



INTERNATIONAL  
FOOD POLICY  
RESEARCH  
INSTITUTE

**IFPRI Discussion Paper 01418**

**February 2015**

**Communities' Perceptions and Knowledge of  
Ecosystem Services**

Evidence from Rural Communities in Nigeria

**Wei Zhang**

**Edward Kato**

**Prapti Bhandary**

**Ephraim Nkonya**

**Hassan Ishaq Ibrahim**

**Mure Agbonlahor**

**Hussaini Yusuf Ibrahim**

**Environment and Production Technology Division**

## INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE

The International Food Policy Research Institute (IFPRI), established in 1975, provides evidence-based policy solutions to sustainably end hunger and malnutrition and reduce poverty. The Institute conducts research, communicates results, optimizes partnerships, and builds capacity to ensure sustainable food production, promote healthy food systems, improve markets and trade, transform agriculture, build resilience, and strengthen institutions and governance. Gender is considered in all of the Institute's work. IFPRI collaborates with partners around the world, including development implementers, public institutions, the private sector, and farmers' organizations, to ensure that local, national, regional, and global food policies are based on evidence. IFPRI is a member of the CGIAR Consortium.

### AUTHORS

**Wei Zhang** ([w.zhang@cgiar.org](mailto:w.zhang@cgiar.org)) is a research fellow in the Environment and Production Technology Division of the International Food Policy Research Institute (IFPRI), Washington, DC

**Edward Kato** is a senior research analyst in the Environment and Production Technology Division of IFPRI, Washington, DC.

**Prapti Bhandary** is a research analyst in the Environment and Production Technology Division of IFPRI, Washington, DC.

**Ephraim Nkonya** is a senior research fellow in the Environment and Production Technology Division of IFPRI, Washington, DC.

**Hassan Ishaq Ibrahim** is a senior lecturer in the Department of Agricultural Economics and Extension at Federal University, Dutsin-Ma, Katsina State, Nigeria.

**Mure Agbonlahor** is a lecturer in the Department of Agricultural Economics and Farm Management at the Federal University of Agriculture, Abeokuta, Ogun State, Nigeria.

**Hussaini Yusuf Ibrahim** is a senior lecturer in the Department of Agricultural Economics and Extension at Federal University, Dutsin-Ma, Katsina State, Nigeria.

### Notices

<sup>1</sup> IFPRI Discussion Papers contain preliminary material and research results and are circulated in order to stimulate discussion and critical comment. They have not been subject to a formal external review via IFPRI's Publications Review Committee. Any opinions stated herein are those of the author(s) and are not necessarily representative of or endorsed by the International Food Policy Research Institute.

<sup>2</sup> The boundaries and names shown and the designations used on the map(s) herein do not imply official endorsement or acceptance by the International Food Policy Research Institute (IFPRI) or its partners and contributors.

Copyright 2015 International Food Policy Research Institute. All rights reserved. Sections of this material may be reproduced for personal and not-for-profit use without the express written permission of but with acknowledgment to IFPRI. To reproduce the material contained herein for profit or commercial use requires express written permission. To obtain permission, contact the Communications Division at [ifpri-copyright@cgiar.org](mailto:ifpri-copyright@cgiar.org).

## Contents

Abstract	v
Acknowledgements	vi
1. Introduction	1
2. Review of Literature and Knowledge Gaps Addressed by the Study	3
3. Methods	5
4. Results	8
5. Discussion	21
Appendix A: Section E of the Village Survey Questionnaire	22
Appendix B: Supplementary Tables	37
References	44

