



Faculty of Tropical
AgriSciences

Assessment of Home-Grown School Feeding Program on Nutrition Status, School Enrollment, Attendance and Performance of Public Elementary School Pupils in Nigeria

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- The school feeding program (SFP) is the world's largest social safety net reaching an estimated 388M children across 163 countries in the world ([WFP, 2020](#)).
- The SFP in Africa is estimated to feed more than 65M children across 39 countries out of which 9.8M pupils are from Nigeria ([World Bank, 2020](#); [AUDA-NEPAD, 2022](#)).
- In developed countries, SFPs are meant to combat the rise in overweight and obesity, while in developing countries are to address short-term hunger, improve nutrition, and improve school attendance among others ([Belot and James, 2011](#); [WFP, 2020](#)).
- Malnourished children have a weakened immune system, which makes them more susceptible to diseases and infections, affecting their school attendance rate ([Afridi et al., 2019](#); [Adelman et al., 2019](#)).
- Starvation may impair attention and motivation, while undernutrition at this age may impair cognitive abilities ([Afridi et al., 2019](#)), and school performance ([Adelman et al., 2019](#)).

- SFP serves as an instrument for supplementing pupils' nutritional status by supplementing the few meals they eat at home ([WFP, 2021](#); [Bundy et al. 2019](#)).
- School meals provide a predictable outlet for local farmers to sell their products, resulting in a stable income, higher productivity and improved food security status ([WFP, 2021](#); [Gelli et al. 2019](#)).
- One specific benefit of SFP is job creation, as local communities are employed as cooks ([Soares et al., 2017](#); [Singh and Fernandes et al., 2018](#)).
- Nigeria SFP is referred to as the National Home-grown school feeding program launched in 2016 ([WFP, 2019](#); [WFP and Anthrologica, 2018](#)).
- The program also collaborates with 150,000 smallholder farmers and 107,550 caterers (food vendors) who are hired to cook for the pupils ([WFP, 2019](#); [NHGSFP, 2020](#)).

STATEMENT OF PROBLEMS

- Boko Haram has killed 2,295 teachers and destroyed 1,400 schools in North-East Nigeria.
- These attacks exacerbated the number of out-of-school children to 10.5M ([UNICEF, 2021](#))
- The Northern region of Nigeria has a high prevalence of stunting among children ([NPC and ICF, 2019](#)).
- Percentage of primary school enrollment, attendance rate and performance are poor in the northern part of Nigeria ([World Bank and UNESCO, 2021](#)).
- Food insecurity is most severe in Nigeria's northern region ([UNICEF, 2021](#)).

OBJECTIVES

The research assesses the effect of the home-grown school feeding program on pupils' nutrition status, school enrollment, attendance and performance in public elementary schools in Nigeria:

- A. Analyse the effect of a school feeding programme on pupils' child nutritional status.
- B. Assess the effect of the SFP on pupils' school enrollment, attendance and performance.
- C. Analyse the effect of homegrown school feeding programme on smallholder farmers' household food security status.
- D. To determine the food safety knowledge, attitude and practice of the food vendors.

STUDY AREA

Assessment of Home-Grown School Feeding Program on Pupils' Nutrition Status, School Enrollment, Attendance and Performance in Public Elementary Schools in Nigeria

