et al.* 2015). Wild foods are argued to be particularly important to vulnerable households, including child-, elderly, or female-headed households and those impacted by HIV/Aids (Kaschula 2008; McGarry and Shackleton 2009). In addition to direct consumption benefits, households may also benefit from the sale of wild foods (Nasi *et al.* 2011).

Wild foods are argued to be more resilient than many crop varieties to changes in both season and climate, and therefore potentially important within the context of societal adaptation to climate change (Pramova *et al.* 2012; Chivandi *et al.* 2015). This is particularly the case in marginal areas of developing countries where agro-ecological constraints, regular crop failures, and recurrent droughts undermine food and nutritional security (Delang 2006). Together with other non-timber forest products (NTFPs), wild foods form part of a "hidden harvest," fulfilling both a regular daily and a safety net role and contributing to livelihood diversification and resilience through their consumption and sale (Shackleton and Shackleton 2004; Arnold *et al.* 2011). Biodiversity loss threatens the sustainability of rural livelihoods, particularly in cases where alternative daily and 'safety net' food resources are limited (McSweeney

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2005). Consequently, ecosystem protection may provide a cost-effective buffer to the impacts of climate variability and change.

Wild foods have received insufficient attention in food security, development, and natural resource management discourses and policies despite both their existing and potential role in resilient and sustainable food systems (Sunderland 2011). Although their use is widespread, questions remain on their exact function particularly with respect to their role in supporting rural livelihoods on a daily basis compared to periods of increased vulnerability (Shackleton and Shackleton 2004; Bharucha and Pretty 2010). Further research is required as to when wild foods constitute a 'daily-net', a 'safety net,' or a poverty trap, as well as whether they are more suitable as a short-term gap-filler or a long-term diversification strategy for adaptation. Wong and Godoy (2003) raise concerns over the ability of informal rural safety nets, including NTFPs and wild foods, to adequately insure households against covariate shocks, although other studies have highlighted the important role of such safety nets in buffering households against covariate, climate-related shocks (Takasaki *et al.* 2004; McSweeney 2005). Levang *et al.* (2005) caution, however, that relying on natural resources as a safety net may constitute a poverty trap in cases where the resource is limited, demand is high, and alternatives are lacking. For vulnerable, natural resource dependent households likely to face increasing risks due to climate change, it may be necessary to consider alternative insurance strategies (Hickey *et al.* 2016). Understanding what factors influence the daily and safety net roles of wild foods is necessary to ensure more locally appropriate interventions that support both sustainable livelihoods and biodiversity (Bharucha and Pretty 2010; Paumgarten and Shackleton 2011).

Although South Africa has been described as food secure at the national level, food insecurity and micronutrient malnutrition persist at the household level, driven by various, often interrelated economic, environmental, and socio-political factors (De Cock *et al.* 2013; Drimie and McLachlan 2013). Food insecurity is a threat to a large proportion of the rural population who face increasing vulnerability to climate change (Drimie and McLachlan 2013), with vulnerability defined as the "state of susceptibility to harm from exposure to stresses associated with environmental and social change and from the absence of capacity to adapt" (Adger 2006: 268). Studies have drawn attention to the widespread consumption of wild foods, including their contribution (through both consumption and sale) to more vulnerable households (Shackleton and Shackleton 2004; Kaschula 2008). Within this context, to better understand the potential contributions, and limitations, of wild foods to household food security, particularly given increased expectations of their role in food security, poverty alleviation, and climate change adaptation policies and with the aim of improving the existing understanding of both the regular and safety net use of wild foods, we investigated their role in rural livelihoods in Limpopo Province, South Africa. We considered the extent of wild food consumption and sale (in terms of the proportion of households reporting these activities), the frequency with which households consume wild foods, both regularly and during times of food shortages and hunger, as well as households' perceptions of the importance of the safety net function of wild foods.

Study Site

Our research was conducted in two rural communities in South Africa's north-eastern Limpopo Province (Fig. S1), one of the country's poorest regions (Statistics South Africa 2014). The villages of Bennde Mutale and Vondo were part of the Venda homeland, one of ten demarcated areas to which black South Africans were forcibly relocated until the 1994 democratic transition. These areas remain characterized by high poverty levels, limited employment opportunities, and low levels of service provision and development (Table 1). Many households continue to live close to the poverty line, engaging in diverse livelihood strategies, including the use and sale of NTFPs (Venter and Witkowski 2013; Ofoegbu *et al.* 2016). Migrant remittances and state welfare grants (including old age pensions, child care, and disability grants) are important sources of income. Food insecurity, a high incidence of HIV/Aids, increasing living costs, a shortage of productive land, and variable (and often extreme) weather, exacerbate vulnerability levels (Neves and Du Toit 2013; Murugani *et al.* 2014).

Both villages fall within the Vhembe District Municipality, approximately 90 km apart (Table 1). Vondo ("wet site") receives 2.8 times the precipitation of Bennde Mutale ("dry site"), with differences in mean annual precipitation being a key primary criterion for the site selection (wet site: 1108 mm ± 371 mm; dry site: 401 mm ± 140 mm). Bennde Mutale is bordered by communal rangelands, conservation areas (e.g., Kruger National Park), and a military corridor while Vondo is bordered by pine and tea plantations.

