Smallholder Farmers and Sustainability Issues: the Case of Fadama III Sub-Projects in Bayelsa State of Nigeria

M. K. Hamadina
Biogeochem Associates Ltd.
P. O. Box 11960, Port Harcourt, Nigeria
m.hamadina@biogeochem.com

E. I. Hamadina
Department of Crop & Soil Science
University of Port Harcourt, Port Harcourt, Nigeria
elsieile@yahoo.com

***Abstract*—Fadama III is a rural development initiative targeting, amongst others, small holder farmers. It is a follow up of previous National Fadama Development Projects, and it is implemented in all but one state of Nigeria. This study covered 5 out of the 8 local counties (known as local government areas, LGAs) of Bayelsa State. This study addressed the social and environmental sustainability of Fadama III projects in the Niger delta, using Bayelsa state as a case study. The study aimed at evaluating the social and environmental status of Fadama III in Bayelsa state, determining compliance with best practices; and suggesting measures to guarantee sustainability. Although there were no detectable adverse effects of the Fadama III sub-projects on the social and environmental settings of the beneficiary localities, there are salient issues that can mar the long-term sustainability of Fadama III. The conceptualization and implementation of rural development programs like Fadama III need improvement. The peculiarities of the smallholders need to be identified and contextualized in the formulation of similar projects in the future, and adequate budget should be provided to fund measures that guarantee sustainability.**

Keywords—smallholder farmer, social and environmental sustainability, rural development

I. INTRODUCTION

As an emerging economy with a population in excess of 160 million people, i.e., 20% of Africa's population, Nigeria is undoubtedly a potential super power in Sub-Saharan Africa [1]. Nigeria is known for its vast oil and gas resources, however, agriculture had always been the main stay of Nigeria's economy, and accounted for most of its gross domestic product, until recent years [1]. However, agriculture is mostly practiced at subsistence level with little or no mechanization and the farm size is usually less than 2 hectares, thus, the bulk of the farmers are smallholders [1]. Nigeria has been battling with efforts to boost agriculture through various programs. One of such interventions is the Fadama project, which is being implemented, with funding provided by the International Development Agency (IDA), a member of the World Bank Group [2]. The word Fadama was adapted from Hausa language, and it means a piece of low-lying land with shallow aquifer level [3].

The Fadama III is a follow up of National Fadama Development Project II, which itself resulted from the first Fadama project [4]. As a result of Fadama project, rural smallholder farmers in Nigeria are said to have earned about 60% higher income [3, 5, 6]. The main aim of Fadama III is to increase the income of rural people through the use of land and water resources on a sustainable basis, thereby reducing rural poverty, increasing food security and contributing to economic growth [4]. To ensure sustainability, the Fadama III sub-projects needed to be implemented in a socially inclusive and environment-friendly manner, in compliance with relevant operational policies of the World Bank Group and applicable extant national laws. This required that, the implementation of the project imbibed all the appropriate mitigations for envisaged adverse impacts [7]. Thus, an important feature of the Fadama III program is that it incorporates the concept of social and environmental sustainability. The potential social and environmental impacts of the entire project cycle have been identified and mitigation and management measures for ensuring sustainability considered in the design and implementation of the project [7]. Specific management plans covering critical aspects such as pest management, social and environmental management and involuntary resettlement has been incorporated into Fadama III program. The Fadama III program is implemented in 35 out of the 36 states, and the Federal Capital Territory, of the Federal Republic of Nigeria [3].

Bayelsa State is geographically located in the River Niger delta at the southern tip of Nigeria (Fig. 1). The area is characterized by low-lying swampy terrain, humid climate, and vegetated by freshwater and mangrove rainforests. Rainfall is heavy and lasts between March and November, with a short dry season in between. The southern parts of the state lie mostly below sea-level, except for a few elevated sections, while its northern fringes are above sea level and cultivated with food and cash crops [8]. Bayelsa is a major oil and gas bearing area and it is home to the first commercial oil well in Nigeria, but the major occupations of locals include fishing, farming, palm oil milling, and cassava processing.

