Animal Source Food (ASF) Consumption in Rural Niger: What are the Drivers?

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Abstract

This paper identified drivers of animal source food (ASF) among rural populations in Niger. This region suffers from high rates of chronic malnutrition and its people are vulnerable to food insecurity, the consequence of depleted agricultural lands, severe droughts and floods, and extreme heat, all of which is being exacerbated by climate change. Populations in this area, including agricultural, agropastoral, and pastoral populations, typically have livestock and have access to their byproducts, including meat, milk, and sometimes eggs, yet, consumption of ASF - nutrient dense foods - remains low.

This paper examined the role that food security, livelihood, agroecology, and demographic context play in determining ASF consumption in a population of rural Nigerien agropastoral and pastoral households. This paper described ASF consumption using data collected in 2011 in eastern Niger. Key findings suggested that household (HH) ethnicity, head of household (HHH) education level, HH agroecology, and food security play a significant role in determining consumption of ASF within the household. Understanding how these characteristics influence ASF consumption may assist policy makers and global health practitioners in developing, targeting, and implementing nutritional interventions and programs that improve nutritional outcomes through increased ASF consumption in low income settings.

Keywords: animal source food (ASF), food security, Niger, pastoralism, livelihood

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Background

Niger, a country located in the African Sahel, is one of the least developed countries in the world (United Nations Human Development Program [UNDP], 2016). Due to complex, widespread structural determinants of poverty, life expectancy is 61.9 years and 45.7% of the population lives below the international poverty line of $1.90 a day (UNDP, 2016). The prevalence rate of child stunting, an indicator of chronic malnutrition, is 43.0%, and child wasting, an indicator of acute malnutrition, is 19.0%, both of which are significantly greater than the global thresholds for “crisis” (United Nations International Children’s Emergency Fund [UNICEF], 2016). These persistent rates of malnutrition reflect a complex set of underlying determinants, including poverty, poor hygiene and sanitation, and limited access to health services. Niger’s rapidly growing population, land degradation, climate change, reduced income-generating opportunities, and gender disparities combine to position it consistently among the poorest and most malnourished countries in the world (Baro & Duebel, 2006 and UNDP, 2016).

Further aggravating malnutrition in Niger is the arid, dry climate that makes land use for agricultural production tenuous and has resulted in extensive food insecurity and several food crises over the last century (Gambo Boukary, Diaw, & Wünscher, 2016). The World Food Program defines food security as the “availability and adequate access at all times to sufficient, safe, nutritious food to maintain a healthy and active life” (World Food Programme [WFP], 2017). On an annual basis, 22% of Niger's population suffers from chronic food insecurity (United States Agency for International Development, 2011). These food insecure households suffer from weak livelihood bases and spend up to 72% of their income on food (World Health Organization [WHO], 2006). An assessment of the daily food intake of rural Nigerien women indicates that starchy foods, including grains, are the most commonly consumed items, while animal source foods (ASF) are the least commonly consumed food items (Cisse-Egbuonye, Ishdorj, McKyer, & Mkuu, 2017).

Although the arid and semi-arid climate of Niger's Sahel agroecology makes crop production extremely tenuous, the environment has fostered livestock production in various forms for hundreds of years. Pastoralism in the Sahel has been described as the specific relationship that has evolved between livestock, people, and the environment in resource limited, arid areas of the world (McKune & Silva, 2013). Pastoralism and livestock production are practiced by nearly all households throughout rural Niger. The value of livestock to households, not only pastoral households, but agropastoral and agricultural households as well, is well documented. Agriculture represents 40% of national GDP, with livestock constituting 33% percent of agriculture-related GDP (International Trade Commission, Department of Commerce, United States of America, 2017). Livestock production provides a financial liquidity, allowing households to meet short and long-term family needs, especially in times of drought and food crises (Ayantunde, De Leeuw, Turner, & Said, 2011). Livestock also provide draft power and inputs, through manure, that improve soil fertility and increase crop yields among farmers (Powell, Pearson, & Hiernaux, 2004). However, the contributions of livestock in meeting the nutritional needs of the household is often overlooked. Particularly among poorer families, self-consumption of ASF produced by household livestock may not be prioritized; families may focus more on maintaining their livestock herds, selling livestock or byproducts when available, and ensuring that there is *any* food (most often, grain) available to be consumed every day. ASF can provide a variety of macro- and micronutrients that are difficult to obtain in adequate quantities from plant source foods alone and are essential to proper development of infant and young children (Murphy & Allen, 2003).