Methods

Data Collection

The relevant local authorities were approached for permission to conduct the research. Quantitative and qualitative data were collected through a trans-disciplinary, case-study approach, which included household interviews, participatory rural appraisal exercises (PRA), key informant interviews, and personal observations. Semi-structured interviews, based on those developed by the Poverty Environment Network (Wunder *et al.* 2014), were administered to 170 households (85 per village), with a household considered to be a unit of

Table 1 Summary profile of the two sites – municipal and village level attributes

	Dry Site	Wet Site
Municipal level attribute		
Local Municipality	Mutale	Thulamela
Population density (people/km^2)	24	110
Av. number people/household	3.8	3.9
Female-headed households (%)	54.8	54.4
Education (aged 20+): None (%)	18.8	17.4
Unemployment rate (%)	48.8	43.8
Av. household income: None (%)	13.2	11.9
Dependency Ratio (per 100: 15–64)	79.9	70.1
Piped water inside dwelling (%)	5.8	15.2
Electricity (for lighting) (%)	83.3	87.2
Pit toilet (%)	92.6	73.7
Biophysical village level attribute		
Latitude; longitude	31° 1′48″E; 22°24′14”S	30°21′60″E; 22°56′5”S
Elevation (m)	308	1022
Approx. MAP (mm)	401	1108
Rainy season	Summer (Nov-Feb)	Summer (Oct-Mar)
Approx. MAT (°C)	24.7	19.0
Vegetation type (Mucina and Rutherford 2011)	Musina Mopane Bushveld; Makuleke Sandy Bushveld	Soutpansberg Mountain Bushveld
Socio-cultural village level attribute		
Village size (no. households)	327	340
Av. number people/household	5.3	4.7
Female-headed households (%)	43.5	42.4
Av. age of household (years since household was established)	19.5	20.8
Av. age of household members (years)	26.3	27.4
Av. education of household members (years)	6.2	7.2
Electricity for lighting (%)	94.1	98.8
Formal housing (%): brick wall; metal roofs (*)	49.4; 67.1	56.5; 100.0
Water sources (%): communal taps (*); natural (*)	97.6; 28.2	41.2; 98.8
Tribe	Venda, Tsonga, Other	Venda
Households owning livestock (%) (*)	61.2	25.9
Households cultivating (%) (*)	63.5	95.3
Households using NTFPs (%)	100.0	96.5
Households receiving migrant remittances (%)	28.2	29.4
Households receiving government grants (%)	84.7	90.6
Households having formally employed members (%) (*)	29.4	16.5
Nearest commercial centers	Masisi (19 km) Musina (118 km) Thohoyandou (95 km)	Phiphidi (5 km) Sibasa (13 km) Thohoyandou (15 km)

Source: Statistics South Africa (2014) for municipal level, our field data for village level. Socio-cultural village level attributes for data collected during the household interviews ($n = 170$) were compared - (*) indicates those variables with differences at $p < 0.05$

people residing in the same dwelling and sharing meals. The sample constituted 26% and 25% of the households in the dry and wet sites, respectively. Each village is subdivided, by the village leadership, into designated zones. The interviews were divided between these zones, with the households selected through a simple, random sampling approach. Whenever possible, the household head was interviewed. In cases where the head was not available, another resident adult was interviewed. Given the length of the survey, it was split into two parts, with each household interviewed twice over the course of the fieldwork. The same respondent was interviewed each time. The PRA was conducted through a series of voluntary, community workshops. After the initial workshop in each village, the same participants were invited to the

subsequent workshops to allow us to build on previous discussions. The group size varied somewhat depending on people's availability but generally consisted of about 20 people, both male and female, of varying ages. Given the non-contentious nature of the discussion topics, we did not feel the need to sub-divide the groups by gender.

The fieldwork was conducted during the winter months, outside of the main agricultural season, to minimise the impact on participants' other responsibilities. For the same reason, only half-day workshops were organized. By hosting the workshops during the cooler, drier months, we ensured that travelling to, and participating in, the workshops was more comfortable for the participants. In addition to this, both villages are more difficult to access during the rainy season and malaria is a risk in the dry site. Key informant interviews were conducted with village elders and chiefs, traditional healers, farmers and livestock owners, the manager of a nearby tourist camp (dry site), and the closest available agricultural extension officers.

The PRA exercises included seasonal calendars; time trend exercises; historical profiles; and impact chain exercises, used to identify (inter alia) fluctuations in vulnerability and the availability, use, and sale of NTFPs, including wild foods (Dazé *et al.* 2009; Turnbull and Turvil 2012). The research was conducted with the assistance of trained enumerators/translators. All ethical standards of the host institution were adhered to. Formal, free, prior and informed consent was obtained, and anonymity assured.

"Wild foods" can include a diverse range of products and species. We focused on the most commonly sourced: wild edible fruits ("fruits"), wild edible herbs ("herbs"), and bushmeat (Powell *et al.* 2013). We use "wild edible herbs" as a broad, all-encompassing term to describe leafy vegetables (including both leaves and flowers), while "bushmeat" refers to edible mammals, birds, fish, insects, reptiles, and amphibians. The use of wild foods was reported through various means. During the workshops, participants listed the diversity of species consumed and discussed both historical and seasonal variations in availability and use. During the household interviews, respondents were questioned on their use of wild foods, both as a daily and a safety net resource. Households described their frequency of consumption (meals per week) of wild foods during three food availability periods, namely: when food is generally plentiful (e.g., after the harvest); when food is scarce (e.g., during seasonal crop shortfalls); and during "hungry periods" (e.g., during drought and unanticipated crop failure). Households were also questioned on their perceptions of the importance of wild foods in helping them survive "hungry periods." It was not within the scope of this study to explore the proportional contribution of wild foods relative to other household food sources (in terms of both quantity and nutritional value), although information of this nature would improve our overall understanding of the daily and safety net functions of wild foods.