In order to ascertain the compliance of the Fadama III intervention in Bayelsa State to the requirements for social inclusion and environmental protection, selected subprojects were evaluated across Bayelsa. The reference points for determining compliance were the World Bank policies and extant environmental requirements in Nigeria. Also, this study evaluated the projects with respect to principles of clean production, social inclusion, and waste management strategies. Environmental risks of the operations of Fadama III sub-projects were assessed; and the overall compliance or otherwise, to social and environmental safeguards were determined and corrective actions identified for non-compliance. Therefore, the main objectives of the study include: 1) to evaluate the social and environmental status of the Fadama III sub-projects in Bayelsa, 2) determine compliance with requirements for environmental best practices; and 3) proffer possible solutions to identified issues. This study covered 5 out of the 8 local counties (known as local government areas, LGAs) of Bayelsa State. In each of the LGAs studied, sub-projects were selected for social and ecological assessment.

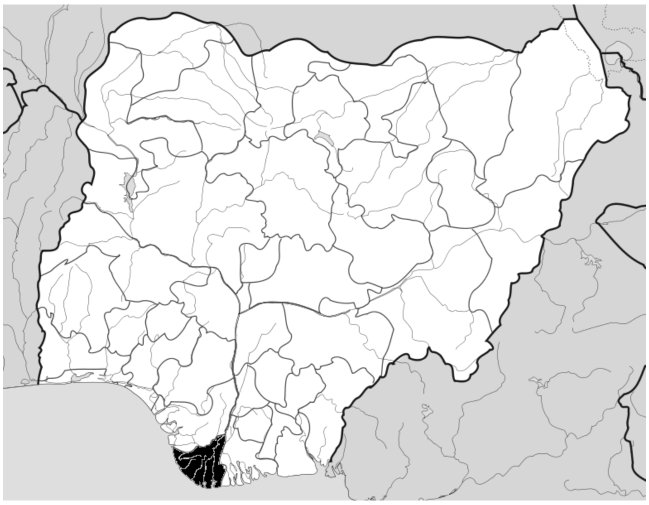

Fig. 1. *Map of Nigeria Showing Bayelsa State*

(Source: http://en.wikipedia.org)

II. Study Methodology

A. *Study Approach*

The study approach involved a salad of methods, including desktop review of relevant documents, e.g., social and environmental safeguards of the World Bank, documents containing concepts and strategies for the Fadama III program, and management plans meant to ensure compliance, especially the environmental and social management plan (ESMP). This was followed by field data gathering and discussions with beneficiary smallholder farmers. Ambient air quality indicator parameters were tested in the field using handheld equipment while soil and water samples were taken for laboratory analysis of relevant aspects, while unstable water quality parameters were tested in situ. During the field data gathering, selected Fadama user groups (FUGs) or subprojects operators were interviewed to gain information about their knowledge, attitude and practice with respect to sustainability issues.

B. *Analytical Methods*

In situ air quality parameters were determined using portable digital gas detectors thus: CO, H2S, and CH3 were tested using Ventrix MX4®; NOx, and SOx using MX6®, and suspended particulate counts were obtained using digital particulate counters. In situ water testing was done for pH (digital pH Meter), ORP (Hanna®), and TDS, Salinity, Conductivity, and Temperature (Bante® 531) DO (Milwakee®), Turbidity, and Colour (Labtech®). Laboratory Analysis of soil and water samples: total N, mineral N using Kjeldahl distillation, organic matter based on Walkley and Black Method [9], TSS by filtration and weighing. Anions (nitrate, sulphate and phosphate) were determined using Spectrophotometry, while cations and heavy metals were determined using Atomic Absorption Spectrophotometry.

III. The Fadama III Sub-Projects in Bayelsa

The implementation of the Fadama III project is done through community associations called Fadama Community Associations (FCAs). Each FCA comprises of end-user groups called Fadama User Groups (FUGs), which is made up of clusters of entities engaged in related activities, i.e., the FUGs implement the subprojects, i.e., the thematic area of intervention. Across the eight LGAs in Bayelsa, there are 95 FCAs comprising of 1,156 FUGs, implementing subprojects that include fishing/aquaculture, fish processing, arable crop farming, agro-processing, artisanal groups, and trading associations [8]. This study, however, focuses on farming and agro-processing subprojects, which are the subprojects that involve the bulk of smallholder farmers, since the agro-processors use products from smallholder farmers.