## Tables

4.1 Community land uses: Percentage of village land area and percentage of villages reporting trend of change in land use in the last five years (N = 102)	8
4.2 Percentage of villages reporting land tenure type by land use type (N = 102)	9
4.3 Percentage of villages that identified services by types of land use (N = 102)	12
4.4 Key parameter estimates for the awareness index for all services combined	15
4.5 Key parameter estimates for the awareness index for provisioning services	16
4.6 Key parameter estimates for the awareness index for regulating and supporting services	17
4.7 Key parameter estimates for the awareness index for cultural services	18
B.1 Trends of change in ecosystem services provision by land use types in the past five years for services identified by more than 30 percent of the villages (percentage of villages reporting trend, N = 102)	37
B.2 Perceived importance of ES identified by more than 30 percent of the villages to people's livelihood and welfare (percentage of villages reporting importance, N = 102)	39
B.3 Actions taken by the villages to maintain or enhance ecosystem services or halt or reverse the decline for services identified by more than 30 percent of the villages (percentage of villages reporting actions taken, N = 102)	39
B.4 Parameter estimates for the awareness index for all services combined	40
B.5 Parameter estimates for the awareness index for provisioning services	41
B.6 Parameter estimates for the awareness index for regulating and supporting services	42
B.7 Parameter estimates for the awareness index for cultural services	43

## Figures

4.1 Awareness of ES by villages for each ecosystem service (N = 102)	10
4.2 Levels of ES awareness by villages across the agroecological zones	11

## ABSTRACT

This research has been undertaken to improve our understanding of stakeholders' knowledge and perception about ecosystem services (ES), which provides a valuable means of gaining insight into the opportunities and constraints that face ES management in a multiuser landscape. Land use preferences are influenced by a variety of motives, attitudes, and values intrinsic to every individual's decisionmaking. Knowledge can affect attitudes and behavioral intentions, and a positive attitude toward the environment has been found to predict conservation practices. Using primary data collected from a village survey of 102 villages in Nigeria between November 2012 and February 2013, this study assesses local communities' awareness, perceptions, and knowledge of a broad range of ES and examines the key factors that explain the variations in the level of awareness across communities, with a special focus on land uses within landscapes. We found that exposure to forest and lowland floodplains was positively correlated with people's level of awareness of ES, highlighting the importance of direct experience and local context in shaping people's perceptions toward ES. Such considerations should be taken into account when designing policies aimed at addressing natural resources and environmental management issues. While provisioning services were generally well recognized, consistent with findings of previous studies, a majority of the sampled villages also appreciated spiritual values as a cultural service. Communities' awareness and knowledge about regulating and supporting ES were generally very low, including those services that are important for maintaining the stability and productivity of agroecosystems (for example, pollination and biological pest control), warranting a greater role for agricultural extension to play in influencing community levels of awareness of ES in Nigeria. Furthermore, incorporating new concepts and topics about ES into the primary school curriculum will better educate people about the importance of ES. Finally, our assessment of communities' attitudes toward payments for environmental services suggests a need to respect local communities' preferences, norms, and traditions when designing policies that encourage natural resources management.

**Keywords:** ecosystem services, awareness, knowledge, perception, rural community, forest, Nigeria

## **ACKNOWLEDGEMENTS**

We thank all farmers who participated in the village survey. We acknowledge the help of enumerators who helped implement the questionnaire. We thank the extension agents, particularly the village extension workers, from the 12 states who facilitated the field work. Samson K. Foli, Felix J. J. A. Bianchi, Adebayo A. Omoloye, and James Ojo compiled the field guide of insects. We also thank Wopke van der Werf, Adebayo Omoloye, and Felix J. J. A. Bianchi for providing constructive comments on the questionnaire. We are grateful for the thoughtful comments from Kimberly Swallow on our initial results and the literature review conducted by Akiko Haruna. This work has been supported by CGIAR's research programs on Policies, Institutions, and Markets (PIM) and Water, Land, and Ecosystems (WLE).