Data Analysis

First, we assessed whether household characteristics and site influence variables related to wild food use with multivariate linear models. We used a logistic regression for binary variables (i.e., all yes/no responses in the interviews (Table 2), such as whether a household consumes or sells wild foods or has experienced food shortages). We reported odds ratios, which show how household characteristics and site influenced the odds that a household used wild foods. We used a Gaussian (normal) regression for continuous variables (e.g., the average number of meals per week in different food availability periods (Table 3)). Independent variables included village (site), household size and age (i.e., years since the household was established), average age and education of the household members, gender of the household head, formal and informal employment, involvement in agriculture and livestock, receipt of grants and remittances, and grant value. Some continuous variables were log-transformed to improve the normality of their distribution. Using the 'step' function in R3.3.2, we applied a backward stepwise procedure to select those independent variables that led to the regression model with the best AIC (Akaike Information Criterion).

Second, we defined archetypes of wild food users by clustering households based on three quantitative, semi-continuous variables representing the number of meals per week including wild foods in the three food availability periods (plenty, scarce, and hungry). We applied a hierarchical cluster analysis (Ward agglomeration method and Euclidian distance measure) with the hclust function of the stats package in R (R Core Team 2017). After applying the NbClust package (Charrad *et al.* 2014) to identify the best number of clusters, we tried clustering with two to four clusters. We decided to build three clusters, which provided the most meaningful interpretation of the clustering results. To describe the three clusters, we fitted binary logistic regressions that related the membership in a cluster to variables related to household location and demographics, livelihood activities and incomes, and coping strategies. We used binary logistic regressions instead of multinomial logistic regressions because we were interested in the variables explaining each cluster compared to all other clusters. For each cluster, we used a backward stepwise procedure to select independent variables and reported the variables that had a significant effect on the odds of a household being in this cluster ($p < 0.05$) (Table 4).

Results

Use and Sale of Wild Foods

Wild foods are used and sold in both villages, contributing to household diets and livelihoods. The consumption of wild

Table 2 Uses and perceptions of wild foods: average over the 170 households (HH) and effects of HH characteristics and location on uses and perceptions, estimated with a logit linear model

Use or perception	% of HH with this use or perception	Interpretation of odd ratios (how the odds of using or perceiving are influenced by HH characteristics and location)
Consumption: HH consuming...		
wild foods	96.5	None
wild fruits	83.5	The odds of consuming wild fruits increase by 3.0 if households have livestock ($p = 0.03$) and by 2.3 if they have twice as many members ($p = 0.02$)
wild herbs	87.6	The odds of consuming wild herbs increase by 7.6 if households have livestock ($p < 0.01$), by 3.1 if they have twice as many members ($p = 0.01$) and by 3.8 if they live in the wet site ($p = 0.01$)
bushmeat	87.1	The odds of consuming bushmeat increase by 11.4 if households live in the dry site ($p < 0.01$)
Sale: HH selling…		
wild foods	33.5	The odds of selling wild foods increase by 72 if households live in the dry site ($p < 0.01$)
wild fruits	1.2	None
wild herbs	0.6	None
bushmeat	32.4	The odds of selling bushmeat increase by 170 if households live in the dry site ($p < 0.01$)
Perceived food challenges: HH reporting...		
experiences of food shortages	98.8	None
increased challenges to finding food	64.1	The odds of perceiving increased challenges to finding food increase by 1.2 if households have half as many formally employed members ($p < 0.01$)
Perceived importance of wild foods during hungry periods: HH perceiving wild food as…		
very important	18.2	The odds of perceiving wild foods as very important increase by 6.0 if households live in the dry site ($p < 0.01$)
important	27.6	The odds of perceiving wild foods as important increase by 2.6 if households live in the wet site ($p = 0.02$) and by 3.0 if they have livestock ($p < 0.01$)
somewhat important	42.3	The odds of perceiving wild foods as somewhat important increase by 2.1 if households receive remittances ($p = 0.03$)
not important	11.8	The odds of perceiving wild foods as not important increase by 6.9 if households do not have livestock ($p < 0.01$)

foods is widespread irrespective of site and household characteristics, reported by 96.5% of households (Table 2). Most commonly consumed are herbs (87.6%), followed by bushmeat (87.1%), and fruits (83.5%). The odds of consuming herbs and fruits are higher in larger households and those with livestock. The odds of consuming herbs are higher in the wet site while the odds of consuming bushmeat are higher the dry site. Workshop participants identified a diversity of species, particularly fruits and bushmeat, in the dry site (Table S1). Wild foods are sold by 33.5% of households. Bushmeat is the most commonly sold wild food, particularly in the dry site.

The use of, and preference for, wild foods seems to be declining. Although wild food consumption was high (based on the proportion of households), respondents in both villages indicated decreasing use (time trend exercises). This was attributed to changing lifestyles, preferences, and the loss of traditional ecological knowledge (TEK), particularly among the younger generations, as well as declining availability. Older respondents associated this declining consumption with poor health and increases in "new diseases" (e.g., high blood pressure and diabetes). Nevertheless, children were observed consuming wild foods.