ASF are associated with increased cognitive function, resistance to infection, improved pregnancy outcomes, and improved school performance of children (Neumann, Harris, & Rogers, 2002). A randomized control trial conducted in 2015 showed that consumption of one egg a day among children aged 6-9 months can reduce stunting in children by 47% (Iannotti et al., 2017). The same study found a 74% reduction in the number of underweight children by the

conclusion of the trial (Iannotti et al., 2017). Supplemental ASF consumption in the diets of school children in developing nations has been shown to improve Vitamin B_{12} concentrations and limit the incidence of malnutrition (McLean et al., 2007). ASF supplementation among school children in Kenya showed increase cognitive performance, as indicated by RAVEN scores at school (Neumann et al., 2007). Though there is evidence supporting ASF consumption for improved full child growth and development, research also indicates significant socioeconomic disparities in ASF consumption. A recent study in urban Ethiopia found households of greater socioeconomic status consumed significantly more ASF than households with lower socioeconomic status (Workicho et al., 2016). Studies conducted within Niger show limited variation in the consumption of ASF between rural populations in the Zinder and Maradi regions, with most household diets containing non-ASF (Cisse-Egbuonye, Ishdorj, McKyer, & Mkuu, 2017). Thus, a full understanding of the barriers and facilitators of ASF consumption is needed.

Aims and Hypotheses

This analysis of ASF consumption among households surveyed in 2011 examines a number of demographic factors historically associated with nutritional outcomes. These include sex of the head of household (HHH), education level of the HHH, and household (HH) ethnicity. In addition to these demographic factors, this analysis explores the relationship between HH agroecology (pastoral, agropastoral or agricultural), livelihood (pastoral, agropastoral or agricultural) and food security (secure, moderate, or insecure) with ASF consumption within these communities.

The aim of this study is to identify the factors associated with increased ASF consumption among agricultural, agropastoral, and pastoral households Niger. Using secondary data collected in 2011 in the Zinder region of eastern Niger, this study provides important baseline information on the nutritional intake of ASF in Niger and delineates the specific types of ASF consumed in these communities. This information serves as a foundation from which

researchers and development practitioners may operate to increase ASF consumption among high-risk populations, specifically in rural, low income, livestock-rich environments, such as Niger, where malnutrition remains endemic.

Methods

Study Design, Setting, Participants

This analysis was based on data collected in 2010-2011 through a cross-sectional study of rural communities in eastern Niger, whose methods included collection through household interviews, focus group discussions, key-informant interviews, and anthropometric measurements (McKune, 2012). The original study sought to understand household vulnerability, food insecurity, nutrition, adaptation, and resilience to climate change. Surveys of 133 households provided information on dietary intake, including 24-hour food recall for men, women, and children on specific foods. This data included information on meat, poultry, fish, dairy (milk or yogurt), and egg consumption. Re-analysis of the dietary diversity data allow for formation of the principal measurement of this study – ASF consumption.

Statistical Procedures and Statistical Measures

SPSS (Statistical Package for the Social Sciences) software was used to execute descriptive statistics and qualitative data analysis on all the variables included in this study. Binary logistic regression and bivariate association (Chi-Squared and Fisher's Exact) were computed to investigate the effects of independent variables on ASF consumption. Independent variables included in this analysis include an agroecology zone, *livelihood continuum* index, and a *food security* index, all borrowed from McKune's original work on these data, in order to examine their role in household ASF consumption (McKune, 2012). The agroecology zones were defined by the 2012 Famine Early Warning System livelihood/food zones of Niger (Famine Early Warning Systems Network [FEWSNET], 2012). Households were assigned to one of three zones based on their location: agricultural, agropastoral, or pastoral, which represented their location in 2011. The livelihood continuum is a multi-item index developed to reflect a range of

livelihoods found in these areas. The index range is from 1-7, on which the fictional pole of “pure agricultural” livelihood is represented at one end (1) and the fictional pole of “pure pastoral” livelihood is represented at the other (7). The index was created based on both objective and subjective indicators of livelihood, ranging from self-identification, ethnicity, and ancestral livelihood patterns (all indicated through household surveys), to herd size, and mobility (see (McKune, 2012) for more detail). The index captures livelihoods at a specific moment in time, allowing for relative comparison across groups as well as the potential to compare the same population over time. The food security index, based on (Maxwell et al., 1999), was calculated based on the frequency and severity of coping mechanisms used by households in times of crisis, including decreased portions at meals, decreased nutritional quality at meals, changed eating habits, decreased number of meals, collection of wild famine foods, day without eating, and sale of personal belongings (Maxwell, 1999 & McKune, 2012). The food security index ranges from 1-15. Using SPSS, data were then binned into three categories at natural breaks and households were assigned to one of the following categories: most secure, moderately secure, and most insecure. It is important to note that this is a relative description from within the sample population, thus all households may be food insecure (or secure), but the categories denote food security relative to the whole sampled population. The inclusion of this measure will assist in determining if ASF consumption differed among households based on their different experiences of food insecurity in 2011.