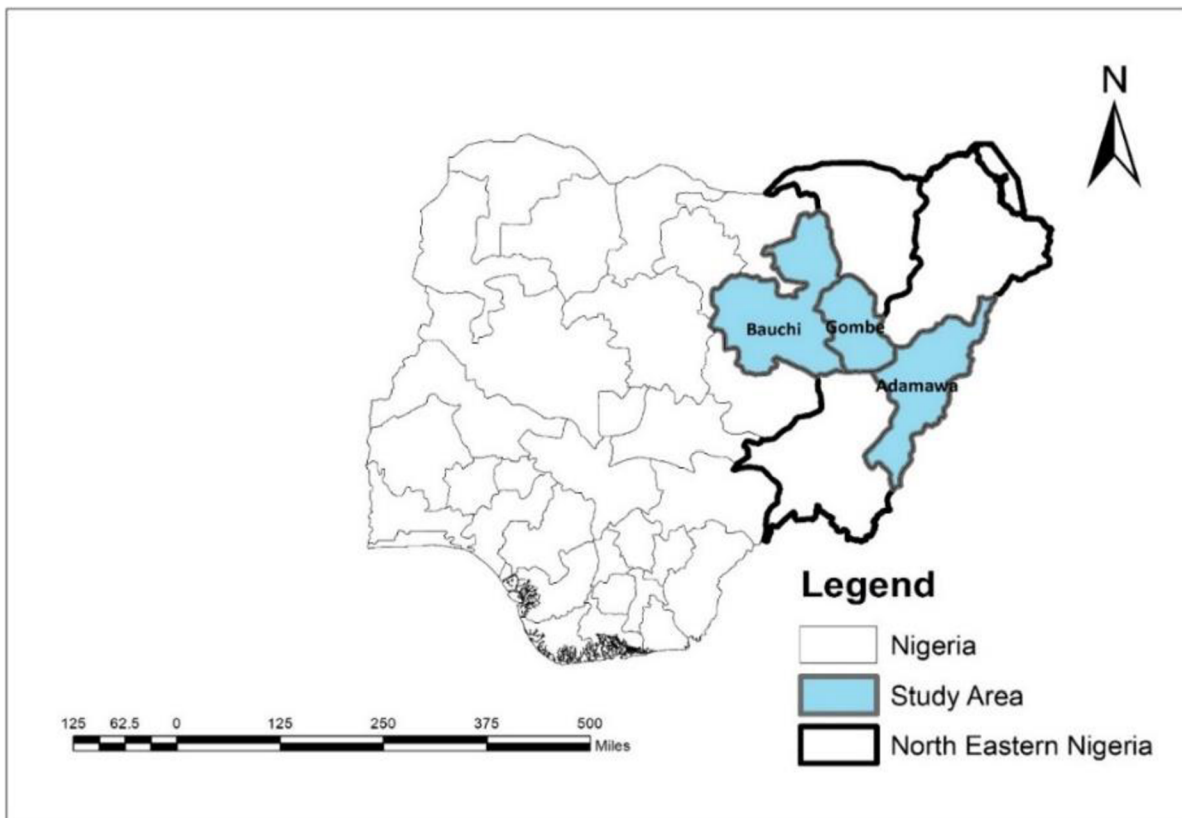


Figure 1: Map of Nigeria showing the study sites

- Nigeria's population was 213 million in 2021.
- Northeast region pupation of 27,558,674 (NBS,2020).
- Nigeria has 10.5 million out-of-school children, 60% of whom live in the northeast.
- 1.74 million people suffer moderate acute malnutrition
- 614,000 children under the age of five suffer from severe acute malnutrition (UNICEF, 2021).
- Majority 60% of the population is highly vulnerable to food security (NBS,2020; WFP, 2020a),

RESEARCH DESIGN

Assessment of Home-Grown School Feeding Program on Pupils' Nutrition Status, School Enrollment, Attendance and Performance in Public Elementary Schools in Nigeria

Indicator/Respondents	Teachers	Pupils	Smallholder farmers	Food vendors
Target group	Teachers in schools the benefiting SFP	Beneficiaries and non-beneficiaries' pupils of SFP	Smallholder farmers linked to caterers under the SFP	Vendors cooking food for pupils benefiting the SFP
Period of survey	November 2020 – February 2021	November 2020 – February 2021	December 2020 – February 2021	December 2020 – February 2021
Type of data	Cross-sectional data			
Sampling procedure	Multi-stage sampling technique	Multi-stage sampling & Systematic random sampling	Multi-stage sampling technique	Multi-stage sampling technique
Sample size	180 teachers (60 primary schools)	780 (600 beneficiaries and 180 non-beneficiaries)	240 smallholder farmers	240 food vendors
Data collection	Face-to-face interview & structured questionnaire administration using kobotoolbox web application			
Econometric approach	Linear regression model	Linear regression, PSM, IPWRA and ESR models	Linear regression, PSM, IPWRA and ESR models	Linear regression and correlation analysis

SFP: School feeding programme, **PSM:** Propensity score matching, **IPWRA:** Inverse Probability Weighted Adjusted Regression, **ESR:** Endogenous switching regression.

Study one: Analyse the effect of a school feeding programme on pupils' child nutritional status.

- **Sample size:** 780 pupils (600 beneficiary and 180 non-beneficiary).
- 60 public primary schools and 9 community primary schools.

Objectives

- Determine the factors affecting pupils' dietary diversity score, BMI-for-age and height-for-age.
- Analyse the effect of SFP on pupils' dietary diversity scores, BMI-for-age and height-for-age.
- Determine the effect of the duration of the SFP on pupils' nutritional status.

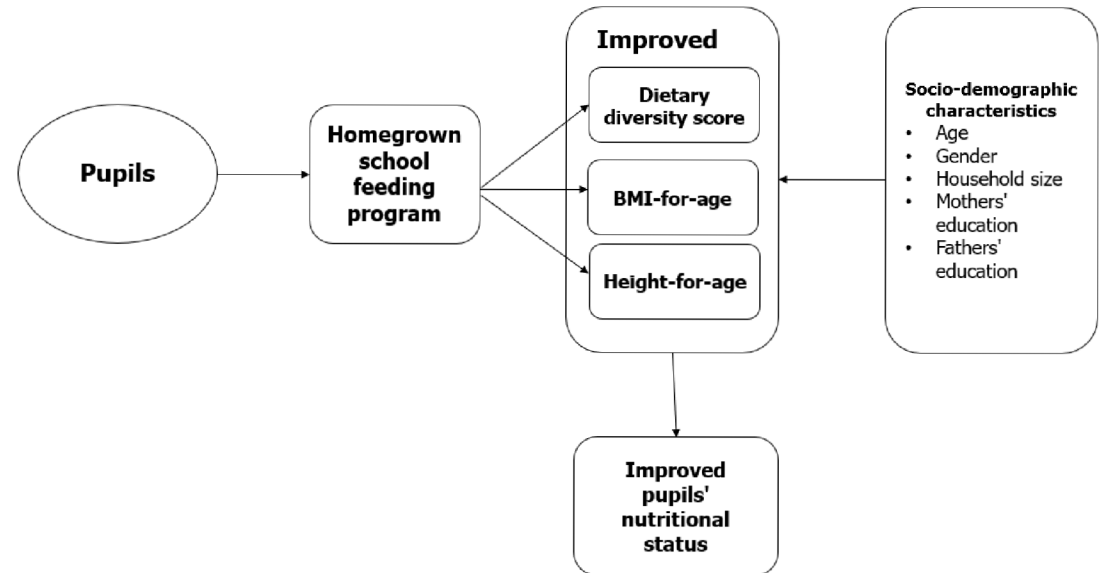


Figure 2: Conceptual framework on the effect of HGSP on pupils' nutritional status

Table 2 Description of variables in Linear regression, PSM, IPWRA and ESR models (n = 780)

Variables	Description	Mean	Std. Dev.	Min	Max
<i>Dependent variables</i>					
Dietary diversity score (DDS)	Number of classes of food consumed within 24 hrs.	5.65	1.855	1	11
BMI-for-age	z-score value from each child	-0.49	1.132	-4.72	2.29
Height-for-age	z-score value from each child	-1.20	1.202	-4.45	2.66
<i>Independent variables</i>					
SFP	Beneficiary =1, non-beneficiary =0	0.77	0.422	0	1
<i>Demographic information of pupils</i>					
Age of pupils	Age of pupils in months	106.37	20.964	60	156
Gender	Male = 1, female = 0	0.50	0.500	0	1
Household size	Number of persons in household	8.44	3.538	1	40
Mothers' education	Quranic/non formal= 1, Primary =2, Secondary= 3, NCE/Diploma = 4, Graduate= 5	2.38	1.028	1	5
Fathers' education	Quranic/non formal= 1, Primary =2, Secondary = 3, NCE/Diploma = 4, Graduate= 5	2.83	1.062	1	5
Pupil weight	Weight measured in kilogram (kg)	24.70	4.567	13.8	53.8
Pupil height	Height measured in centimeters (cm)	124.44	8.767	102	160