A. *The Farming Sub-projects*

In the upland areas of Bayelsa, farming is the predominant occupation of the rural communities, and the farmers grow various crops, prominent amongst them are cassava and plantain (both are included in subprojects of Fadama III in Bayelsa State). The basic activity of cassava farming starts with land preparation which precedes the planting of cassava. Thereafter, other activities include routine husbandry operations such as weeding, pest control, fertilization (not applied in most cases in Bayelsa State, except basal NPK) and tendering the plants until maturity, which takes roughly one year. At harvest, the cassava roots are harvested for processing as '*garri'*, starch or *Loyi-Loyi* (a local staple in Bayelsa state), and *kpokpo garri* (a snack). Apart from water which is being supplied by rain, material inputs into cassava farming subproject include labour (mostly manual), planting materials, herbicides, and pesticides. The wastes generated in the process of cassava farming include waste plant materials, weed biomass, waste herbicides, pesticides and their containers [8].

For plantain farming, suckers are planted after initial land preparation, and thereafter, regular weed, pest and disease control measures are employed until harvest. In addition, organic materials are added as mulches around the plantain plants. When established, the plantain does not necessarily need much input, except occasional pruning, weed control and possibly staking of fruit-bearing suckers, to protect them from being lodged by wind. At harvest, the fruit-bearing mother stem is harvested by felling it down, i.e., after cutting off the fruit bunch, leaving the daughter suckers to grow into the next cropping cycle. After harvesting the fruits, the daughter suckers are tendered and/or pruned, as needed, to avoid crowding in the subsequent crop cycle. Similar to cassava farming, the inputs for plantain farming comprise of planting materials, herbicides, and pesticides, while wastes generated include unwanted plant materials, as well as excess herbicides and pesticides [8].

B. The Agro-Processing Sub-projects

In garri processing, the chain comprises of the inputs, the process itself, and the wastes. The inputs are the cassava tubers, which are peeled, washed, and then grated using small diesel powered machines [8]. The grated cassava is then squeezed to remove excess water it is fry-dried, before sifting and bagging as garri (local staple).

Edible starch processing follows the same steps with that of garri, but after dewatering of the grated cassava, fresh water is added to extract edible starch by 'washing out' the starch. The process of making *Fufu* (also called *Loyi-Loyi*) is similar to that of edible starch, but instead of extracting the starch, the grated cassava is soaked in water and left to ferment. The fermented product is washed thoroughly and pounded to *Fufu* or *Loyi-Loyi*.

The major inputs in cassava processing operations include cassava (raw material), labour (manual and mechanical), water, fuel (usually diesel), grease, lube oil, firewood, and sacks, while wastes include cassava peels, leachate, emissions, spent oil and grease, chaff, charcoal and gaseous emissions. Wastes generated during edible starch processing include cassava peels, wastewater, as well as spent engine oil/grease and gaseous emissions from the small grating machines.

IV. Relevant Social and Environmental Status

A. Socio-Economic Setting

Smallholder Livelihood: Bayelsa is an admixture of rural and urban setting, with Yenagoa, the capital, being the most developed and cosmopolitan while other local government areas are more rural in nature with very poor infrastructure and low level of services. The urbanized status of Yenagoa has attracted people from other tribes, while other local governments areas are composed of predominately Ijaw tribe. More than half of the population of Bayelsa engages in some of artisanal fishing, but only a few fisher folks engage in fishing at sea, due to lack of appropriate resources. Second to fishing, farming is the most popular occupation practiced in most of the communities in Bayelsa State. Farming is usually practiced at subsistence level involving such crops as cassava, plantains, banana, yams, rice, vegetables, and oil palm. In recent periods, cassava is being produced on larger scale and processed into garri, starch and *Loyi-Loyi*. In general, income from farming is very low and there is general poverty amongst small holder farmers in Bayelsa. The Fadama III project, amongst other poverty reduction initiatives, was devised to improve the income of the people and alleviate their standards of living [8].

Infrastructure: The bane of Bayelsa State is the dearth of adequate infrastructure despite efforts by successive governments at local, state and federal levels. Most of the state is covered in swamp, with no roads linking 'island' communities, except in the upland areas; but even at that, the roads are mostly narrow and dilapidated. Heavy rains and flash floods are often cited as the main problem hindering road construction and maintenance in Bayelsa state.

Until recently, such 'island communities' like Nembe, Brass, and Ekeremor can only be accessed using water crafts, which in Bayelsa are dominated by outboard engine boats, while in villages and hamlets within the swampy areas, only small canoes are available. The attendant high cost of transportation affects prices of commodities in Bayelsa state, which in turn results in high cost of production that is disproportionately drastic on the smallholder farmers.