Table 3 Number of meals including wild foods per week during three periods of food availability: Descriptive statistics and household characteristics affecting those numbers according to a Gaussian linear model

Variable	Average value	Standard deviation	Median value	Household characteristics affecting the number of meals (log-transformed)	Interpretation (after correcting for log-transformations)
Number of meals with wild foods per week when food is plentiful	3.8	4.6	2	Agriculture (coefficient = 0.306, p = 0.03)	Number of wild food meals is 36% higher if households engage in agriculture
Number of meals with wild foods per week when food is scarce	4.0	3.7	3	Household age (coefficient = 0.0094, p = 0.01)	Number of wild food meals is 9.9% higher if households are 10-years older
Number of meals with wild foods per week during hungry periods	4.7	2.8	4	Household age (coefficient = 0.019, p < 0.01), grant value (log2-transformed, coefficient = −0.053, p = 0.02)	Number of wild food meals is 21% higher if households are 10-years older and 5.2% lower if the grant value received is twice as much

Availability of Wild Foods

Respondents indicated a declining trend in the availability of wild foods, which they attributed to land expropriation, land conversion, overharvesting, and a (perceived) decline in rainfall (time trend exercises). Over time, both communities have lost access to harvesting areas with land expropriated for agriculture, conservation, and military purposes (historical profiles). According to respondents, this, combined with an increasing population and the associated conversion of land for settlement and agriculture, has placed pressure on the remaining resource base, creating competition among users (time trend exercises). Land conversion has been greater in the more productive wet site, with population densities in the surrounding area being higher. In the dry site, the surrounding communal rangelands and the adjacent protected areas provide a more extensive habitat for a diversity of wild foods. Households in the dry site noted the maintenance of wild indigenous fruit trees on their homestead plots. Those in the wet site have shifted to exotic species, such as mango, litchi, and macadamia.

Respondents reported that wild foods are affected by competing activities. For example, overgrazing has impacted the availability of herbs; agricultural pesticides have reduced the availability of edible insects; uncontrolled fires (started by honey hunters and livestock owners (for grazing)) have destroyed fruit trees, and in response to fuel wood scarcity, people have started to cut fruit trees. In the dry site, overharvesting of fuel wood and mopane worms in response to a large external market was noted as a concern (workshops).

Seasons and extreme climate events were also identified as determinants of wild food availability. Respondents in both sites noted seasonal variations in the availability, use, and sale of wild foods, being higher in the summer rainy season, providing a pre-harvest source of food and income, but low during the annual "hunger season" towards the end of winter (Figs. S2a and S2b). This pattern is clearer in the dry site although exceptions exist including the emergence of mopane worms at the end of summer and the availability of baobab fruit during winter. Both droughts and floods have affected wild food availability (Figs. S3a and S3b). For example, recent floods and heavy storms knocked fruit off trees and washed away riverine fruit trees. Respondents noted fewer mopane worms after drier summers, and associate periods of low wild food availability with food shortages, hunger, and poor health (seasonal calendars and impact chain exercises).

Perceptions of Food Shortages

Consistent food availability is a widespread challenge, with ~99% of households reporting the experience of food shortages at some point during the course of a year (Table 2). In addition, 64% of households perceive increasing difficulties in finding sufficient food, with the odds of perceiving these difficulties being higher in households with fewer formally employed members. Child-headed households (i.e., those with a head 18-years old or younger) were also described as susceptible to food shortages, often relying on government food parcels (workshops). Increasing food and living costs, unemployment, declining agricultural production, and declining wild food availability were identified as challenges to meeting household food needs.

Collective food shortages were associated with seasons and climate events. The "hunger season" described above was characterized by seasonal crop, livestock, and wild food shortfalls (Figs. S2a and S2b). Respondents in both wet and dry communities also noted hungry periods associated with extreme events, although these were considered less extreme in the wet site. Both floods and drought restrict food supplies, with crop, livestock, and wild food losses reported (Figs. S3a and S3b). Previous floods damaged food stores and

Table 4 Household characteristics with a significant effect on the odds of being in a cluster

Variable with a significant effect on the odds of being in a cluster	Coefficient sign	*p*-value	Odd ratio (detailed interpretation on how the odds of being in a cluster are influenced by the variable)
Odds of being in the cluster "Dependence"			
Average age of HH members	+	0.001	Odds increase by 2.8 times if average age doubles
Coping by reducing meals	–	0.012	Odds decrease by 2.6 times if HH copes with shocks by reducing meals
Coping by HH spending reductions	–	0.001	Odds decrease by 3.8 times if HH copes with shocks by reducing spending
Coping by finding work	–	<0.001	Odds decrease by 5.3 times if HH copes with shocks by finding work
Coping with NGO assistance	–	0.002	Odds decrease by 3.9 times if HH copes with shocks by seeking NGO assistance
Odds of being in the cluster "Safety"			
Location in the dry site	+	<0.001	Odds increase by 4.6 times if HH is in the dry site
Livestock	+	0.043	Odds increase by 1.9 times if HH has livestock
Agriculture	–	0.016	Odds decrease by 2.9 times if HH practices agriculture
Coping with spending reductions	+	0.002	Odds increase by 2.8 times if HH copes with shocks by reducing spending
Coping by finding work	+	<0.001	Odds increase by 4.3 times if HH copes with shocks by finding work
Coping with NGO assistance	+	0.016	Odds increase by 2.3 times if HH copes with shocks by seeking NGO assistance
Odds of being in the cluster "Disinterest"			
Location in the dry site	–	<0.001	Odds decrease by 37 times if HH is in the dry site
Household age	–	0.001	Odds decrease by 2.2 times if household age doubles
Child grants	+	0.047	Odds increase by 1.3 times if the HH receives one additional child grant
Agriculture in summer	+	<0.001	Odds increase by 16 times if the HH engages in seasonal (summer) agriculture
Formal employment	–	0.037	Odds decrease by 8.4 times if HH members are formally employment
Livestock	–	0.019	Odds decrease by 3.2 times if HH has livestock
Coping with NTFPs	–	0.007	Odds decrease by 5.6 times if HH copes with shocks with NTFPs