Table 3 Factors affecting pupils' Dietary diversity scores, BMI-for-age and Height-for-age index

Variables	Dietary score	diversity BMI-for-age	Height-for-age index
<i>National safety net programme</i>			
SFP	2.218 (0.149)***	-0.545(0.113) ***	0.521 (0.111)***
<i>Demographic characteristics</i>			
Age (in months)	-0.001(0.003)	-0.004 (0.002)**	-0.027 (0.002)***
Gender	0.036 (0.115)	-0.079 (0.077)	-0.191(0.076)**
Household size	-0.012 (0.018)	-0.035 (0.012)***	-0.013 (0.012)
Mothers' education	0.300 (0.083)***	0.239 (0.056)***	-0.066 (0.055)
Fathers' education	-0.035 (0.079)	-0.155 (0.053)***	0.080 (0.053)
Constant	3.579 (0.366)	0.035 (0.260)	1.801 (0.257)
F-value	0.000	0.000	0.000
R ²	0.258	0.106	0.227
Adjusted R ²	0.252	0.098	0.220
Observation	780	780	780

SFP: School feeding programme, *** 1% level of significance; **5% level of significance; *10% level of significance
Standard errors are reported in parentheses

Table 4 Effect of School Feeding Programme on pupils' nutritional status

Variables	Average Treatment Effect on the Treated (ATT)		
	PSM	IPWRA	ESR
	1	2	3
Dietary Diversity Score	1.938*** (0.129)	1.722*** (0.264)	0.897*** (0.042)
BMI– for-Age	-0.715*** (0.156)	-0.339* (0.171)	-1.143*** (0.029)
Height-for-Age	0.240* (0.220)	0.092* (0.164)	0.146*** (0.055)
N	780	780	780

PSM: Propensity score matching, IPWRA: Inverse Probability Weighted Adjusted Regression, ESR: Endogenous switching regression, ATT: average treatment effect on the treated: Robust standard errors are reported in parentheses, α level of significance; 0.01 = ***; 0.05 = **; 0.1 = *

Table 5 ANOVA Result of the Effect of SFP Duration

Groups A	Group B	DDS	Height-for-age	BMI-for-age
16-24 months	Control	2.797***	0.146	-0.393***
	< 8 months	0.127	1.363***	0.418**
	8-15 months	0.376***	0.650*	0.132

Source: Own survey 2021, *** 1% level of significance; **5% level of significance; *10% level of significance, DDS: dietary diversity score

Second study: Assess the effect of the SFP on pupils' school enrollment, attendance and performance.

- **Sample size:** 180 Teachers
- From 60 schools across 3 states

Objectives

- Analyse the effect of a school feeding program on pupils' school enrollment, attendance, and performance.
- Determine the effect of the duration of the feeding program on pupils' academic performance.