Using the 24-hour food recall data, a variable for overall *ASF* consumption was created which included information on the intake of meat, poultry, fish, and dairy. Initial analysis was conducted for men, women, and children within each household. No intra-household differences were determined between men, women, and children. Given that reported data on ASF were nearly the same for men, women, and children, children’s consumption was used as a proxy indicator for household ASF consumption. The *ASF* indicator used is a dichotomous variable describing if the household consumed any ASF or not within the previous 24-hours.

In addition to the *ASF* variable describing consumption of any dairy, meat, fish, poultry, or eggs within the household, ASF consumption was broken down into more detailed indicators. The *Meat* ASF variable was created using data reported during 24-hour recall of consumption of meat, poultry, and fish for men, women, and children, separately. Similar to the *ASF* indicator, no intra-household differences were identified (men, women, and children), so a dichotomous variable of the overall household consumption of meat was produced using children's consumption. Likewise, the *Dairy* (milk and yogurt) and *Eggs* variables were analyzed separately from *Meat* to determine differences in the consumption of these products at the household level. The *Dairy* variable was created using the same methodology for the *ASF* and *Meat* variables. Egg consumption was zero across all households, thus it has been excluded from further analysis. Distinction of these variables (*Meat*, *Dairy*, and *Eggs*), in addition to the more general *ASF* variable, is important in these populations, as literature indicates that milk consumption is typically higher among more mobile pastoral populations and is historically credited with keeping nutritional status of mobile pastoral children better than children of nearby settled families (Fratkin, E. & Roth, E.A. (Eds.), 2005). Thus, independent variables (agroecology, food security, and livelihood) were assessed against not only ASF, but each of these outcome variables as well.

Demographic indicators that were explored as confounders include HHH sex, HH ethnicity, and HHH education level as reported in 2011.

Results

Variable Descriptions

A total of 133 household surveys were analyzed. Table 1-1 depicts the characteristics of the participants and households in the survey. Although most of the survey participants were male (79.7%), female HHHs were present, making up 20.3% of the total survey respondents.

Based on the (FEWSNET, 2012) map of agroecology zones, 14.3% of households in this sample were located within the agricultural zone, 28.6% were in the agropastoral zone, and

57.1% were in the pastoral zone. Households within the agricultural zone were used as the reference population in later analysis.

The livelihood continuum index showed households across a range of livelihoods, ranging from those highly dependent upon crop-based agriculture (25 households, or 18.8%) to those dependent on highly mobile pastoralism (5 households, or 3.8%). Table 1-1 presents the distribution of households across the livelihood continuum, rounding to the nearest whole number between 1-7. Notably, no household existed at the highly agricultural pole (1), but 5 households were determined to exist at the highly pastoral pole (7) during the time of this survey.

Likewise, descriptive analysis of the food security index showed 35.3% households as most food secure, 17.3% as moderately food secure, and 45.1% as most food insecure. Food insecure households were utilized as the reference population in later analysis.

ASF consumption data, the key outcomes in this study, were categorized into four distinct categories: *Meat, Dairy, Eggs,* and any *ASF*. Among households reporting 24-hour food recall data, 14.3% consumed meat, 36.8% consumed dairy, and 0% of households consumed eggs. These combine for a total of 38.3% of households reporting any ASF consumption in the past 24 hours, or 51 of the 133 households sampled.

During the survey, demographic data were collected on HHH education, HHH sex, and household ethnicity. Education data indicate that 78.9% of HHHs had received no formal education, 2.3% attended primary school but did not complete their studies, 4.5% completed primary school, 1.5% attended some secondary school, and 12% attended only Koranic school. For analysis purposes, the no education population was used as a reference group to determine statistically significant associations between education levels and ASF. Of the 133 households, 24.8% identified as Hausa, 33.8% Tuareg, 23.3% Peul, and the remaining 18.0% were Beri-Beri. The Djerma ethnicity was not represented in the sample population. The Tuareg ethnicity,

being the largest ethnic group represented in the data set, were used as the reference population in later analysis of ASF consumption between ethnicities.