# 1. INTRODUCTION

The concept of ecosystem services (ES) is increasingly being used in natural resources and environmental decisionmaking (Hauck et al. 2013; Lamarque et al. 2011; TEEB 2010) and policy fields including sustainable agricultural intensification and poverty reduction (for example, the Ecosystem Services for Poverty Alleviation program of the UK). It has been deemed helpful in communicating the benefits of ecosystem management to diverse stakeholder groups (Reid et al. 2006) and enabling a comprehensive evaluation of the impacts of policies and technologies. A necessary condition for integrating the concept into policy and decisionmaking is a sound assessment of perceptions of ES that incorporates the diversity of stakeholder perceptions, knowledge, and preferences (Hauck et al. 2013) regarding the ways ES contribute to human well-being and livelihoods and the natural resource base that underlines the service provision.

Decision analysis studies with input from sociology and psychology indicate that land use preferences are influenced by a variety of motives (including financial and nonfinancial), attitudes, and values intrinsic to every individual's decisionmaking (Morris and Potter 1995; Rogers 2003; Willock et al. 1999). Knowledge can affect attitudes and behavioral intentions (Willock et al. 1999). Farmers who have the relevant knowledge and information may appreciate the fact that indiscriminate use of chemical insecticides can damage the populations of beneficial insects that provide important pollination and natural pest control services to their crop production. Such beliefs, if held with conviction and strength, will result in specific behaviors that minimize negative effects associated with indiscriminate agrochemical use (Willock et al. 1999). A number of studies have demonstrated that a positive attitude toward the environment is predictive of conservation practices (see review in Willock et al. 1999). Specifically regarding ES, Poppenborg and Koellner (2013) examined how the knowledge of four services—primary production, flood regulation, water purification, and biodiversity—influences farmers' crop choices, in a South Korean watershed. They found that farmers' decisions to plant perennial crops are most often accompanied by positive attitudes toward ES.

Perspectives of people about the benefits they derive from their interactions with ecosystems are influenced by the ecological features of the landscapes where they are located (Urgenson, Prozesky, and Esler 2013) as well as their values, beliefs, and socioeconomic and cultural statuses and attributes (Cowling et al. 2008; Willock et al. 1999; Hein et al. 2006; Vermeulen and Koziell 2002). Cognitive awareness and appreciation are also shaped by physical exposure to or experience with the environment. For example, Muhamad et al. (2014) and Sodhi et al. (2010) found that people living close to forests tend to have higher appreciation for ES in West Java, Indonesia. Abram et al. (2014) observed marked spatial variations in rural local people's values and perceptions of ES in the forested regions of Borneo. Understanding stakeholders' knowledge and perception about ES, from different contexts, provides a valuable means of gaining insight into the opportunities and constraints that face ES management in a multiuser landscape (Urgenson et al. 2013). This is necessary to facilitate the implementation of strategies that are aimed at improving the capacity of the poor to draw vital ES from landscapes.

Demand is growing for managing ES provided by alternative land uses to enhance local livelihoods and well-being, ultimately contributing toward conservation objectives and poverty reduction (Muhamad et al. 2014). Additionally, the sustainable development and Green Economy efforts, which emphasize integration and balanced consideration of social, economic, and environmental objectives (Zaccai 2012), have raised the need for better understanding of ES. Research on local farmers' perception of ES and land uses that provide these services can provide insights into the interplay of the innate linkages between humans and their environment (Urgenson et al. 2013). This in turn can facilitate fuller integration of ES information into planning and management and contribute toward identifying ways to improve land use management and designing effective incentives for promoting ES provision.

Using primary data collected from a survey of 102 rural communities in Nigeria between November 2012 and February 2013, this study aims to (1) assess local communities' awareness and knowledge of a broad range of ES and identify land uses within the respective landscapes that provide the ES; (2) explore local communities' perceptions of ES in relation to importance to their livelihoods and attitude toward payment for environmental services (PES) as a management strategy; (3) examine the association between awareness level and land uses within landscapes; and (4) gain understanding of the socioeconomic factors that explain the variations in the level of awareness across communities.