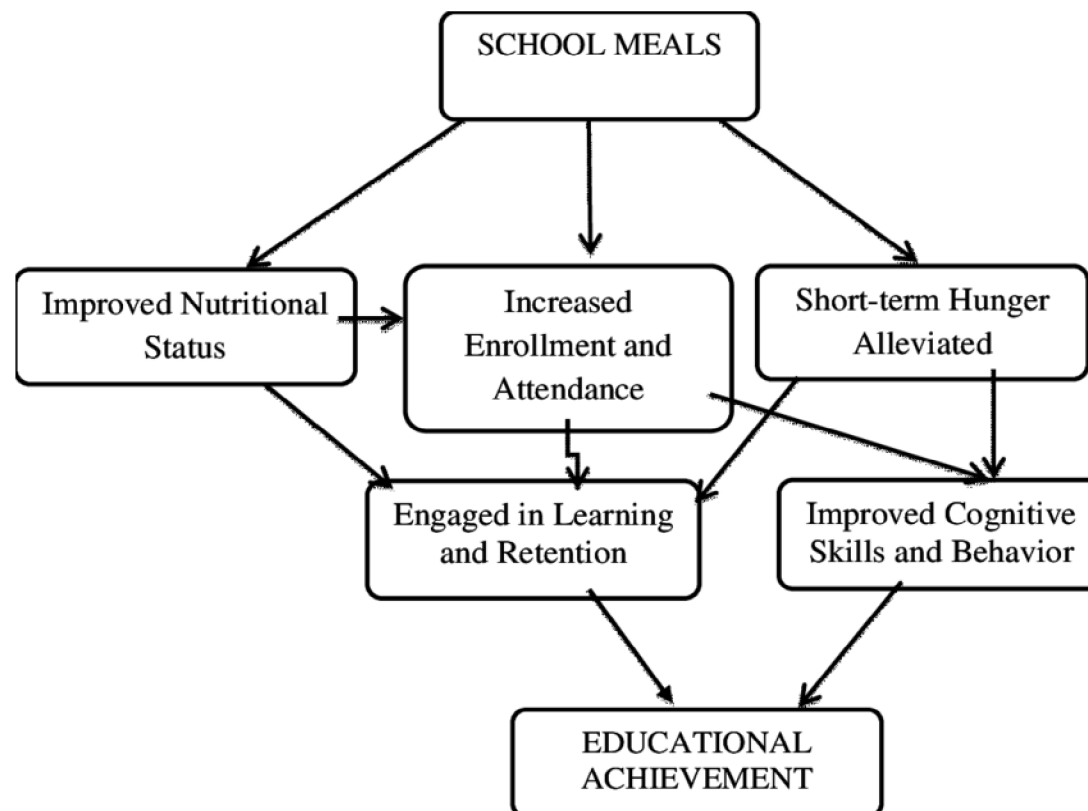


Fig 3 Conceptual framework for SFP on educational achievement



Table 5 Description of variables in the linear regression model

Variables	Description	Mean	Std. Dev.	Min	Max
<i>Dependent Variables</i>					
Math score	Math score measured on a point scale of 0-100	48.77	9.357	15	66.5
English score	English score measured on a point scale of 0-100	48.21	8.533	15	68
<i>Teachers' characteristics</i>					
Gender	Male = 1, female = 0	0.572	0.496	0	1
Age	in years	41.21	8.139	26	55
Teaching experience	years of teaching experience	15.73	7.094	2	30
Graduate education	Graduate=1 others=0	0.233	0.424	0	1
Postgraduate	Postgraduate=1 others=0	0.039	0.194	0	1
<i>School characteristics</i>					
Duration of the SFP	Months	15	2.971	8	24
Teachers' pupils' ratio	Number of pupils per teacher in a school	33.78	14.81	7.69	66.66
Pupils in a class	Number of pupils in a class	64.05	18.72	35	120
Average school attendance boys	% of school attendance in 100 days	90.34	2.321	88	100
Average school attendance girls	% of schools attendance in 100 days	89.4	3.176	85	100

Table 6 Effect of School Feeding Program on Educational Performance (n=180)

Variables	Items	Mean (SD)	t-value	p-value
Net school enrollment rate (%)	Before	73.38 (18.53)	-19.75	0.000**
	After	93.59 (23.07)		
Total net attendance rate (%)	Before	70.58 (17.59)	-15.75	0.000**
	After	90.86 (21.91)		
Math score ¹	Before	46.98 (8.42)	-3.82	0.000**
	After	48.78 (9.36)		
English score ¹	Before	46.53 (8.19)	-4.05	0.000**
	After	48.21 (8.53)		

** Significant at 0.05; Paired-sample t-tests; ¹measured on a scale 0-100 points.

²The net enrollment rate = students enrolled who are of the official age group for a given level of education / the population for the same age group (UIS, 2011). ³Total net attendance rate = the total number of students in the official school-age range for the given level of education attending school at any level of education/population of the same age group (UIS, 2011).

⁴Grade 1-3 means from primary one to three participating classes. ⁵The performance in Math and English were measured by points on a scale 0-100.

Table 7 Linear regression on factors affecting pupil's educational performance

Variables	Performance English*		Performance Math*	
	Coefficient	p-value	Coefficient	p-value
Teachers' characteristics				
Age of the teacher	-0.022	0.810	0.173	0.076
Gender of the teacher	-4.034	0.004	-3.688	0.014
Graduate	7.091	0.001	8.277	0.000
Postgraduate	1.599	0.610	2.623	0.441
School characteristics				
Teacher pupil's ratio	0.039	0.400	0.019	0.704
<i>Duration of the feeding program</i>	0.863	0.001	0.682	0.013
Number of pupils in a class	-0.127	0.003	-0.108	0.018
Average school attendance boys	-0.398	0.000	-0.331	0.000
Average school attendance girls	0.362	0.001	0.302	0.007
(constant)	44.958	0.000	38.951	0.000
F-value		4.412		4.897
R ²		0.189		0.206
Adjusted R ²		0.146		0.164

Source: Own Survey *Performance in English and Math for grades 1-3, measured on a scale 0-100 points.

Third study: Analyse the effect of HGSF on smallholder farmers' household food security status

- **Sample size:** 240 smallholder farmers

Objectives

- Analyse the effect of farmers' access to credit on their food security status.
- Analyse the effect of linking farmers to caterers and processors on smallholder farmers' household food security status.
- Determine the factors affecting smallholder farmer household food security status.

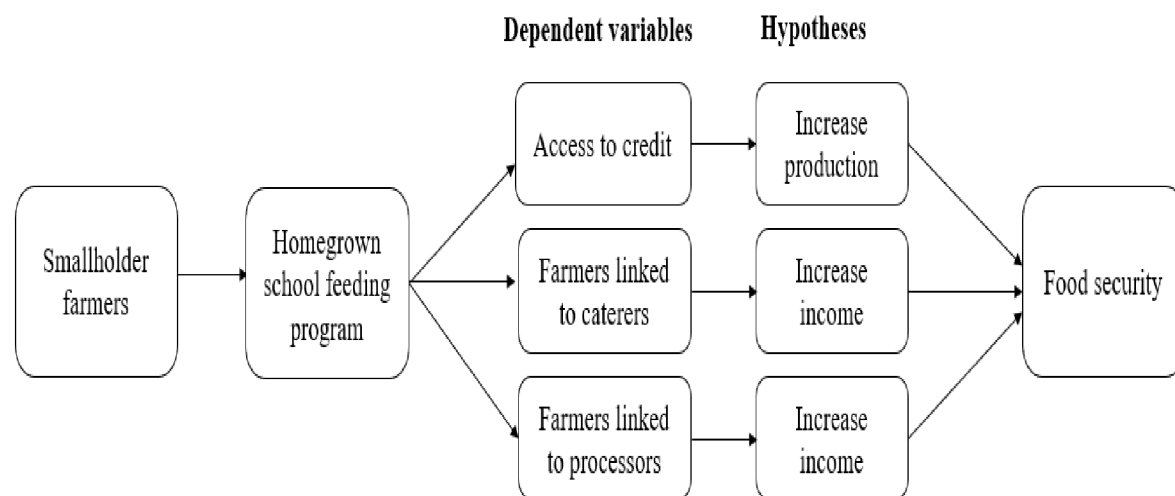


Figure 7 Conceptual framework linking smallholder farmer to HGSF on their household food security