Table 1-1. Characteristics of the population, 2010-2011 Eastern Niger Data Set

Overview	**Frequency (Percentage) of Sample Population**	**Frequency (Percentage) Consuming *any* ASF**
Total	133 (100)	51 (38.3)
HHH Sex		
Male	106 (79.7)	43 (40.6)
Female	27 (20.3)	8 (29.6)
Household Ethnicity		
Hausa	33 (24.8)	13 (39.4)
Djerma	0 (0.0)	0 (0.0)
Tuareg	45 (33.8)	26 (57.8)
Peul	31 (23.3)	5 (16.1)
Beri-Beri	24 (18.0)	7 (29.2)
HHH Education		
None	105 (78.9)	37 (35.2)
Primary Incomplete	3 (2.3)	0 (0.0)
Primary Complete	6 (4.5)	4 (66.7)
Secondary	2 (1.5)	0 (0.0)
Koranic School only	16 (12.0)	9 (56.3)
Missing	1 (0.8)	1 (0.0)
Household Agroecology Zone		
Agricultural	19 (14.3)	11 (57.9)
Hausa	*1 (0.8)*	*1 (100.0)*
Tuareg	*18 (13.5)*	*10 (55.6)*
Agropastoral	38 (28.6)	7 (18.4)
Hausa	*19 (14.3)*	*5 (26.3)*
Beri-Beri	*19 (14.3)*	*2 (10.5)*
Pastoral	76 (57.1)	33 (43.4)
Hausa	*13 (9.8)*	*7 (53.8)*
Tuareg	*27 (20.3)*	*16 (35.6)*
Peul	*31 (23.3)*	*5 (16.1)*
Beri-Beri	*5 (3.8)*	*5 (100.0)*
Household Livelihood Continuum		
1.00	0 (0.0)	0 (0.0)
2.00	25 (18.8)	13 (52.0)
3.00	47 (35.3)	14 (29.8)
4.00	22 (16.5)	9 (40.9)
5.00	14 (10.5)	6 (42.9)
6.00	15 (11.3)	7 (46.7)
7.00	5 (3.8)	0 (0.0)
Missing	5 (3.8)	2 (40.0)
Household Food Security		
Most Secure	47 (35.3)	23 (48.9)

Moderately Secure	23 (17.3)	11 (47.8)
Most Insecure	60 (45.1)	16 (26.7)
Missing	3 (2.3)	1 (33.3)
Animal Source Food (ASF) Consumption		
Any *ASF* (meat, poultry, fish, dairy)	51 (38.3)	
Missing	2 (1.5)	
Consumed no ASF	80 (60.2)	
Meat (meat, poultry, fish)	19 (14.3)	
Missing	1 (0.8)	
Dairy (milk and yogurt)	49 (36.8)	
Missing	1 (0.8)	
Eggs	0 (0.0)	

Statistical Tests and Outcomes

Demographic associations with ASF.

Ethnicity. Binary regression tests were calculated to distinguish associations between HH ethnicity and ASF consumption. Statistical tests illustrated that ethnicity is a predictor for not only ASF, but meat and dairy consumption, respectively, as well.

Table 2-1. *ASF* Consumption by ethnicity

Household Ethnicity	**Unstandardized Coefficient**
Tuareg (reference population)	---
Hausa	-.856*
Peul	-2.074**
Beri-Beri	-1.312**
Constant	.425
Model Fit	
Adjusted R Square^{+}	.163**
N (# of participants)	131

Notes: *p<0.1; **p<0.05; --- reference population; $^{+}$ Nagelkerke R Square

Table 2-1 emphasizes the role that ethnicity plays as a determinant of ASF consumption. Examination into the relationship of ethnicity and ASF consumption showed that when

compared to the Tuareg, each other ethnic group within the sample population was significantly less likely to consume any ASF during the time period.

Table 2-2. *Meat* Consumption by ethnicity.

Household Ethnicity	Unstandardized Coefficient
Tuareg (reference population)	---
Hausa	.526
Peul	-19.538
Beri-Beri	.056
Constant	-1.665
Model Fit	
Adjusted R Square +	.155**
N (# of participants)	132

Notes: *p<0.1; **p<0.05; --- reference population; + Nagelkerke R Square

For ethnicity and *Meat* consumption using binary logistic regression tests, no significant differences were found when comparing each of the ethnic groups to the Tuareg, indicating that ethnicity was not predictive of meat consumption for this particular sample population (Table 2-2).