## 2. REVIEW OF LITERATURE AND KNOWLEDGE GAPS ADDRESSED BY THE STUDY

Despite the importance of stakeholders' perceptions and knowledge of ES to their management and conservation strategies, the concept of ecosystem services has received limited research interest, especially in developing countries. A number of studies have looked at stakeholder perceptions of ES, mostly focusing on limited geographic regions (such as European countries), limited land use systems (for example, grassland and forest), or a narrow range of ES (Lamarque et al. 2011), with the exceptions of Muhamad et al. (2014) and Martín-López et al. (2012), who considered multiple interlinked services. Furthermore, a number of methodological limitations, such as nonrandom sampling, reliance on basic statistical tests, and reliance on statistical techniques for searching for the best-fitting models without systematically controlling for confounding factors, limit the generalizability of the findings of previous studies.

In this section we highlight relevant literature on people's perception and awareness of ES and point to the research gaps that this study contributes to. Lamarque et al. (2011) explored stakeholder perceptions of grassland ES in relation to knowledge on soil fertility and biodiversity in European mountain regions. Lugnot and Martin (2013) combined a literature review of 39 scientific articles and interviews with eight farmers and three farm advisors in a French region, characterized by a diversity of livestock production systems, to assess stakeholders' knowledge about ES provided by biodiversity and whether this knowledge agrees with the scientific results. Both studies focused on ES provided by biodiversity, reflecting the emphasis on biodiversity conservation by the EU agro-environmental policy.

Hauck et al. (2013) used a suite of tools including policymaker interviews, focus group discussions with policymakers from the European Commission and member states, and an online questionnaire survey of 52 representatives of organized groups to capture a regional perspective regarding ES in three European regions. While familiarity with the ES concept varied widely among the respondents, agricultural food production was the dominant service identified across the three regions, consistent with the finding of Rodriguez et al. (2006) that provisioning services were usually valued most. Although some differences were seen concerning the importance of ES across regions, respondents from all three areas agreed that the services of aquaculture; biochemical, medical, and genetic resources; and aesthetic and spiritual use of landscapes and the gain of scientific knowledge and education were of very low importance. In recognition of the difficulties associated with the identification of the importance and value of ES by stakeholders, Hauck et al. (2013) submitted that cultural background and previous exposure to natural disasters such as floods influence people's preference for services.

Few peer-reviewed studies have assessed perceptions or knowledge of regulating or supporting ES by African farmers. Munyuli (2011) assessed farmers' perceptions and knowledge of the importance of pollination services in coffee production in Uganda, using a stratified random sample of 120 small-scale coffee growers from 26 study sites selected to represent a range of habitat types with varying degrees of anthropogenic disturbances and management intensities. The study found that more than 90 percent of the farmers were not aware of the role of bees in coffee yield and that farmers were not willing to manage their lands to protect pollination services, primarily because they considered pollination service an unsolicited "free service" or "public good." Farmers were not aware of the role of seminatural habitats serving as reservoirs for pollinators in the surrounding of coffee fields. Farmers who sprayed herbicides to control weeds were not aware that herbicides had negative impact on bees. However, they were aware of such ES delivered in the coffee-banana farming system as shading. A logistic regression analysis found that awareness of pollination services was associated with age, coffee farming experience, regular contact with extension services, and mode of acquisition of the coffee field. In addition, tribe and the agroecological zone may also have an effect: While knowledge of pollination was limited among the Baganda ethnic group in central Uganda, farmers living in the mountainous region communities in western Uganda were more aware of the value of pollinators. Similarly, Kasina et al. (2009) showed that most farmers in western Kenya were not aware of the importance of pollination for crop production and

recommended a review of the extension program to incorporate aspects on the positive effects of bees for pollination and how to increase bee pollination. Focusing on extension staff in the North West Province, South Africa, Oladele (2012) found that the level of knowledge about ES varied widely among a sample of 100 extension officers and recommended that extension services should change from a generalist approach to a specialist approach.