temporarily restricted access to shops while droughts resulted in increased crop raiding and livestock losses to wildlife. Some respondents attributed the increase of home-gardens to drought-related losses of wild herbs (workshops). Both events were associated with increased spending on food. Drought was identified as the bigger threat, with household food production able to recover more quickly from floods. Drying and storing food (including wild foods) were reported as a means of coping although producing/collecting surpluses for storage were identified as a challenge.

Importance of Wild Foods for Coping

Overall, the greatest proportion of households consider wild foods to be only "somewhat important" for coping with hungry periods (42.3%), with the odds of this being higher for households receiving migrant remittances (Table 2). The odds of households perceiving wild foods as "very important" for coping with hungry periods were higher in the dry site. Households with livestock and those in the wet site perceived wild foods as "important" while those without livestock perceived wild foods as "not important."

Wild foods help households cope with flood- and drought-related food shortages, sustaining children in particular (workshops). Although wild foods are themselves impacted by these extreme events, they still contribute to household food security. For example, respondents in both villages noted certain important, more drought resistant fruit species, including *Adansonia digitata, Berchemia zeyheri, Trichilia dregeana,* and *Xanthocercis zambesiaca* (dry site), *Vangueria infausta* and *Strychnos spinosa* (both sites), and *Parinari curatellifolia*

(wet site). Respondents in the dry site told of eating birds found sheltering in the shade of their homes during droughts.

Frequency of Use of Wild Foods during Different Times

Overall, the frequency of consumption of wild foods increased during times of food shortage. On average, only 3.8 meals/week incorporated wild foods when food was plentiful (Table 3). This frequency increases with increasing food scarcity. The odds of households increasing their frequency of wild food consumption per week, in response to increased food scarcity (including hungry periods), are higher for older households. Households receiving a lower value of state grants also increase their frequency of consumption during hungry periods.

Three types of households clearly differed in their frequency of wild food consumption, both as a daily and 'safety net' strategy (Fig. 1). A quarter of households (25.3%), the second largest cluster, consume a high number of meals (at least one meal/day) containing wild foods during "times of plenty." Their frequency of consumption decreases when food is scarce (but remains notably higher than the other clusters), and continues to decrease during hungry periods. Because of their reliance on wild foods, we categorized this cluster as "Dependence." Most households (58.8%) belong to a cluster characterized by a low frequency of consumption during "times of plenty" with consumption increasing with increasing food scarcity, indicating a safety net function (categorized as "Safety"). Households in the smallest cluster (15.9%), consumed wild foods approximately every second day during times when food was plentiful, more than the "Safety" cluster, but decreased their use during food shortages. Because of their low overall use of wild foods relative to the other clusters we categorized this cluster as "Disinterest."

The odds of a household being in the "Dependence" cluster increase amongst households with older members (reflected by the high average age) (Table 4). The odds decrease if the household reported coping with shocks by reducing household spending, reducing the quantity/quality of meals, or by seeking work and assistance from NGOs. The odds of a households being in the "Safety" cluster are higher for households located in the dry site and those engaged in livestock rearing rather than arable agriculture. The odds are also higher for households who reported coping with shocks by reducing household spending, or by seeking work and assistance from NGOs. The odds of a household being in the "Disinterest" cluster are higher for younger households, those receiving child grants, those in the wet site, and those engaging in summer agriculture rather than livestock rearing and formal employment. The odds of a household falling within this cluster decrease if the households rely on NTFPs to cope with shocks.

Discussion

The Role of Wild Foods in Rural Livelihoods

The consumption of a diversity of wild foods remains a common feature of rural livelihoods in Venda, South Africa, reported by almost all the households. This high proportion, irrespective of site and household characteristics, implies either widespread need or that products are collected opportunistically when available or in response to dietary preferences and cultural traditions (Trefry *et al.* 2014; Sylvester *et al.* 2016) and emphasizes the ongoing role of wild foods in supplementing diets and livelihoods, suggesting that greater cognizance be taken of wild foods in biodiversity and food assessments and policies (Hickey *et al.* 2016). In their review