Table 2-3. *Dairy* Consumption by ethnicity.

Household Ethnicity	Unstandardized Coefficient
Tuareg (reference population)	---
Hausa	-1.061**
Peul	-2.016**
Beri-Beri	-1.255**
Constant	.368
Model Fit	
Adjusted R Square +	.158**
N (# of participants)	132

Notes: *p<0.1; **p<0.05; --- reference population; + Nagelkerke R Square

Likewise, the use of regression tests outlined major associations for ethnicity and *Dairy* consumption (Table 2-3). Compared to the Tuareg, each ethnicity was less likely to consume dairy ASF. Historically, the Peul are known for their high rates of dairy consumption. These data indicate that they were less likely to consume dairy than the Tuareg population, a finding that is further explored in the discussion section. Additionally, this analysis provided specific evidence that ethnicity is a significant predictor of dairy consumption.

HHH sex. Chi-squared tests and Fisher's Exact tests were utilized to establish associations between HHH sex and ASF consumption. When analyzed to determine if HHH sex was associated with *ASF* consumption, the results were not significant (p=.499). Correspondingly, Chi-squared and Fischer's Exact were run to observe if HHH sex was associated with *Meat* consumption, the results of which were not significant (p=.120), and for *Dairy* consumption the results were not significant (p=.824). The lack of associations between HHH sex and indicators of ASF consumption indicated that living in a male or female headed household was not predictive of ASF consumption in these populations. This variable was removed from any further statistical procedures and analysis.

HHH Education. Similarly to HH ethnicity, binary logistic regression tests were run to identify any associations between the educational status of the HHH and ASF consumption. A significant association between HHH education and *Meat* consumption was identified. Specifically, completion of primary school by the HHH was associated with increased consumption of meat ASF (p=.011) when compared to the uneducated group. Those educated through Koranic school also showed significance for improved meat consumption (p=.022). Likewise, HHHs educated through Koranic school were also significantly positively associated with *Dairy* consumption (p=.088) compared to the uneducated population. These findings suggested that higher education levels of HHHs are associated with greater consumption of meat and dairy products. No significant association between HH education levels and the *any ASF* variable were identified.

HH Agroecology. Binary Logistic regression tests were applied to identify associations between HH agroecological zones and *ASF, Meat,* and *Dairy* consumption. Findings indicated that HHs located within the *agropastoral* agroecological zone are associated with greater *ASF* consumption overall (p=.002) and *Dairy* consumption (p=.004). Agropastoral zoned HHs were significantly less likely to consume any ASF or dairy products than the agricultural group. Agroecological zone did not prove to be a significant predictor of *Meat* consumption.

Food security. Similarly, regression tests were calculated to determine associations between food security and *ASF, Meat,* and *Dairy* consumption. Findings suggested that most secure HHs and ASF (p=.011) and moderately secure HHs and ASF (p=.070) were positively associated with increased intake of any ASF. Findings for food security and *Meat* consumption found no significant association. However, the most food secure HHs were more likely to consume *Dairy* ASF (p=.026) than the most food insecure population. These developments suggested that improved food security is associated with higher consumption of ASF and specifically, dairy ASF.

Livelihood continuum. Chi-Squared and Fisher's Exact tests were run to identify any associations between livelihood and *ASF, Meat,* and *Dairy* consumption. Results showed no association between the livelihood continuum and *ASF* consumption (p=.207). This finding indicated that there is no association between livelihood and the intake of ASF within this sample population. Additionally, no significant association was found between livelihood and *Meat* (p=.297) with the application of Fisher's Exact tests for small sample sizes and no associations between livelihood and *Dairy* consumption (p=.255).

Cofounder Models of Independent Variable Associations with ASF. Multiple binary logistic regression models were generated to examine the relationship between the independent variables of agroecology, food security, and livelihood on ASF consumption. Potential cofounders were included in each consecutive model. These included HH ethnicity and HHH education level.

Table 3-1. Binary Logistic Regression Models Investigating the Effects of HH Ethnicity, HHH Education, HH Agroecology, Food Security, and Livelihood on *ASF* consumption.