RESULTS

Table 24 Factors affecting level of food security – results of probit model

Variables	Coefficient	Std. Err.	P-value	Marginal Effect
<i>Household Head Characteristics</i>				
Age	-0.047	0.005	0.043	-0.010
Gender	0.185	0.049	0.443	0.038
Marital Status	0.050	0.079	0.896	0.010
Years of farming experience	0.021	0.005	0.365	0.005
Educational qualification	0.088	0.143	0.188	0.019
<i>Household characteristic</i>				
Household size	0.048	0.008	0.188	0.010
<i>Homegrown School Feeding Program instruments</i>				
Access to HGSF credit (Fund)	0.195	0.054	0.435	0.042
Farmers link to caterers	0.619	0.421	0.015	0.102
Farmers link to processor	1.061	0.379	0.001	0.130
Household with children benefiting SFP	-0.026	0.052	0.914	-0.006
<i>Institutional characteristic</i>				
Access to extension service delivery	0.464	0.077	0.090	0.115
Access to input subsidy	0.548	0.073	0.062	0.136
Access to market information	1.147	0.314	0.234	0.374
Membership in cooperative society	0.687	0.240	0.408	0.199
Number of observations	240			
Constant	-1.975	0.965	0.041	
LR Chi (14)	21.52		0.089	
Pseudo R ²	0.103			

HGSF: Homegrown school feeding program, SFP: school feeding program

Table 25 Effect of access to credit, farmers link to caterers and farmers link to the processor on household food security status.

Variables	Average treatment effect on the treated (ATT)		
	PSM	IPWRA	ESR
	1	2	3
Access to credit	4.931** (1.997)	3.258** (1.582)	5.554*** (0.476)
Farmers link to caterers	1.660 (3.000)	1.721 * (1.498)	19.998*** (1.232)
Farmers link to processor	1.176* (3.693)	0.825 * (1.983)	9.910*** (1.502)
N	240	240	240

PSM: Propensity score matching, IPWRA: Inverse probability weighted adjusted regression, ESR: Endogenous switching regression, ATT: average treatment effect on the treated, FCS: Food consumption score, Robust standard errors are reported in parentheses, α level of significance; 0.01 = ***; 0.05 = **; 0.1 = *

Source: Authors' estimations

Fourth study: To determine the food safety and handling knowledge of the caterers (food vendors).

- Sample size 240 food vendor

Objective

- Determine the food safety knowledge, attitude and practice of food vendors engaged in the SFP.
- Analyse the factors affecting food vendors' food safety knowledge, attitude and practice?

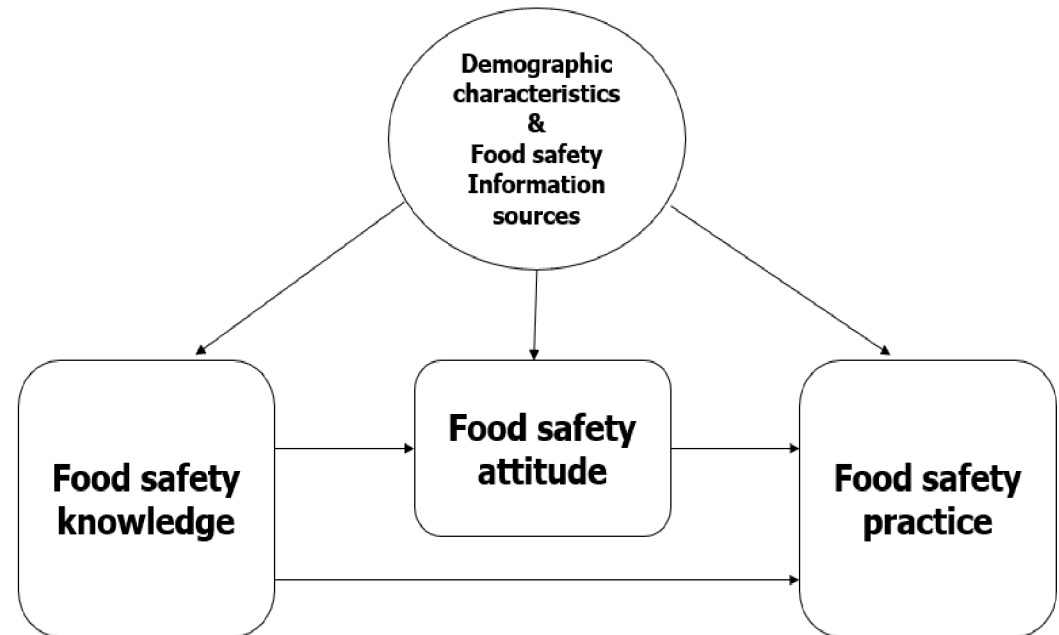


Figure 4 Conceptual framework of food safety knowledge, attitude, and practice shows the model through which practices can be changed.

Table 29 Multiple Linear Regression of the food safety KAP scores of food vendors in Northeastern Nigeria (n=240)

Variables	Food safety knowledge		Food safety attitude		Food safety practice	
	Coefficient	Std. Err.	Coefficient	Std. Err.	Coefficient	Std. Err.
<i>Socio-demographic characteristics</i>						
Age	-0.027	0.023	0.240	0.079***	-0.057	0.085
Gender	0.727	0.644	4.388	2.173**	3.774	2.337
Household size	0.030	0.038	-0.284	0.129**	-0.132	0.139
Food vending experience (years)	-0.001	0.027	0.165	0.091*	0.243	0.098**
Education qualification	0.051	0.026**	-0.017	0.087	-0.096	0.094
Food vending profit	0.000	0.000	0.000	0.000	0.000	0.000
<i>Food safety information sources</i>						
Food handling training	0.328	0.298	-0.902	1.003	-0.036	1.079
Radio	0.578	0.318*	2.195	1.077**	1.581	1.158
Television	0.676	0.269**	-0.582	0.918	0.220	0.987
Food inspection institution	0.653	0.243***	1.540	0.831*	3.148	0.893***
Social media	-0.454	0.438	2.504	1.478*	0.448	1.589
Friend & colleagues	0.117	0.448	-2.823	1.505*	-2.201	1.619
Internet	0.501	0.324	2.530	1.094**	3.057	1.176**
Food safety knowledge			0.181	0.224	0.168	0.241
Constant	8.189	0.787	23.426	3.219	28.291	3.462
F-value	0.050		0.000		0.000	
R-square	0.092		0.244		0.165	

*** 1% level of significance;
**5% level of significance;
*10% level of significance

- The SFP was revealed to improve pupils' nutritional status, by increasing their DDS and Height-for-age, while it reduces their BMI-for-age.
- Similarly, the feeding program improved pupils' school enrollment, attendance rate and academic performance.
- There is strong evidence that the impact of the SFP increases with the increase in the duration of the program (improvement in DDS, Height-for-age, BMI-for-age and academic performance).
- Linking smallholder farmers with caterers and processors were found to improve smallholder farmer household food security.
- The findings revealed that food vendors who acquire access to food safety information through a food inspection institution have a positive influence on their food safety knowledge, attitude, and practice.