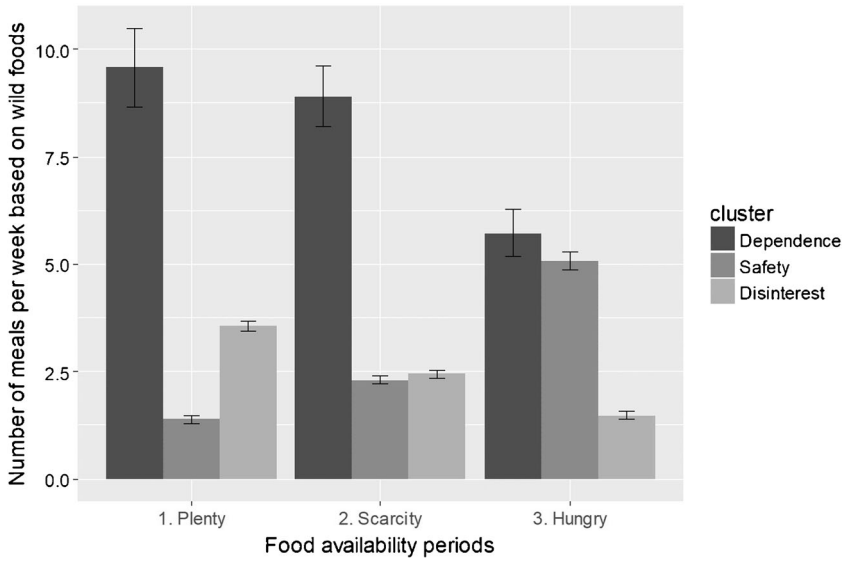

Fig. 1 Wild food consumption (based on number of meals per week) by different household food dependency clusters during periods of decreasing food availability

of NTFP use by households in 14 South African villages, Shackleton and Shackleton (2004) noted similarly prevalent wild food consumption, while in their global comparison, Hickey *et al.* (2016) found wild food collection to be most common in Africa. Several studies have drawn attention to the diversity of species consumed (Addis *et al.* 2005; Bharucha and Pretty 2010; Bvenura and Afolayan 2015).

Fewer households were engaged in the sale of wild foods, with the consumption-to-sale ratio being similar to that reported in Hickey *et al.* (2016). Nevertheless, the proportion selling is considerably higher than that noted in other South African studies, particularly as these considered a wider selection of NTFPs than wild foods (Dovie 2001; Paumgarten and Shackleton 2009). Although driven in part by an external market, sales also reflect that households are willing to pay for locally available (and essentially "free") resources. This suggests barriers to collection, including time and labor constraints, skill and equipment requirements, and risk and/or illegality concerns that some households are either more capable of overcoming (e.g., through access to labor) or more willing to tackle in response to opportunity or need (Baiyegunhi and Oppong 2016; Sylvester *et al.* 2016).

Although widespread, wild food use is not generic. Variations exist in the use and sale of different sub-categories of wild foods (i.e., herbs, fruit, and bushmeat). Household size, existing livelihood strategies (livestock ownership), and location influence the proportion of households consuming wild foods, with location also influencing their sale. Larger households with labor for harvesting may rely more on wild foods to supplement their diets (Baiyegunhi and Oppong 2016). The consumption of herbs and fruit by households with livestock suggests opportunistic harvesting while herding, and that the maintenance of communal grazing lands ensures better access to these resources (McGarry and Shackleton 2009). Wild herbs were consumed by a greater proportion of households at the wet site despite arable agriculture being more common. These herbs may be actively maintained on agricultural land (Bharucha and Pretty 2010) and benefit from the higher rainfall and lower levels of livestock grazing in this site. Bushmeat consumption was more prevalent in the dry site, despite the high proportion of households engaged in animal husbandry. Although access may be the primary driver, it also suggests a preference for bushmeat and/or that households consume bushmeat to save costs and to preserve livestock, which is valued as an insurance option. In addition, it reflects the presence of mopane worms. An increasing number of studies from Limpopo province have drawn attention to the contribution of edible insects to households' nutritional and financial needs (Egan *et al.* 2014; Dzerefos and Witkowski 2015; Baiyegunhi and Oppong 2016).

Wild foods fulfil both a daily and a safety net function. On average, they were consumed once every two days suggesting that they continue to make a regular and important contribution to households' diets; however, data on the quantities consumed and nutritional value (relative to other foods) would strengthen this argument (Powell *et al.* 2015; Ncube *et al.* 2016). Although the overall consumption frequency of wild foods is high, nuances exist which suggest they play a more important role in some households than others. For example, even during times of high food availability, households in the "Dependence" cluster reported the daily consumption of wild foods, suggesting that they associate high food availability with wild foods, and may be constrained by the costs associated with farming and therefore have limited alternative food sources. By relying on wild foods, they may be able to direct limited household funds to other household necessities. Relative to the "Dependence" cluster, the "Safety" cluster's household consumption of wild foods under good conditions (i.e., when food is plentiful) is low, suggesting wild foods are not preferred during periods of high food availability from other sources but rather serve as a safety net in times of scarcity. For households in the "Disinterest" cluster, consumption of wild foods is driven more by availability (i.e., opportunistic harvesting) than need.

The frequency of wild food consumption increases with increasing food scarcity. A number of studies draw attention to this safety net role in response to both idiosyncratic and covariate shocks (Takasaki *et al.* 2004; McSweeney 2005; Baiyegunhi and Oppong 2016). Older and poorer households were more likely to rely on wild foods during hungry times, suggesting the influence of previous experience of this coping option and limited alternatives. Although households in the dry site assigned a higher value to the safety net function of wild foods, households in the wet, less marginal site still considered them "important" for coping with hungry periods. Households with livestock also perceived wild foods as important, reflecting the association between livestock herding and wild food collection. Households with migrant remittances considered wild foods as only "somewhat important" during times of scarcity, possibly reflecting labor constraints but also the contribution of remittances to household food security. Studies indicate high (and regular) levels of NTFP use as a safety net, particularly by poor households in low agro-ecological zones where drought, crop pests, and food shortages are frequent, and incidences of HIV/Aids are high (Shackleton and Shackleton 2004; Arnold *et al.* 2011).