Independent Variables	Model 1	Model 2	Model 3	Model 4	Model 5
HH Ethnicity					
Tuareg (reference population)	---	---	---	---	---
Hausa	-.865*	.512	.273	1.081	1.020
Peul	-1.927**	-1.863**	-1.891**	-1.659**	-1.673**
Beri-Beri	-1.579**	.202	.266	.632	.863
HHH Education					
No education (reference population)	---	---	---	---	---
Primary incomplete	-20.087	-19.515	-19.561	-19.524	-19.612
Primary complete	1.558	1.115	.955	.951	.787
Secondary	-20.294	-21.036	-20.960	-21.493	-21.405
Koranic School	.995	.998	.919	.954	.858
HH Agroecology Zone					
Agricultural (reference population)		---	---	---	---
Agropastoral		-2.418**	-2.170**	-2.942**	-2.774**
Pastoral		-.171	-.078	-.226	-.248
Food Security Index					
Insecure (reference population)			---		---
Moderate			.409		.476
Secure			.756		.868*
Livelihood Continuum				-.047	.017
Constant	.274	.381	-.022	.516	-.168
Model Fit					
Adjusted R Square[+]	.235**	.331**	.354**	.352**	.380**
N (# of participants)	130	130	127	125	122

Notes: *p<0.1; **p<0.05; --- reference population; [+] Nagelkerke R Square

Table 3-1 presents the binary logistic regression associations for the independent variables and *ASF* consumption. Each of the predictor and confounding variables were included in the models to estimate their influence on ASF intake. Among cofounders, HH ethnicity, specifically being of Peul ethnicity, was significantly negatively associated with consumption of ASF compared to the Tuareg. Results showed that there is a significant relationship between

being in an *agropastoral* zone and the intake of ASF. In other words, households within the *agropastoral* agroecology zone were significantly less likely to consume ASF than those within the *agricultural* zone (reference population) across all the models. Findings also showed that when agroecological zone, food security, and livelihood were included in a model together, HHs within the *agropastoral* zone (p=.062) were still less likely to consume ASF than those in the *agricultural* zone and food *secure* HHs were more likely to consume ASF than food *insecure* HHs (p=.089). Regression analysis found that the livelihood index is unassociated with ASF consumption for this population.

Table 3-2. Binary Logistic Regression Models Investigating the Effects of HH Ethnicity, HHH Education, HH Agroecology, Food Security, and Livelihood on *Meat* consumption.

Independent Variables	Model 1	Model 2	Model 3	Model 4	Model 5
HH Ethnicity					
Tuareg (reference population)	---	---	---	---	---
Hausa	.599	1.778**	1.677**	1.427	1.360
Peul	-19.167	-18.698	-18.685	-18.535	-18.547
Beri-Beri	-.238	1.269	1.265	.795	.807
HHH Education					
No education (reference population)	---	---	---	---	---
Primary incomplete	-18.850	-18.102	-18.122	-18.217	-18.223
Primary complete	1.982**	1.839*	1.811*	1.607	1.600
Secondary	-19.383	-19.734	-19.967	-19.869	-20.025
Koranic School	1.242*	1.329*	1.327*	1.234*	1.247*
HH Agroecology Zone					
Agricultural (reference population)		---	---	---	---
Agropastoral		-2.574**	-2.389**	-2.420**	-2.286**
Pastoral		-.996	-.935	-.572	-.541
Food Security Index					
Insecure (reference population)			---		---
Moderate			.505		.327
Secure			.129		.063
Livelihood Continuum				-.362	-.335
Constant	-2.060	-1.543	-1.720	-.320	-.509
Model Fit					

Adjusted R Square+	.258**	.332**	.339**	.357**	.359**
N (# of participants)	131	131	128	126	123

Notes: *p<0.1; **p<0.05; --- reference population; + Nagelkerke R Square

Table 3-2 presents the binary logistic regression model for agroecology, food security, and livelihood on *Meat*. In the presence of the food security indicator, we found that HHH education was significantly associated with increased meat consumption. Specifically, among HHs where the HHH *completed* primary school, more meat is consumed and among HHs where the HHH attended *Koranic school*, more meat was consumed. Findings also indicated that being Hausa was significantly positively associated with meat consumption compared to the Tuareg, when food security and agroecological zone were included in the model. Additionally, the models found that food security on *any* level and livelihood, were not predictive of meat consumption beyond the effects of household education and HH ethnicity. However, the models consistently found that households within the *agropastoral* zone of agroecology were significantly associated with less meat consumption compared to those within the *agricultural* zone. These findings remained significant (p=.048) in the final model, where all three independent variables (agroecology, food security, and livelihood) were considered, suggesting that households within the *agropastoral* zone were less likely to consume meat ASF than the *agricultural* zoned group.