- The study indicates SFP improved pupils' nutritional status, as such, continuing the programme for a longer time will significantly increase the desired effects.
- The effects of COVID 19, climate change, and recently the global political crisis, on food security are expected to exacerbate food insecurity in Northeast Nigeria ([FAO, 2021](#); [WFP, 2020a](#); [UNICEF, 2020a](#)), making SFPs an essential safety net for young cohorts.
- The duration of the feeding programme was found to have a positive effect on the academic performance of the pupils in English and Mathematics, which revealed school SFP improved academic performance. It can be thus expected that prolonging the school feeding programme will further improve the academic performance of pupils.
- The link between farmers, caterers, and processors will increase the value chain, providing a reliable market for the farmer's product and thus improving household food security.
- However, only 45% of the 240 smallholder farmers interviewed for the study were able to obtain credit, 15% were linked to caterers, and 5% were linked to processors. Indicating poor coordination in program implementation.

LIMITATIONS

- The study's limitation is the lack of baseline and recalls data, which is especially problematic when conducting surveys in conflict zones.
- The study lack home information on household income and wealth assessment which is important in assessing household food security status.
- The study did not evaluate the food quality (proximate analysis) provided to pupils through the SFP.
- Challenges of a poor access road.
- Threat of kidnapped has limited the study coverage.

- Assessment of the effect of school feeding programmes on child nutritional status in a conflict region of Northeastern Nigeria (**Under Review**).
- Effect of School Feeding Program on Pupils' Educational Enrolment, Attendance, and Performance in Northeastern Region of Nigeria (**Under Review**).
- The Effect of Migration and Remittances on Household Food Security in Northern Nigeria (**Submitted**).
- Access to food vs. education - why feeding the stomach is important for feeding the mind (**Ready for Submission**).
- Food safety knowledge, attitude and practices of food vendors in school feeding programs in developing countries: Evident from Nigeria (**Ready for Submission**).
- Impact of Homegrown School Feeding Program on Smallholders' Farmer Household Food Security in Northeastern Nigeria (**Work in Progress advance stage**).
- Child Labour Market and Working Hours: Refugee and non-refugee children working the streets in Nigeria (**Rejected**).
- Relationship Between Heat Stress Perception and Adaptation Strategies of Poultry Farmers in Bauchi State, Nigeria (**work in progress**).

ACKNOWLEDGEMENTS

Assessment of Home-Grown School Feeding Program on Pupils' Nutrition Status, School Enrollment, Attendance and Performance in Public Elementary Schools in Nigeria



THANK YOU FOR LISTENING



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Appendix A1. Socio-demographic characteristics between the beneficiary and non-beneficiary pupils

Variables	Beneficiary pupils (n=600) Mean ± S.D.	Non beneficiary pupils (n=180) Mean ± SD	Mean difference	t-statistics
Age in months	110.10 (21.00)	93.93 (15.31)	16.17***	9.59
Gender	0.50 (0.50)	0.50 (0.50)	0.00	0.00
Household size	8.52 (3.58)	8.20 (3.39)	0.32	1.05
Dietary diversity score	6.13 (1.76)	4.02 (1.09)	2.12***	15.31
Height-for-age	-1.21 (1.24)	-1.18 (1.07)	-0.03	0.26
BMI-for-age	-0.60 (1.100)	-0.12 (1.15)	-0.48***	-5.10
Weight of pupils (kg)	24.75 (4.94)	24.54 (3.01)	0.21	0.54

Source: Own survey 2021, *** 1% level of significance; **5% level of significance; *10% level of significance, Standard deviations are reported in parentheses

Appendix A2. Comparing socio-demographic characteristics between the beneficiary and non-beneficiary pupils

Variables	Beneficiary pupils (n=600)	Non-beneficiary pupils (n=180)	Chi-square value	Sig.
Mothers' education			30.74	0.112
Quranic/non-formal	28.83	27.22		
Primary	20.33	20.00		
Secondary	39.50	40.56		
NCE/Diploma	10.34	11.67		
Graduate	1.00	0.56		
Fathers' education			34.24	0.120
Quranic/non-formal	24.00	26.11		
Primary	12.67	11.44		
Secondary	49.00	50.22		
NCE/Diploma	8.83	7.22		
Graduate	5.50	5.01		

Source: Own Survey, 2021; Chi-square test/independent t-test

Appendix A3. Distribution of pupils according to international nutritional status cutoffs (Children 5-19 years)

Anthropometric Indicator	Condition	Z-score	Beneficiary pupils (n=600)	Non-beneficiary pupils (n=180)
Height-for-age	Severe stunting	< -3 SD	7.2	6.1
	Moderate stunting	≥ -3 to < -2 SD	19.7	15.6
	Normal	≥ -2 SD	73.2	78.3
BMI-for-age	Severe thinness	< -3	2.8	2.2
	Moderate thinness	≥ -3 to < -2	7.0	5.0
	Normal	≥ -2 to ≤ +1	84.5	76.1
	Overweight	> +1 to > +2	5.5	15.0
	Obesity	>+2 to >+3	0.2	1.7

Source: Own survey, 2021

Appendix A4. Description imported into the multiple linear regression model (N = 240)

