Original Research Article

Food Security Status and Coping Strategies of Households in Inland Fisheries: Evidence from Fishermen from Niger River Basin

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ABSTRACT

Inland fisheries play an important role in economic growth and food security in developing landlocked countries. In Mali, fishing from the Niger River contributes to national food security and nutrition but the food status of fishermen remains a research question to be explored. The objective of this study is to analyze the security status and coping strategies of fishermen households' in Pelengana municipality located along the Niger River in the Segou region. The adopted methodology is based on the food security index (FSI) which is a composite indicator based on Food consumption score (FCS), Economic vulnerability (EV), and Coping strategy index (CSI). The collection of data by survey concerned 204 households of fishermen in the municipality. The results of the FSI analysis indicate all fishermen's households are food secure. According to the FCS, EV, and CSI analysis, 1.3%, 6.9% and, 8.3% are food insecure. The households sell the fish and buy 98% of their food at the market. In conclusion, fishing allows fishermen to ensure their food security through the generated income for purchasing food at the market. The study encourages development partners and the government of Mali to invest in the development of the fish value chain to improve incomes and strengthen the food security of stakeholders, especially fishermen. For

further research, an in-depth analysis of the impact of fish chain development on national food security is needed.

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Keywords:Fisheries, food security, households, inland, Mali

1. INTRODUCTION

Inland waters are considered lakes, rivers, streams, canals, reservoirs, and other land-locked waters [1]. They represent 0.01% of the total volume of water on earth [2], but they provide 40% of the world's capture finfish fisheries and aquaculture production [3]. In many areas of the world, inland capture fisheries are a last resort when primary income sources fail due to, for instance, economic shifts, war, natural disasters, and water development projects [4,5,6][3]. They serve as social safety nets, providing alternative or supplemental sources of income, employment [7,8,9]

Inland fisheries provide food and livelihood respectively for billions and millions of people worldwide [3]. The relative contribution of inland fisheries to a country's food and economic security is dependent on its level of economic development and social context and, often, this is higher in the developing world and emerging economies [10,4]. Inland fisheries contribute significantly to food security and economic security by providing primary sources of animal protein, essential nutrients, and income[11]. The food and income benefits provided by inland capture fisheries and aquaculture can afford opportunities for empowering individuals where opportunities in other sectors are limited [7].

Inland fishes are important food and nutritional resources, especially for rural economies in developing countries[11,12]. Low-income and food-deficit countries account for 80% of the total reported harvest from inland capture fisheries[13]. Over 90% of global inland capture fisheries production is used for human consumption, the majority of which is in the

developing world[11]. For example, fish account for 50% of all animal protein consumed in Bangladesh [14].

Inland fishes are particularly important in addressing hidden hunger[13,8]. In the developing world, small fish are eaten whole to provide an important source of nutrients (eg, calcium and vitamin A) that are difficult to obtain through other dietary sources [12]. Consumption of inland fish has been shown to mitigate the effects of some micronutrient deficiency-related illnesses, such as rickets in Bangladeshi children [14].

Eighty percent of inland capture fisheries are reported to be operating in the developing world[13]. Many of these fisheries are driven by the rural poor, often for subsistence and small-scale economic security. While inland capture fisheries account for less than 14% of the global harvest total, these fisheries support at least 21 million fishers (36% of all capture fishers worldwide) and over 36 million more are employed in post-harvest activities, indicating that inland fisheries have a proportionally higher influence on livelihoods than marine fisheries, particularly in Asia and Africa [15]

In Mali, the fishing sector contributes up to 4.2% of the Gross Domestic Product and plays an important role in job creation [16]. It directly employs more than 300,000 people made up of fishermen, collectors, processors, fishmongers and wholesalers [17]. Fishing activities are practiced between three categories of actors, namely farmer-fishermen who devote more time to agriculture by investing in it, sedentary professional fishermen whose income comes from fishing with self-consumption of the fish caught and agriculture as a secondary activity and migrant professional fishermen (bozos) who practice fishing for profit[18].

In Mali, fishing is practiced on the entire hydrographic network made up of rivers, ponds, lakes, hydro-agricultural dams, flooded plains, etc.[18]. The Niger River Basin in Mali is the largest area of fish production [19]. Fisheries production (including aquaculture production) can reach 80,000 and 100,000 tons of fish per year, if flood and rainfall conditions are good[16]. Over 90% of production is consumed domestically [17]. It contributes to food and

nutritional security through the consumption of captured fish (self-consumption). However, the food status of fishermen is little addressed by previous studies in the countries of the Niger River basin[20,21,22].