Table 3-3. Binary Logistic Regression Models Investigating the Effects of HH Ethnicity, HHH Education, HH Agroecology, Food Security, and Livelihood on *Dairy* consumption.

Independent Variables	Model 1	Model 2	Model 3	Model 4	Model 5
HH Ethnicity					
Tuareg (reference population)	---	---	---	---	---
Hausa	-1.127**	.026	-.113	.642	.631
Peul	-1.868**	-1.903**	-1.935**	-1.761**	-1.823**
Beri-Beri	-1.592**	.116	.183	.579	.823

HHH Education					
No education (reference population)	---	---	---	---	---
Primary incomplete	-19.911	-19.339	-19.365	-19.400	-19.456
Primary complete	1.720*	1.295	1.165	1.184	1.065
Secondary	-20.066	-20.708	-20.578	-21.052	-20.909
Koranic School	1.154*	1.164*	1.126	1.105	1.050
HH Agroecology Zone					
Agricultural (reference population)		---	---	---	---
Agropastoral		-2.213**	-2.013**	-2.661**	-2.534**
Pastoral		.075	.154	-.058	-.079
Food Security Index					
Insecure (reference population)			---		---
Moderate			.186		.244
Secure			.587		.704
Livelihood Continuum				.037	.116
Constant	.205	.166	-.126	.011	-.616
Model Fit					
Adjusted R Square[+]	.237**	.358**	.346**	.340**	.362**
N (# of participants)	130	131	128	126	123

Notes: *p<0.1; **p<0.05; --- reference population; [+] Nagelkerke R Square

Similar to *ASF* and *Meat,* regression analysis was conducted to determine associations between the independent variables and *Dairy* consumption. Regression analysis showed that households within the *agropastoral* zone were less likely to consume dairy ASF compared to those within the *agricultural* zone, across all the models, including the final model (p=.012) when agroecology, food security, and livelihood were all included. Being of the Peul ethnic group was significantly negatively associated with dairy consumption, compared to the Tuareg, across all models. These findings remained significant in the final model (p=.011) when agroecology, food security, and livelihood were considered indicating that the Peul were less likely to consume dairy than the Tuareg population. The food security and livelihood indicators did not show association with dairy consumption for this sample population.

Discussion

Animal source food has emerged as a critical source of necessary vitamins, minerals, and amino acids, demonstrating significant impact on child nutritional outcomes. The purpose of this study is to identify factors associated with ASF consumption in a sample of households across an agricultural-pastoral continuum in rural Niger where poverty and malnutrition are endemic. In the sample of 133 households, 38.3% of the households consumed *any* ASF in 24 hours, 14.3% of the population consumed a meat product, and 36.8% of the sample population consumed a dairy product. As indicated in the results section, most of the ASF consumed within the study population were dairy products, with significantly less meat being consumed, and no egg consumption, whatsoever. The analysis yielded a number of interesting results, some of which corroborate existing literature (e.g. a significant positive association between food security and ASF consumption), while other results ran counter to what literature and general knowledge of the region and its people would have suggested (e.g. a significant negative association between being of Peul ethnicity and milk consumption). Significant associations between HH ethnicity and ASF, and HH agroecology and ASF, arose across multiple models. Additionally, a significant positive association between HHH educational level and meat consumption was identified. The implication and interpretation of these findings are discussed below.

The association between HH ethnicity and ASF may be considered the most interesting finding of the study. While strong associations between HH ethnicity and ASF consumption were anticipated, the discovery that the Peul, a historically pastoral ethnic group in the region, consumed significantly less ASF, particularly milk, than other groups is difficult to explain. Despite extensive understanding and knowledge that many of the Peul practice sedentary agricultural and agropastoral livelihoods in the region, they are well-known for their production and sale of milk. Thus, further research will be required to explain this finding. Some possible explanations that should be explored include the vulnerable position many Peul HHs may have been forced into, following the 2010 food crisis, when the data utilized in this study was

collected in 2011. During the crisis, entire livestock groups decimated– including loss of donkeys –leaving the Peul in a moment of vulnerability, which may have been reflected in the study survey. Alternately, as Fratkin and others have documented, when pastoralists settle, they become extremely vulnerable, as it tends to be the most vulnerable who are forced out of mobile pastoralism, and their ability to produce crops and engage in sedentary livelihoods is limited by a lack of traditional knowledge of farming practices. The lack of milk consumption amongst the Peul, an ethnic group that has historically been associated with high rates of dairy consumption, may be explained using either rationale.