Variables	Description	Mean	Std. Dev.	Min	Max
<i>Dependent variables</i>					
Food safety knowledge	Food safety knowledge score	8.82	1.96	2	12
Food safety attitude	Food safety attitude score	34.51	7.21	8	40
Food safety practice	Food safety practice score	33.04	7.37	9	45
<i>Socio-demographic characteristics</i>					
Age	Number of years	35.20	8.68	20	58
Gender	0 = Female and 1 = Male	0.04	0.20	0	1
Household size	Number of people in the house	7.60	3.48	1	27
Food vending experience	Years in food vending business	10.90	7.29	1	30
Education qualification	Years of education	7.70	5.27	0	15
Food vending profit	Amount of profit made (Naira) ^a	8031.25	3378.20	2000	20000
Food handling training	Yes =1 No = 0	0.30	0.46	0	1
<i>Food safety information sources</i>					
Radio source	Yes =1 No = 0	0.78	0.42	0	1
Television source	Yes =1 No = 0	0.61	0.50	0	2
Food inspection institution	Yes =1 No = 0	0.32	0.47	0	1
Social media	Yes =1 No = 0	0.10	0.31	0	1
Friend & colleagues	Yes =1 No = 0	0.10	0.31	0	1
Internet	Yes =1 No = 0	0.21	0.41	0	1

Appendix A5. Relationship between food safety knowledge, attitudes and practices.

Variables	Mean	Std Err.	FSK	FSA	FSP
Food safety knowledge (FSK)	8.816	1.960	1.000		
Food safety attitude (FSA)	34.513	7.205	0.064	1.000	
Food safety practice (FSP)	33.04	7.374	0.090	0.450***	1.000

Correlation *** 1% level of significance, FSK: Food Safety Knowledge, FSA: Food Safety Attitude, FSP: Food Safety Practice

Appendix A6. Description of variables in probit regression model (n = 240)

Variables	Description and measurement	Frequency (%) (Yes)	
<i>Dependent variable</i>			
Food security indicators			
Food consumption score	0 = poor and borderline (up to 35), 1 = acceptable (>35)	NA	NA
<i>Independent Variables</i>			
<i>Household head characteristics</i>			
Age	Age of household head (years)	Mean = 42.09 (8.48)	
Gender	Male = 1, Female = 0	161	67.1
Marital status	Married = 1, unmarried = 0	213	88.8
Years of Farming experience	Farming experience in years	Mean = 17.67 (8.91)	
Educational qualification	Quranic Edu. = 1, primary = 2, secondary = 3, NCE = 4, graduate = 5, postgraduate = 6	Mean = 2.83	
<i>Household characteristics</i>			
Household size	The household size in numbers	Mean = 7.94 (3.88)	
<i>Homegrown school feeding program instruments</i>			
Access to HGSF credit (Fund)	Yes = 1 No = 0	109	45.4
Farmers linked to caterers	Yes = 1 No = 0	36	15.0
Farmers linked to processor	Yes = 1 No = 0	12	5.0
Households with children benefiting from HGSF	Yes = 1 No = 0	146	60.8
<i>Institutional variables</i>			
Access to extension services	Yes = 1 No = 0	43	17.9
Access to input subsidy	Yes = 1 No = 0	84	35.0
Access to market information	Yes = 1 No = 0	102	42.5
Member of cooperative society	Yes = 1 No = 0	52	22.5

APPENDIX

Appendix A7. Endogenous switching regression results of the effect of SFP participation on pupils' BMI-for-age

Variables	Effect of SFP on Pupils BMI-for-age					
	SFP		SFP beneficiaries		SFP non-beneficiaries	
	Status					
	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
Age in months	0.022	0.004***	-0.011	0.002***	-0.011	0.006*
Gender	-0.053	0.121	-0.021	0.089	-0.217	0.173
Mothers' education	-0.713	0.105***	0.363	0.060***	0.377	0.253
Fathers' education	0.602	0.100***	-0.236	0.060***	-0.308	0.235
DDS	0.511	0.046***				
Constant	-3.984	0.481***	0.594	0.305*	0.708	0.603
/lns1	0.116	0.033***				
/lns2	0.132	0.055*				
/r1	-0.936	0.168***				
/r2	-0.182	0.176				
sigma_1	1.123	0.036				
sigma_2	1.141	0.063				
rho_1	-0.733	0.078				
rho_2	-0.180	0.171				
Log likelihood	-1404.50					
Wald test χ^2 (4)	55.92					
LR test of independent equations χ^2 (1)	31.74 ***					

Appendix A8. Average Expected Effect of SFP on Pupils BMI-for-age; Treatment and Heterogeneity Effects

Sub-samples	Decision stage		Treatment effect
	Beneficiaries	Non-beneficiaries	
SFP Beneficiaries' pupils	-0.606 (0.014)	0.537 (0.024)	TT= -1.143*** (0.029)
SFP Non-beneficiaries' pupils	-0.670 (0.015)	-0.120 (0.014)	TU=-0.543*** (0.029)
Heterogeneity effects	BH ₁ =0.064	BH ₂ =0.657	TH=-0.600***

BH_i: the effect of base heterogeneity for beneficiary pupils (i = 1), and non-beneficiaries (i = 0)

Appendix A9. Endogenous switching regression results of the effect of SFP participation on pupils' height-for-age

Variables	SFP Status		Effect of SFP on Pupils' height-for-age			
	Coefficient	Std. Err.	SFP beneficiaries		SFP non-beneficiaries	
			Coef.	Std. Err.	Coef.	Std. Err.
Age in months	0.024	0.004***	-0.028	0.002***	-0.006	0.006
Gender	-0.052	0.125	-0.169	0.087*	-0.191	0.160
Mothers' education	-0.761	0.109***	-0.140	0.059**	-0.065	0.239
Fathers' education	0.668	0.103***	0.156	0.059***	0.099	0.224
DDS	0.510	0.047***				
Constant	-4.222	0.457***	1.659	0.306***	-0.441	0.567
/lns1	0.071	0.032				
/lns2	0.056	0.056				
/r1	0.523	0.165				
/r2	0.194	0.181				
sigma_1	1.074	0.034				
sigma_2	1.057	0.059				
rho_1	0.480	0.126				
rho_2	0.192	0.174				
Log-likelihood	-1389.38					
Wald test χ^2 (4)	173.09					
LR test of independent equations χ^2 (1)	11.23 ***					