The objective of this study is to analyze the security status and coping strategies of fishermen households' in Pelengana municipality located along the Niger River in the Segou region. The adopted methodology is based on using of food security index (FSI) which is a composite indicator based on Food consumption score (FCS), Economic vulnerability (EV), and Coping strategy index (CSI). The collection of data through the survey concerned all the households of fishermen in the municipality.

The rest of the paper is organized as follows. In section 2, the material and methods are focused on the description of the study area, theoretical framework, data sources and analysis. Section 3 presents the results and discussion which show socioeconomic characteristics, food consumption, food expenses, coping strategies, and food security of fishermen's households. Section 5 concludes the paper.

2. MATERIAL AND METHODS

2.1 Description of the study area.

The study is conducted in the Pelengana municipality, which is in the Segou region, central Mali (Figure 1). This commune covers an area of 327,799 km². The climate is of Sudano-Sahelian type with maximum temperature around 44°C (April-May) a minimum temperature of 17°C (December-January). It is characterized by two seasons: a dry season that lasts eight months (October–May), and a rainy season that lasts four months (June–September). The average annual rainfall varies between 400 mm and 960 mm.

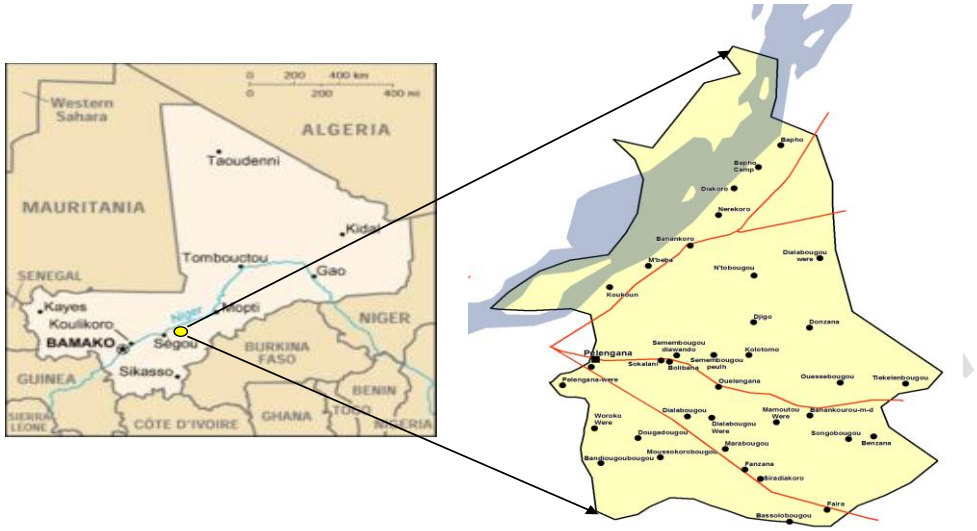

Figure1. Map of the study area

The municipality of Pelengana is limited to the north by the Niger River which offers important fishing resources to the population estimated at 78,943 inhabitants with a density of 241 inhabitants/km² in 2020. Fishing is a predominant activity in the villages located along the Niger River. It is a source of income and contributes to the food and nutritional security of the population. Secondary activities include agriculture and animal husbandry.

2.2 Theoretical framework

The most common definition of food security food is when all people at all times have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life [23]. It is based on consensus pillars which are: food availability (supply and production), food access (economic and physical), food utilization (use), and food stability (consistency). However, there are several indicators for assessing food security at the household level [24,25]. These indicators are not always consistent within and between research institutions and international development organizations depending on areas of studies [26,27,28].

In Sub-Sahara the most frequently used indicators to measure households food security are focused on household food insecurity access scale[29,30], household hunger scale [31], household food security survey module [32], household pulse survey [28], household dietary diversity scores [33,34], household consumption and expenditure surveys[24,35], months of adequate food provisioning [36], food adequacy questionnaire [36], food consumption score [37,33,38], food insecurity experience scale [39], measures the severity of food insecurity in population [28], household dietary diversity score [40], calorie adequacy indicator [24], coping strategy index [38,32], food consumption score [39], food security index [41,42,43]. In previous studies, indicators are jointly used taking into account not only their advantages and weakness but also food security multi-dimensions [36,44,45,41,46,47]. For example, [46] applied the household food Insecurity access scale, Dietary diversity score (DDS), and Coping strategies index [38] to measure household food security in Taraba State, Nigeria. Food security index, Coping strategy index, Food consumption score and Food expenditure share to investigate food security [48,49,50,51].