Energy source: Some parts of Bayelsa state such as Yenagoa, Ogbia, and Kolokuma/Opokuma LGAs are linked to the national electricity grid, while others are not and rely on small portable generators for their energy needs. Energy for cooking and other uses is gotten from firewood, which is often obtained from the surrounding forests. The use of firewood has been identified as a major environmental problem that leads to forest degradation in Bayelsa [10]. The national electricity grid is characterized by incessant power outages and poor quality, in terms of voltage and frequency, forcing Bayelsa inhabitants to rely on other sources for most of the time. The only exceptions are communities that are serviced by gas turbines provided by international oil companies where the electricity is of a better quality and supply is stable.

Source of water: Most of the Fadama III communities lack potable water supply, as there is general lack of potable water in Bayelsa state, despite the state being covered in swamps. For domestic use, or agro-processing, smallholder farmers rely on water from hand-dug wells, rain, rivers, or private tube wells. There are complaints of surface water sources being polluted by oil spills, raw sewerage and open defecation. Also, indiscriminate dumping of wastes directly into rivers and streams is common place and these render the surface water unfit for consumption.

B. Environmental Setting

Air Quality: The results of air quality testing within the immediate vicinity in the localities of selected Fadama III LGAs in Bayelsa State (Table I) show that the ambient air is within regulatory limits for the parameters tested. The total suspended particulate concentrations ranged from 68.1 to 116 µg m^{-3}, while the concentrations of carbon monoxide (CO), oxides of nitrate (NOx), oxides of sulfur (SOx) and methane (CH_4) were not detected. All the parameters were within air quality limits (Table II).

TABLE I. AMBIENT AIR QUALITY IN SELECTED LGAS

LGA	TSP	CO	NO_x	SO_x	CH_4
	-------------------µg m^{-3} -------------------				
Ogbia	89.5	<0.1	<0.1	<0.1	<50
Yenagoa	68.1	<0.1	<0.1	<0.1	<50
Ekeremor	78.2	<0.1	<0.1	<0.1	<50
KOLGA	78.2	<0.1	<0.1	<0.1	<50
Sagbama	116.4	<0.1	<0.1	<0.1	<50

TABLE II. NATIONAL AIR QUALITY STANDARDS [8]

	FMoE	WHO Standards			
	24-hour	1-hr	8-hr	24-hr	1-yr
	-------------------µg m^{-3} -------------------				
TSP	250	500	-	-	-
CO	1000-5000	30,000	10,000	-	-
NOx	4-100	200	-	-	40
SOx	50-500	-	-	125	50

Soil Characteristics: The results analysis of soils sampled from selected Fadama III sites show that the soils are acidic in nature (Fig. II), with soils under cassava being relatively more acidic (Sites A-C) than that cultivated with plantain (Sites D-J). The pH of surface soil under plantain was >4.5, while that of cassava field was <4.5. The subsurface soil pH followed a similar pattern with that of surface soil.

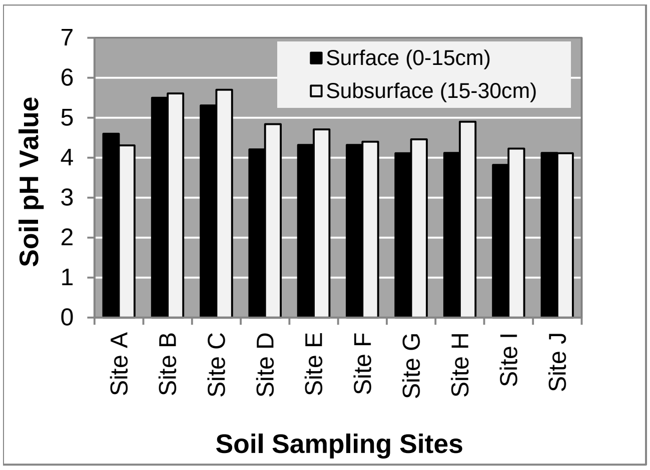

Fig. 2. *Soil pH on Plantain (A-C) and Cassava (D-J) Sites.*

Electrical conductivity values suggest appreciable soil moisture content, while the total N and organic matter suggests inherent low fertility. The total N % indicates the need for nitrogen fertilization to sustain continuous cropping, even with organic matter levels of 2.06-3.34% (Table III).