Appendix A10. Average Expected Effect of SFP on Pupils height-for-age; Treatment and Heterogeneity Effects

Sub-samples	Decision stage		Treatment effects
	Beneficiaries	Non-beneficiaries	
SFP Beneficiary pupils	-1.204 (0.027)	-1.350 (0.044)	T=0.146*** (0.055)
SFP Non-beneficiary pupils	-1.034 (0.008)	-1.179 (0.014)	TU=0.145*** (0.016)
Heterogeneity effects	BH ₁ = -0.170	BH ₂ = -0.171	TH=0.001***

BH_i: the effect of base heterogeneity for beneficiary pupils (i = 1), and non-beneficiaries (i = 0)

Appendix A11. Endogenous switching regression results of the effect of SFP participation on pupils' DDS

Variables	Effect of SFP on Pupils DDS					
	SFP Status		SFP beneficiaries		SFP non-beneficiaries	
	Coefficient	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
Age in months	0.027	0.004***	0.003	0.004	0.010*	0.006
Gender	-0.139	0.125	0.047	0.140	0.178	0.156
Mothers' education	-0.610	0.115***	0.256	0.101**	-0.283	0.221
Fathers' education	0.556	0.107**	0.005	0.096 *	0.167	0.212
Distance to school	0.001	0.002***				
Constant	-11.907	1.079***	4.119	1.746	4.209	1.674
/lns1	0.544	0.034				
/lns2	0.013	0.053				
/r1	0.431	0.192				
/r2	-0.026	0.232				
sigma_1	1.723	0.058				
sigma_2	1.013	0.054				
rho_1	0.406	0.161				
rho_2	-0.026	0.232				
Log likelihood	-323.26					
Wald test χ^2 (4)	45.03					
LR test of independent equations χ^2 (1)	31.74 ***					

Appendix A12. Average Expected Effect of SFPs on Pupils DDS; Treatment and Heterogeneity Effects

Sub-samples	Decision stage		
	Beneficiaries	Non-beneficiaries	Treatment effects
SFP Beneficiary pupils	6.135 (0.020)	5.238 (0.037)	T=0.897*** (0.042)
SFP Non-beneficiary pupils	4.342 (0.019)	4.017 (0.028)	TU=0.325*** (0.038)
Heterogeneity effects	BH ₁ = 1.793	BH ₂ = 1.221	TH=0.572***

Appendix A13. Endogenous switching regression results in the effect of access to credit on the household food security status

Variables	Effect of credit access on household food security					
	Credit Status		Access to credit		No-access to credit	
	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
Age	0.022	0.022	-0.386	0.196**	-0.156	0.218
Gender	-0.116	0.211	2.811	2.173	-1.128	2.003
Household size	0.015	0.037	0.893	0.302***	-0.591	0.389
Years of experience	-0.015	0.022	-0.085	0.191	0.210	0.220
Education qualification	0.619	0.079***				
Access to input subsidy	-0.771	0.268***				
Farmers link to processors	0.688	0.418*				
Constant	-3.127	0.852***	41.064	6.132***	45.647	5.997***
/lns1	2.275	0.082***				
/lns2	2.354	0.062***				
/r1	-0.695	0.223***				
/r2	0.032	0.266				
sigma_1	9.726	0.805				
sigma_2	10.531	0.651				
rho_1	-0.601	0.142				
rho_2	0.032	0.265				
Log-likelihood	-1000.408					
Wald test χ^2 (4)	4.67					
LR test of independent equations χ^2 (1)	8.64***					

Appendix A14. The average expected effect of access to credit on smallholder farmer household food security status, treatment and heterogeneity effects

Sub-samples	Decision stage		Treatment effect
	Credit access	No-credit access	
Farmers with credit access	39.853 (0.344)	34.299 (0.319)	TT= 5.554*** (0.476)
Farmers with no credit access	32.706 (0.340)	31.741 (0.292)	TU=0.965*** (0.964)
Heterogeneity effects	BH ₂ =7.147	BH ₁ =2.558	TH=4.589***

BHi: the effect of base heterogeneity for beneficiary pupils ($i = 1$), and non-beneficiaries ($i = 0$)

Appendix A15. Endogenous switching regression results in the effect of linking farmers to caterers on smallholder farmer household food security status

Variables	Effect of farmers' link to caterers on household food security					
	Farmers status		Farmers link to caterers		Farmers not linked to caterers	
	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
Age	-0.011	0.010	-0.398	0.212*	-0.231	0.116*
Gender	-0.256	0.148*	-1.479	3.168	1.856	1.788
Household size	0.062	0.021***	0.850	0.498*	0.055	0.251
Access to extension service	0.246	0.172	-3.160	3.569	1.775	2.085
Education qualification	0.008	0.001***				
Market information	-1.452	0.069***				
Constant	0.937	0.341***	38.447	4.132***	46.149	7.782***
/lns1	2.496	0.047***				
/lns2	2.133	0.130***				
/r1	16.874	16.873***				
/r2	0.186	0.412				
sigma_1	12.132	0.573				
sigma_2	8.436	1.094				
rho_1	1.000	1.120				
rho_2	0.184	0.398				
Log-likelihood	-960.573					
Wald test χ^2 (3)	15.57					
LR test of independent equations χ^2 (1)	57.49 ***					

Appendix A16. The average expected effect of linking farmers to caterers on smallholder farmer household food security; treatment and heterogeneity effects

Sub-samples	Decision stage		Treatment effect
	Linked to caterers	Not linked to caterers	
Farmers linked to caterers	35.060 (0.160)	15.061 (0.920)	TT=19.998*** (0.541)
Farmers not linked to caterers	15.061 (0.907)	35.059 (0.160)	TU=-19.998*** (0.537)
Heterogeneity effects	BH ₂ =19.999	BH ₁ =-19.999	TH=39.998***

BH_i: the effect of base heterogeneity for beneficiary pupils (i = 1), and non-beneficiaries (i = 0)