For this study, we use the Consolidated Approach for Reporting Indicators of Food Security (CARI) developed by the World Food Program (WFP) to analyze and report the level of household food security [52]. CARI is based on the food security index whose components are food consumption score, economic vulnerability, and coping strategy index (Figure 2).

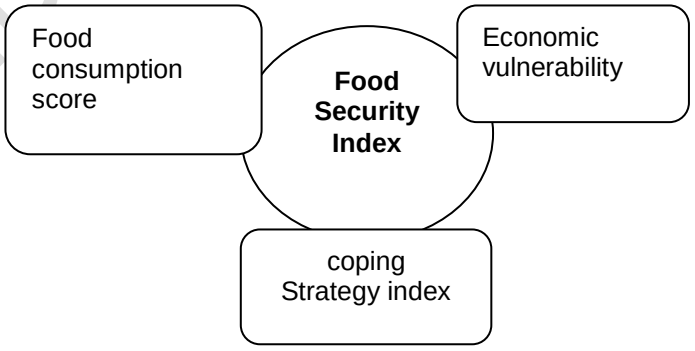

Figure 2. Theoretical framework of food security analysis

2.3. Sources of data

Data collection consisted of conducting household surveys in all the villages located along the Niger River in the municipality of Pelengana. This data collection concerned 6 villages: Diakoro, Bapho, M'Pèba, Banankoro, Nerekoro and Koukoun.

Data collection was carried out in two stages. The first step consisted of identifying all the households that practice fishing as their main activity with the support of the Ségou regional fisheries directorate. This census made it possible to count 213 fishing households. The second step was to conduct surveys of the households identified. These surveys of 204 households took place from August to September 2020; 9 households were unavailable during the survey period for social reasons (death, marriage, travel, etc.). They are concerned the socio-economic characteristics, production systems, food consumption, food sources, expenditures, incomes, and food adaptation strategies of fishing households.

Table 1. Surveyed fishermen

villages	**Fishing households enumerated**	**Fishing households surveyed**	**Fishing households were absent during the survey**
Banankoro	71	69	2
bapho	42	39	2
Diakoro	12	12	0
Koukoun	29	26	2
M'Peba	22	21	1
Nerekoro	38	37	1
Total	**213**	**204**	**9**

2.4. Data analysis

The analysis consisted of processing data collected from fishing households. It is based on a Consolidated approach to reporting indicators of food security (CARI) guidelines [53]. Three-component indicators of the Food security index (FSI) are considered: food consumption score, economic vulnerability, and coping strategies [54].

The status of food security is determined by Food Consumption Score (FCS) through the frequency of consumption of the eight food groups consumed during the last seven days preceding the survey by households. Those eight food groups include cereals and tubers, legumes, vegetables, fruits, meats and fish, milk, sugar, and oil (Table 1). The food frequency was measured as the number of days a particular food group consumed in the previous seven days. And then multiplying the value obtained for each food group by its weight. The FCS was computed by summing up the items of the consumption frequency of each food group and its corresponding weight. Households were classified according to their FCS score into three categories [52]: poor consumption (FCS=1.0 to 28); limit (FCS= 28.1 to 42); and acceptable consumption (FCS ≥ 42.0).

The formula used to determine this indicator is:

$$FCS_j = \sum_{i=1}^{8} a_i * X_{i,j} \quad (1)$$

Where a_i is the weight of each food group i and X_i is the frequency of consumption of food (number of days that household members have eaten the food item i during the past 7 days).

Table 2. Food groups and nutrition weights

No.	Food groups	Weight
1	Cereals and tubers	2

2	Pulses and nuts	3
3	vegetables	1
4	Fruits	1
5	meat and fish	4
6	sugar and honey	0.5
7	Oil, fat, and butter	0.5
8	dairy products	4

Economic vulnerability (EV) is measured through the proportion of the household budget devoted to food taking into account other needs which are health, education and other expenses [55]. Food expenditure share (FES) is determined by Total expenditure (TE). Index of vulnerability to food security (IVFS) is given by the equation (2):

$$EV_i = \frac{FES_i}{TE_i} \quad (2)$$

A household is in a situation of food security, borderline food security, moderate food insecurity and severe food insecurity when the share of the budget devoted to food is respectively less than 50%, between 50% to 65%, 65% to 75% and greater than 75% [56].