TABLE III. SOIL CONDUCTIVITY, NITROGEN AND ORGANIC MATTER

	EC		Tot. N		Org. Matter	
	----- µS cm^{-1} -----		------------------- % --------------			
Depth	15cm	30cm	15cm	30cm	15cm	30cm
Site A	263	481	0.08	0.07	2.92	2.99
Site B	1,844	2,683	0.10	0.06	2.34	3.30
Site C	1,621	1,842	0.09	0.08	3.34	2.60
Site D	341	884	0.11	0.10	3.37	2.29
Site E	1,884	1,889	0.10	0.08	2.73	3.22
Site F	336	492	0.11	0.10	2.58	2.48
Site G	334	846	0.11	0.10	2.92	2.27
Site H	487	921	0.10	0.07	2.06	1.69
Site I	601	643	0.10	0.09	2.67	2.58
Site J	842	753	0.11	0.10	3.34	2.60

The base cations concentrations of the soils (Table IV) show elevated concentrations of Ca, Mg and K, as compared to typical forest soils. However, it is within normal ranges for the 'meander belt' soils found in Bayelsa state [11].

TABLE IV. SOIL EXCHANGEABLE BASE CATION CONTENTS

	Ca		Mg		K	
	-------------------- meq 100^{-1} ---------------------					
Depth	15cm	30cm	15cm	30cm	15cm	30cm
Site A	1.72	1.79	0.20	0.53	1.32	0.92
Site B	1.94	0.64	0.50	0.23	1.60	1.76
Site C	0.66	0.91	0.36	0.54	1.60	0.80
Site D	0.96	1.55	0.95	0.34	1.00	1.76
Site E	1.90	1.46	0.98	1.10	0.88	0.99
Site F	1.78	1.71	0.80	0.49	0.88	1.17
Site G	1.81	1.82	0.17	0.30	0.99	0.80
Site H	1.49	1.02	0.30	0.94	1.32	0.99
Site I	1.67	1.78	0.36	0.21	1.17	1.60
Site J	1.78	1.71	0.80	0.49	0.88	1.17

Surface Water Characteristics: The results of surface water samples analyses show that natural surface waters within the vicinity of selected Fadama III sites were slightly acidic (Table V). The surface waters were freshwater, warm, with low total suspended solids contents, and carbonate concentrations of ≤0.1 mg l^{-1}. The total dissolved solids (TDS) and cations contents, as well as electrical conductivity values were within normal ranges expected (Table V).

TABLE V. PHYSICO-CHEMISTRY OF SURFACE WATER

	pH	EC	TDS	TSS	NO_3^-	CO_3^{2-}	Cl^-
		uS cm^{-1}	---------- mg l^{-1} -------------------				
Sample A	6.3	45.7	23.2	1.1	0.43	0.1	0.1
Sample B	6.0	52.5	26.1	1.4	1.02	0.1	0.1
Sample C	6.3	86.1	42.8	1.8	0.85	ND	0.3
Sample D	6.3	42.8	22.1	1.4	0.27	ND	0.2
Sample E	6.1	34.2	17.0	1.2	0.38	ND	0.2

V. SOCIAL AND ENVIRONMENTAL EFFECTS

A. Socio-economic Effects

The implementation of the Fadama III subproject presented the various participants with direct opportunities to improve their livelihood by increasing their skills to produce more efficiently and profitably. Fadama III participants in Bayelsa State have been empowered financially and technically through direct supply of inputs, financial grants, training, and advisory services.

There were no significant adverse social effects of the Fadama III subprojects on either the beneficiaries or non-beneficiaries. Nevertheless, a point of concern is the smoke generated during garri processing, which exposes the operators to air emissions, the effect of which might take a much longer time to manifest. Also, there is the issue of nuisance associated with odor from cassava processing, which is actually a non-issue to the local smallholder farmers, and they don't mind it, but bad odor could attract vermin.

B. Environmental Effects

There were no drastic negative environmental effects of the Fadama III subprojects on the biophysical environment. Nevertheless the effects associated with Fadama III, though insignificant, could cumulate with other impacts from unrelated projects (e.g., oil spills) to pose greater ecological threats.

These effects include the use of pesticides, insecticides and other agro chemicals, and wastes generated during crop production; which may find its way into the ecosystem and the food chain leading to bio-accumulation and biomagnifications. Another important aspect of cassava processing is the release of cyanide in the leachate during dewatering of grated cassava could be toxic to humans [11]. In addition, waste water from cassava processing also release unpleasant odor, which needs to be addressed.