Another perplexing finding was the significant association of agroecology and ASF- specifically that households located within the agricultural zone are more likely than other groups to consume ASF. However, important to interpreting these data is the fact that nearly all households within the agricultural zone were identified Tuareg, another historically pastoral ethnic group within the region. More research is needed to understand who these Tuareg households are. They may be mobile agropastoralist or pastoralists still practicing pastoralism but were captured in the survey during a time they were residing in an agricultural zone. Another interpretation is that they are in fact settled Tuareg populations who consume high levels of milk consumption.

Finally, the significant positive association between HHH education level and meat was not unexpected. Results showed there is an association between completing primary school and increased meat consumption, which corroborates widespread understanding that increases in education levels are associated with decreased prevalence of childhood health conditions and disabilities and lower rates of malnutrition. Results also suggested a more consistently positive association between attending Koranic school and meat consumption. In the context of Niger, the finding of an association between Koranic schooling and meat consumption is extremely important, as “literacy” is often regarded as being literate in the French language and excludes individuals who are competent in reading and writing in Arabic (which is learned in

Koranic school for purposes of reading and writing the Koran). More research is needed to understand more about those HHHs who attended Koranic school in order to perceive its relationship to HH meat consumption.

If future research is to improve the intake of ASF, it is important that we begin to better understand how independent factors, such as ethnicity and livelihood interact with food security to improve nutritional outcomes of the population. Though this research indicates that ethnicity, education, and agroecology are all significantly related to ASF consumption, it has also generated a number of hypotheses for future research.

Limitations

There are significant limitations to this research. First, there is a small sample population utilized in the survey and the participants are from the same geographical region, restricting the representativeness of the data. The data used in this study represent a subset of communities from a larger study conducted in 2005, thus were not randomly selected. These results may not be generally representative of the ethnicities included in this sample. For an extensive and comprehensive understanding of the drivers of ASF consumption in this region, a significantly larger sample size should be gathered, and surveys should be administered at various times of the year to account for seasonal differences (temporality) in agroecology, food security, and livelihood.

Another important component to consider is that the reported low rates of ASF consumption and the limited types consumed leave room for uncertainty in determining the drivers for the consumption of ASF. The data collected for this analysis is entirely dependent on the participant's ability to recall information (recall bias) and the transfer of the data into statistical software presents room for sampling and measurement errors. Additionally, it is critical to note that the households in this research are all food insecure, but they were categorized into most insecure, moderately secure, and most secure to simplify the data calculations and to create a baseline grouping of food insecurity levels for this population. All the

households represented in this sample are highly vulnerable to food insecurity. Furthermore, this study did not take into consideration cultural and direct financial/economic influences as predictors of ASF consumption. Specific traditions, religious/ethnic beliefs, and customs may influence the consumption of ASF as well as financial insecurity. The thriving market for livestock and its efficient liquidity value was not considered in this study; livestock production and sales have shown to be significant predictors of ASF, especially in poverty-stricken populations.

Future Research

A deeper analysis of pastoralist lifestyles, agroecology, ethnicity, and food intake practices may prove beneficial to developing sustainable nutritional practices for all livelihoods in the region. More research on the teachings and educational practices of Koranic school will provide a better understanding of its function in improving ASF consumption, specifically meat intake, within these populations. Targeted nutritional and educational programs for increasing ASF consumption among high-risk populations can lead to improvements in multiple facets of health, especially in the case of Niger, where dairy consumption is high among multiple ethnic groups, including the Peul. Understanding if and how milk consumption is evolving within these communities, specifically, the Peul, can provide further insight to improving nutritional outcomes in the region. An examination of their dietary habits, particularly, the consumption of meat and dairy products, may be used to determine if there is a scope for using these strategies to increase ASF consumption across the communities.

Conclusion

In this study, HH education level, HH ethnicity, and HH agroecology are identified as significant drivers of consuming ASF. The (FEWSNET, 2012) agroecological zones and food security index proved to be significantly associated ASF consumption. The livelihood index proved to be an insignificant indicator of consuming ASF. To procure a broader understanding of ASF in the African Sahel, strategic and targeted interventional programs considering a

multitude of variables, including accessibility to improve dietary diversity, and affordability should be considered, and policy should be implemented to diminish food insecurity, increase livelihoods, and better the health outcomes of malnourished high-risk populations, such as these communities in Niger.

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