Wild Foods as a Safety Net – A Nuanced Perspective

Interesting nuances emerge when looking at the typology of households and the frequency with which they consume wild foods under circumstances of increasing food scarcity. For the "Dependence" cluster (25.3% of households), the safety net function of wild food appears limited. Although they consume wild foods regularly during good times, their frequency of consumption declines with food scarcity and hunger, which

given their apparent reliance on wild foods as a primary part of their diet, in addition to indications of limited coping options, is cause for alarm. "Dependence" households are characterized by older members who may struggle to collect wild foods if weakened by increasing hunger and in situations of increasing competition for limited resources (i.e., when the "Safety" cluster increases their wild food consumption). Several studies have highlighted the essential role of NTFPs and wild foods in supporting more vulnerable households (Pattanayak and Sills 2001; Drimie and McLachlan 2013; Sylvester *et al.* 2016). However, this reliance may constitute a poverty trap in cases where access to crucial resources becomes constrained either permanently (e.g., through land conversion) or temporarily (e.g., during certain seasons and extreme climate events) (Levang *et al.* 2005). Our findings indicate this is the case with the "Dependence" cluster.

Although 96.5% of households consume wild foods, suggesting the safety net function is available to most, only 58.8% (the "Safety" cluster) increased their frequency of consumption in response to increased food scarcity. Although this may indicate limitations to the safety net function of wild foods, these households' use of wild foods as a safety net, despite low daily use, also suggests possible advantages (Paumgarten and Shackleton 2011). During times of increased need, this cluster may be more willing to discount the challenges associated with wild food collection. It is unclear however, why their frequency of consumption during food shortages does not increase further. Possible explanations include that they had sufficient food or, more worryingly, they could not access more. In the first case, it is possible that these households were able to meet most of their dietary requirements (more easily) through other means, with wild foods providing an occasional buffer. However, given the high proportion of households who reported increasing challenges in finding sufficient food, unsustainable use is a risk, particularly in the case of covariate shocks to the food system (e.g., droughts, rising food prices, etc.), and particularly for those households who rely on the frequent consumption of wild foods (i.e., the Dependence" cluster).

The "Disinterest" cluster's reduced frequency of consumption of wild foods in response to food scarcity most likely reflects their general disinterest in and lack of reliance on NTFPs as a safety net. These households suggest a younger generation of people with limited ties to the natural resource base, less ecological knowledge, and changing preferences, all accentuated by the more extensive land conversion in the wet site (see also Bvenura and Afolayan 2015; Hickey *et al.* 2016).

Limitations to the Safety Net Function of Wild Foods

The safety net function of wild foods has four limitations, namely seasonality, the impact of extreme climate events, declining availability, and labor intensity. It is important to recognize that this list is not exhaustive, nor does it necessarily apply to the overall safety net function of NTFPs. For example, other studies have highlighted limitations associated with weak or absent markets and the loss of traditional ecological knowledge and skills (McSweeney 2005; Weyer *et al.* 2017).

Researchers have noted the role of wild foods in smoothing seasonal food gaps, with the diversity of species ensuring some availability throughout the year (Fukushima *et al.* 2010; Bvenura and Afolayan 2015). Chivandi *et al.* (2015) describe the role of wild foods in sustaining up to 80% of households in Malawi, Mozambique, and Zambia through an annual three-month hunger period. Our findings indicate a similar "hunger season," particularly in the dry site, occurring post-harvest in the face of challenges to producing (and storing) sufficient quantities of food to ensure stable consumption. Low levels of wild food consumption during the same period indicate limited availability (Ncube *et al.* 2016). Interestingly, high levels of wild food availability and use during the pre-harvest period suggests that wild foods reduce the length of the "hunger season" but do not eliminate it completely. The pre-harvest period coincides with a period of high expenditure (e.g., school fees), with wild foods possibly allowing for essential cost-savings (Shackleton and Shackleton 2004; Paumgarten and Shackleton 2011). Other studies suggest variable wild food consumption and sale are driven more by seasonal availability than periods of increased need (De Cock *et al.* 2013; Powell *et al.* 2015).

Our results indicate occurrences of food scarcity and hunger associated with climate extremes such as droughts and floods and that wild foods have an (existing and often underestimated) role in supporting households during periods of climate-induced vulnerability, contributing to climate change adaptation, being more resilient than cultivated crops (Arnold *et al.* 2011; Bvenura and Afolayan 2015). They further suggest, however, that there is the need for more tempered expectations. Both floods and droughts decrease the availability of wild foods, compounding crop and livestock losses. The capacity of wild foods to supplement rural diets may be insufficient in the face of more frequent and extended climate shocks, implying limitations to their effectiveness for ecosystem-based adaptation (EBA) (Pramova *et al.* 2012). Although maintaining a diversity of species across the landscape is advocated as a means of ensuring sustainable and resilient diets (Powell *et al.* 2013), Elmqvist *et al.* (2003) argue that when considering ecosystem resilience, response diversity may be more important than functional diversity, as species react differently to disturbances. Thus, there is the need for an improved understanding of the impact of climate extremes and climate change on the diversity of wild foods as well as their actual and expected role relative to other coping and adaptation options (Takasaki *et al.* 2004; McSweeney 2005; Pramova *et al.* 2012).