Although field measurements show that ambient air quality are within acceptable limits, continuous exposure of personnel to smoke from firewood may lead to unpleasant effects in the long-term. Also, inefficient usage of firewood could exacerbate the threat posed by deforestation, especially if the Fadama III subprojects are 'scaled up' in the future.

VI. ENVIRONMENT AND SOCIAL MANAGEMENT

Like any other World Bank project, Fadama III considered social and environmental effects, including their mitigation and management through the entire project cycle. Following a comprehensive and thorough assessment, an environmental and social management plan (ESMP), pest management plan (PMP) and resettlement action plan (RAP) have been prepared and put in operation to manage social and environmental effects of Fadama III subprojects. Also, each Fadama III project is covered by a local development plan (LDP), with budgetary provisions for their implementation [8].

In general social and environmental management covered all the phases of Fadama III subprojects and responsibilities are properly defined. In terms of structure for social and environmental management, there are environmental officers or committees at every hierarchy of the Fadama III project. There are qualified Fadama III environmental officers at both national and state levels. These officers are seconded from the federal or state ministries of environment, as the case may be, and their duties specifically confined to social and environmental management. At the local government level down to community and user-group levels, there are committees that handle social and environmental issues and they relate directly to the state environmental officer.

VII. CRITICAL FADAMA III SUSTAINABILITY ISSUES

In the case of Bayelsa State, it appears that the Fadama III subprojects did not incorporate people's expectations and what motivates them. In a setting where the oil industry offers higher remuneration for a menial job than the income of most smallholder farmers, there is great need to re-orientate the local mindset, which is only possible following a thorough contextual understanding of the localities [2, 6, 12].

The Fadama III organization structure shows adequate institutional capacity to ensure sustainable implementation of the subprojects. However, what is doubtful is the level of commitment associated with Nigeria's bureaucratic setting, and paucity of budget allocated for implementing ESMP in the LDP [8]. Although Fadama III was formulated as a local community development intervention, there is dearth of local capacity to domesticate global concepts of sustainable development, and this blurs the path to sustainability.

Fadama III subprojects presented local folks the opportunity to improve upon their income by enhancing their productivity. However, it seems that Fadama III did not give much consideration to the socio-cultural peculiarities of Bayelsa: most smallholder farmers engage in multiple occupations and practice mixed cropping as a safety net against uncertainties. In contrast, Fadama III constrained the farmers to one user group, mostly engaged single-enterprise activity.

VIII. MEASURES FOR ENSURING SUSTAINABILITY

The formulation of the subprojects must ensure a ‘bottom up’ approach in the screening for social and environmental sustainability, in practice as it is in intent, to ensure social inclusion and adoption long after project closure. The opinions of the local people are heavily sought during environmental screening of the sub-projects. Also, local agricultural practices need to be identified and included in the integrated pest management plans for the Fadama IIII sub-projects.

There is need for a paradigm shift, for smallholder farmers to appreciate long-term goals of environmental management practices. The Fadama III end-users (FUGs) in Bayelsa seldom realize the benefits derivable from social and environmental sustainability. This scenario is worsened by inadequate provisions for ESMP (<5% of LDP budget), therefore, there is need to provide sufficient funding.

Sound waste management strategies based on principles of ‘reduce’, ‘reuse’, ‘recycle’ and where possible, ‘recover’ is needed throughout the Fadama III subproject cycle. The incorporation of the practice of organic manuring, or biogas production, for example could leverage the production efficiency of the subprojects.

Proper attention needs to be paid to housekeeping in agro-processing sub-projects. For instance, pest and odor control are very important as these affect not only food quality and acceptability, but also attract disease-spreading vermin. Similarly, there is need for control and monitoring of leachate from cassava processing for cyanide content, which could be controlled through proper fermentation [13].

IX. Conclusing Remarks

This study addressed the social and environmental sustainability of Fadama III sub-projects in the Niger delta state of Bayelsa as a case study. Although there were no detectable adverse effects of the Fadama III sub-projects on the social and environmental setting of the localities where they are sited, there is need to improve the conceptualization and implementation of local development programs targeting smallholder farmers. The peculiarities of the smallholders need to be identified and contextualized in the formulation of similar projects in the future, and adequate budget should be provided to fund measures that guarantee sustainability.

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