The coping strategy index (CSI) assesses the frequency of occurrence of increasingly severe coping strategies which are the behaviors households engage in when they cannot access enough food. These strategies are classified into three groups, organized in ascending order according to the intensity of their effect on livelihoods and asset depletion: stress, crisis, and emergency (Table 2). Stress strategies indicate a diminished capacity to face crises in the future due to the current reduction of resources or increase in debts. Crisis strategies directly reduce future productivity, including human capital formation. In addition to affecting future productivity, emergency strategies are irreversible and indicate the depletion of household resources. Households that do not carry out any of the afore mentioned

strategies are$CSI_{s,i}$households with food security. Those who apply stress strategies are households with marginal food security, those who use crisis strategies are in moderate food insecurity, and those who use emergency strategies are severely affected by food insecurity. It is important to clarify that, according to this methodology, each household is classified according to the most severe coping strategy reported.

Table 3. Livelihood coping strategy to ensure food secure.

Categories	**Livelihood coping strategy**
Stress strategies	Using credit for buying food
	Borrowing money for buying food
	Buying foods daily
	Expend savings for buying food
	Extension of breastfeeding period to children
Crisis strategies	Food barter
	Sending household members to eat at community kitchens
	Diminishing education and health expenses
	Selling household goods
	Selling productive assets
	Selling household cars
	Looking informal jobs
	Working with payments in foods

Emergency strategies	Selling house or lands
	Remove children from school
	Taking risky jobs
	Begging for money on the streets
	Looking for leftovers within the garbage

The Food Security Index (FSI) is obtained by combining the three indicators evaluated: food consumption score, economic vulnerability, expressed by the proportion of spending on food, and livelihood coping strategies, which are round to the nearest integer. The index offers four categories according to the score: Food Security (FS), Marginal Food Security (MFS), Moderate Food Insecurity (MFI) and Severe Food Insecurity (SFI).

Food Security index (FSI) is based on an algorithm focused on FCS, EV, and CSI. It is calculated following equation [56]:

$$FSI_i = \frac{FCS_{s,i} + \frac{VFS_{s,i} + CSI_{s,i}}{2}}{2} \quad (3)$$

Households are classified in four categories: in Food Secure ($FSI \leq 1.5$), Marginally Food Secure ($1.5 < FSI \leq 2.5$), Moderately Food Insecure ($2.5 < FSI \leq 3.5$), Severely Food Insecure ($FSI > 2.5$).

3. RESULTS AND DISCUSSION

3.1 Socio-economic characteristics

The analysis of socio-economic characteristics focused on sex, matrimonial status, households' size, organization, categories of fishers, agriculture, and livestock practices (Table 4). The results show that surveyed sample of fishermen is constituted by men which

57.6% of them are married. Other fishermen (42.4%) are single and divorced. In fisheries, several activities are divided according to gender. Men ensure fishing through canoes while women are more involved in fish transformation, conservation, and trading [57,58].This social division of fishing activities explains why women are absent in the surveyed sample. More than 90% of women are engaged in post-harvest processing [4]. Cultural norms around gender are barriers for women involved in fisheries [59].

Table 4. Socio-economic characteristics

Socio-economic characteristics	**percent**	**Average**	**Standard-deviation**
sex			
Man	100		
Women	0		
Age		46	14
Marital status			
No	42.4		
Yes	57.6		
Household size		9	6
organization			
Yes	59.1		
No	40.9		
Fishermen categories			
Sedentary	53.2		
Migrant	46.8		
Agriculture practice			

No	46.3
Yes	53.7
Livestock practice	
No	67.0
Yes	33.0

The fishermen old are of 46 years average with households' size of 9 persons. They are categorized into two groups. The sedentary and migrant fishermen are 53.2% and 46.3%, respectively (Table 4). The migrant are fishermen who are moved outside their village and Pelengana municipality along Niger river to practice fishing. Agriculture and livestock are practiced by 53.7% and 33% of fishermen, respectively, as secondary activities. This diversification of activities is a climate adaptation strategy for fishermen [18] and a way for income generation [60].