Wild food availability is perceived to declining, possibly undermining their current and future safety net function and potential role in EBA and compounding seasonal and

extreme-event fluctuations. As a consequence a reliance on wild foods may constitute a poverty trap, specifically for households who rely on their regular consumption (i.e., "Dependence" households) (Levang *et al.* 2005). During times of collective food insecurity (e.g., droughts), the "Dependence" cluster's "normal" harvesting levels of wild foods may be unsustainable, especially if competition for resources increases (with "Safety" households, livestock, and wildlife all increasing their consumption). Although storage may help, households may be unable to collect and store sufficient quantities to maintain their usual consumption levels (Pramova *et al.* 2012; Ncube *et al.* 2016). Increasing food insecurity may drive these households to illegal harvesting (e.g., poaching in protected areas), increasing their overall vulnerability. Given the large proportion of households in the "Safety" cluster, as well as indications of increasing difficulties in meeting food needs, declining availability of wild foods is worrying if alternatives are limited. The challenges of land loss, land conversion, competing resource users, and overharvesting all undermine the capacity of wild foods to support household food needs, exacerbating vulnerability (Ickowitz *et al.* 2014; Hickey *et al.* 2016). Well-defined property rights, effective local management, or off-farm coping and adaptation options may be needed to avoid unsustainable use and conflict among users, which may further undermine the livelihoods of the "Dependence" cluster (Pramova *et al.* 2012). It should however be noted that evidence suggests that increased out-migration from South Africa's rural areas, dietary transitions to a more westernized diet, and households' reliance on government social grants, are decreasing harvesting pressure on NTFPs (Ncube *et al.* 2016).

As a livelihood strategy, the collection of NTFPs (including wild foods) is argued to be attractive to the rural poor because of limited barriers to entry, although it is argued that those with control over labor often have greater access (Angelsen and Wunder 2003). Negative impacts on labor, including hunger and ill health associated with food shortages (e.g., seasonal crop shortfalls and droughts), may therefore constrain wild food collection. For "Dependence" households, characterized by existing labor constraints (i.e., composed of older members), maintaining necessary harvesting levels may become increasingly difficult during hungry periods. Although these households may rely on wild foods because their limited labor restricts their engagement in agricultural production and wage labor, increasing resource scarcity and competition over resources may limit the returns on effort, especially if they result in the need to travel further on collecting trips (Baiyegunhi and Oppong 2016). Further, limited labor may leave these households unable to collect, prepare, and store sufficient quantities of wild foods to sustain them during periods of resource scarcity. For this cluster with limited alternative coping strategies, difficult times are likely to increase in the face of climate change and declining resource availability.

Opportunities to the Use of Wild Foods as a Safety Net

Although our findings suggest limitations to the safety net function of wild foods, there are opportunities worth recognizing. The high proportion of households that do rely on wild foods as a safety net gives credence to their value (or suggests limited alternatives). Although wild foods undergo seasonal fluctuations, the diversity of species consumed ensures some supply throughout the year and it is suggested that in general, wild foods help reduce the length and intensity of the post-harvest "hunger" period associated with seasonal crop shortfalls. Similarly, this diversity is likely to ensure some availability during climate extremes, even though overall availability may be reduced. In addition to greater resilience to climate change, many wild foods can be dried and stored, and either used or sold. Their contribution to sustaining children during hungry times was noted. Relying on wild foods allows for cost-savings and prevents the need to use other resources (e.g., sell livestock), which may ensure longer-term resilience of the household.

Conclusions

Wild foods, including herbs, fruit, and bushmeat, are still used extensively by rural households in Venda, South Africa. Although wild foods are generally consumed frequently, for most households this frequency increases during periods of food scarcity. Given the regular contribution of wild foods, declining availability (whether as a result of permanent land conversion or during seasonal and climate-driven variations) poses a threat to households' ability to sustain their livelihoods both in the present and in the face of increasing climate variability and change. This is particularly so for those households who rely on wild foods on a daily basis, suggesting the need for sustainable management that accounts for increasing global environmental change.

Although wild foods fulfill a safety net function, our findings suggest the need for more cautious expectations of their role in helping households cope with covariate shocks and adapt to climate change. Declining and variable availability, driven in part by seasonality and climate extremes, means these foods may not be available in sufficient quantities when required. Furthermore, should increasing food insecurity drive increased (and possibly unsustainable) harvesting of wild foods, those households dependent on wild foods on a daily basis may find it increasingly difficult to meet their requirements. Although our findings support calls to acknowledge the role of wild foods in sustaining rural livelihoods by providing food (and nutritional) security, either regularly or on an ad hoc basis in response to increased need, we argue that wild foods should be considered as part of a suite of strategies. In certain circumstances, providing alternative, off-farm options

may be required. In sum, the role of wild foods both as a daily resource and a safety net in times of scarcity needs further exploration, particularly in terms of when their safety net function may be weak or detrimental to the livelihoods of the most vulnerable.

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Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflict of interest. The necessary ethical clearance to conduct the research was obtained from the Research Office of the University of the Witwatersrand (H120803). All ethical standards were adhered to. The relevant local authorities were approached for permission to conduct the research and formal, free, prior and informed consent was obtained from all participants. Anonymity was assured.

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