3.2. Food consumer sources

Table 5 shows the sources of fishermen households' food consumption. Markets are main sources of fishermen's food. Overall, surveyed sample fishermen households' purchase 90.7% of consumed food at market. The food produced by fishermen covers 3.6% of their consumption. Also, the fisheries and hunting contribute to 4.1% of fishermen food consumption. Specifically, the market provided 80% cereal and grains for consumption of fishermen. It is contributing more than 86% to other food consumption, excepted fisheries and hunting which is provided to 65.2 % by fisheries and hunting. Captured fish is priority for household self-consumption [35]. Fish is not only a source of dietary energy (calories) and just protein but also high in essential vitamins and minerals [12]. After taking the share of fish for self-consumption, but the fishermen also sell the excess fish [8,60]. Women ensure selling fish in the villages, municipal market, and market in the town of Segou. They use

income from fish to purchase other foods like cereal, grain, tubers, fruits, sugar, etc. Their food security depends on income from fish trading [10].

Table 5. Food consumption sources

Foods	own production	Fishing/ Hunting	Picking	Market (purchase with cash)	Market (purchase on credit)	Barter work or goods for food	Donations from family members or friends
Cereals and tubers	9.8	0	0.0	89.3	0.3	0.8	0.0
Pulses and nuts	2.5	0	0	95	0.5	2	0
vegetables	5.0	0	1.0	93.3	0.3	0.4	0.1
Fruits	3.0	0	0.8	94.6	0.5	0.3	1.0
Mat and fish	2.0	81.1	0.0	15.9	0.4	0.3	0.3
Sugar and honey	0.0	0	0.0	99.5	0.5	0.0	0.0
Oil, fat, and butter	0.0	0	0.0	99.5	0.5	0.0	0.0

Dairy products	2.0	0	0.0	97.5	0.5	0.0	0.0
Mean percent	3.0	10.1	0.2	85.6	0.4	0.5	0.2

3.3. Food expense assessment

The table 6 shows expenses of fishermen for food, health, education and other (transport, communication,). These expenses are estimated at 738.6 USD/fishman. Food and heath expenses represent 32.4% (239.1 USD/fishermen) and 8.5% (62.5 USD/fishermen), respectively of all expenses. With a share of 57.1%, other expenses are more than cumulative expenses of food, education, and health. However, food supply charges represent more than third of household's expenses. It means that food access is a priority for fishers' households in inland developing countries[61].This is supported by the previous study done by [60] who find that 86% of fishermen income are for food purchase. These findings are in line with several previous studies [9]. Women are responsible for fishermen to manage households' expenses [62].

Table 6 Fishermen's household expenses

Expenses	**FCFA**	**USD**	**percent**
Food	143,073.0	239.1	32.4
Heath	37,405.7	62.5	8.5
Education	9,035.7	15.1	2.0
Other	252,333.8	421.8	57.1
Total	441,848.2	738.6	100

3.4. Food coping strategies

The analysis indicates that the majority (51.2%) of fishermen households are livelihood coping strategies for food security (Figure 3). Households in stress, crisis and emergency

are 42.9%, 3.9% and 4.4% respectively. Households are 48.8% without coping strategies. These findings show heterogeneity of fishers' households coping strategies depending on their adaptation capacities to food security [63,64].

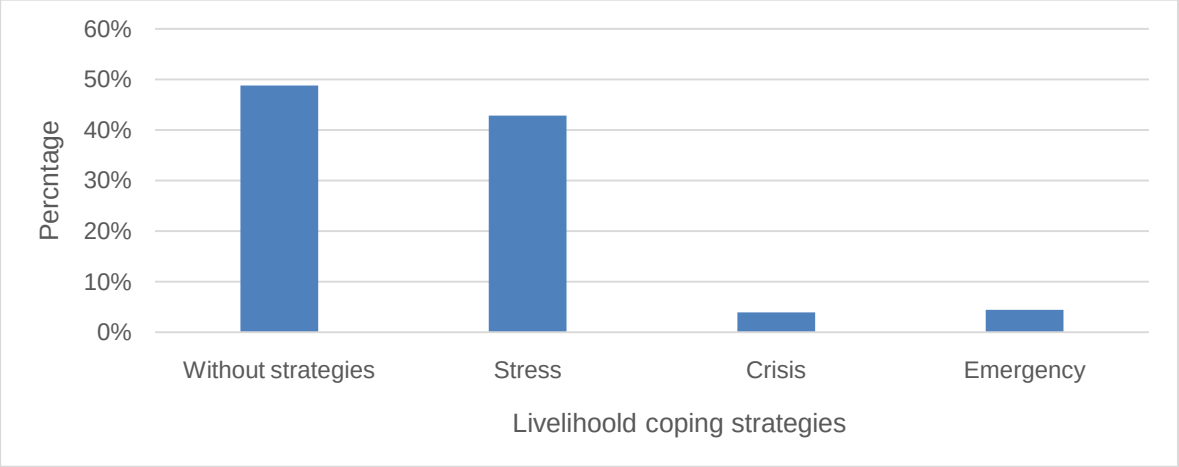

Figure 3. Food coping strategies

The fishermen have several coping strategies for food security (Table 7). The stress strategies are sold household assets/goods (25.1%), Send members of the household to eat elsewhere (13.8%), sold more animals (non-productive) than usual (12.3%), spend savings for buying foods (9.4%) and borrowing money for buying foods (1%). As crisis strategies, fishermen households sold productive goods or means of transport (19.2%), reduce non-food expenditures on health and education (18.7%) and removed children from school (14.3%). According to emergency strategies, they mended (24.1%), sold house and lands (15.3%) and last female animals (11.3%). The analysis reveals that dominant coping strategies adopted by fishermen are selling household assets (stress strategy), products goods (crisis strategy) and mendicity (emergency strategy).This is in agreed with the previous states which indicated that coping strategies include sold livestock, labor job and migration [18,64].

Table7. Livelihood coping strategies.

Categories	Components of coping strategies	percent
Stress	Sold household assets/goods	25.1
	Expend savings for buying food	9.4
	Sold more animals (non-productive) than usual	12.3
	Send members of the household to eat elsewhere	13.8
	Borrowing money for buying food	1.0
Crisis	Sold productive goods or means of transport	19.2
	Removed children from school	14.3
	Reduce non-food expenditures on health and education	18.7
Emergency	Selling house or lands	15.3
	Mended/begging	24.1
	Sold the last female animals	11.3

3.5. Households' food security

The results of fishermen's households' food security analysis are shown in table 8 The FSI results indicate that 90.1% of fishermen's households are food secure. Only 9.9% of them are marginal food secure. The food insecure does not exist within surveyed sample fishermen households. According to livelihood coping strategies, 48.8% and 42.9% of households are food secured and marginal food secured respectively. The severely food insecure impact 4.4% households and moderate food insecure concern 3.9% of them.

Economic vulnerability assessment show that 84.7% of surveyed fishermen households are food secure while 8.4% of them are marginal food secure. Moderate food insecure and severely food insecure affect 2% and 4.9% households respectively. For food consumption, 98.5% households are food secure. Food insecure touched 1. 5% fishermen households (1% moderate food insecure and 0.5% severely food insecure). The analysis of FIS, CSI, EV and FCS show the importance of inland water for fish supply for rural people [10,65]. Inland water provides over 40% of world's finfish production although it only covers less than 0.01% of the total volume of water on earth [7]. This production of inland water fish increased more than 60% from 1990 to 2020 given the growing demand for needs of the world's population, particularly in developing countries [3].

Table8 . Consolidated approach for reporting indicators of food security reporting console

Domain		**Indicator**	**Food safe (%)**	**Marginal food safe (%)**	**Moderate food insecure (%)**	**Severely food insecure (%)**
Current status	Food consumption	FCS	98.5		1.0	0.5
Coping capacity Food	Economic Vulnerability	EV	84.7	8.4	2.0	4.9
	Coping strategies index	CSI	48.8	42.9	3.9	4.4
Food security index		FSI	90.1	9.9	0	0

4. CONCLUSION

The present study highlighted the socioeconomic characteristics, food security status and coping strategies of fishermen households in inland fisheries, especially of Niger river in Pelengana municipality located in Mali center. The findings show that fishing is essentially practiced by men aged 46 years on average with 9 members in their households. Fisheries serve as a major source of food and mostly income for fishermen households for suppling food from local markets. Overall, fishermen households purchase 90.7% of consumed food at market with fishing's income. Market provided 80% cereals and grains for consumption of fishermen. It is contributing more than 86% to other food consumption, excepted fisheries and hunting which is provided to 65.2 % by fisheries and hunting. The analysis of FCS indicates that 98.5% of fishermen's households are food secured and 1.5% of them are food insecure and 0.5% severely food insecure. Economic vulnerability assessment show that 84.7% and 8.4% of surveyed fishermen households are food secured and marginal food secured, respectively. Only 6.9% households are in food insecure. The FSI results revealed that all fishermen's households are food secure.

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