Nigeria's ecosystems are diverse, encompassing semiarid savanna ecosystems in the north and tropical forest ecosystems in the south. The land degradation problem is widespread and of critical concern in Nigeria (Titilola 2008). Overgrazing and other forms of rangeland-degrading practices increase soil erosion and reduce fodder yield and consequently livestock productivity and carbon sequestration. Eboh et al. (2005) estimated that fodder yield in 2003 was 10–20 percent lower than its yield in 1985 and that the annual cost of fodder yield loss was equivalent to 1.9 percent of the 2003 gross domestic product of the country. Likewise, the low use of fertilizer and organic soil fertility management practices leads to soil nutrient depletion, loss of soil carbon, and persistently low crop yield. Deforestation in Nigeria is about 3.7 percent, the third highest rate in the region after Comoros (9.3 percent) and Togo (5.1 percent) (FAO 2011). Adding to the diverse agroecological conditions is the heterogeneity in ethnicity and cultures, as well as drastic differences in the types of resource constraints facing different regions, which may impact people's views and needs relating to their natural environment and the ES they experience differently. Studies on ES in Nigeria are very limited. Available studies are limited in scope and content. The focus of previous studies has been on measuring the value of water provisioning (for example, Acharya 2000a; Acharya and Barbier 2000, 2002), soil conservation, and biodiversity (Acharya 2000b; Etkin 2002) to agricultural production, partly reflecting the resource constraints faced by the agricultural sector.

This study contributes to fulfilling an important area of knowledge gap for Nigeria, a country where information on local communities' awareness and perceptions of ES is greatly needed. In addition, the study makes a clear departure from the methodological limitations of previous studies. First, we consider a comprehensive set of ES, categorized into provisioning, supporting and regulating, and cultural services. Instead of using statement-like questions regarding the importance of given ES as adopted in most previous studies, our questionnaire links awareness of ES to specific land uses to highlight association between the land use type and ES. Second, the sampling approach in most previous studies on perceptions about ES was not designed to provide representative results but to explore different lines of augmentations and perspectives of experts from very different sectors (Hauck et al. 2013).<sup>1</sup> Our sample provides a broad geographic coverage of the country and covers a wide range of the agroecological zones to ensure a plausible generalization of our findings. Third, we adopt multiple regression analysis to explore the associations between awareness levels and land use types as well as socioeconomic conditions of the communities. A common problem in the existing literature is that studies often claimed causal relationships between the dependent variable and explanatory variables without using the proper data and analysis methods for identifying causality. Using cross-sectional data, this study addresses *association*, not causality. We consider a large set of alternative models with different specifications of explanatory variables to (1) improve the robustness of findings, (2) cope with the constraint of a relatively small sample, and (3) enable model selection based on the Akaike Information Criterion (AIC), accounting for both the goodness of fit and complexity of alternative models.

---

<sup>1</sup> For example, Lugnot and Martin (2013) kept interviewing additional stakeholders until no new fact or information emerged. The number of interviewees thus mainly depended on the diversity of attitudes regarding the issues addressed. Similarly, for Lamarque et al. (2011) and Lugnot and Martin (2013), the main limitation is the selection of stakeholders and the nonrepresentativeness of the sample, which makes it impossible to extrapolate research findings and their implications for production systems outside the study areas and conditions where research was conducted. Munyuli (2011) used a stratified random sample of coffee growers, with the study sites intentionally selected based on assumptive criteria of drivers.

### 3. METHODS

#### Data and Sample

Data collection in the current study was linked to the sample for an impact evaluation study for a World Bank–supported national community-driven development project in Nigeria, known as the Fadama III project (Nkonya et al. 2013). The evaluation study conducted two rounds of surveys, including a community focus group discussion and household survey, in 2009 (baseline) and 2012 (midline). We undertook a new village survey to collect information related to ES and natural resource management during November 2012 to February 2013, using a subset of the midline survey sample used in the Fadama III study. The new survey took place within six months of the completion of the midline survey to minimize the time lag between the two datasets. Since the new survey shared the sample with the Fadama III midline survey, we were able to merge data collected from both efforts.

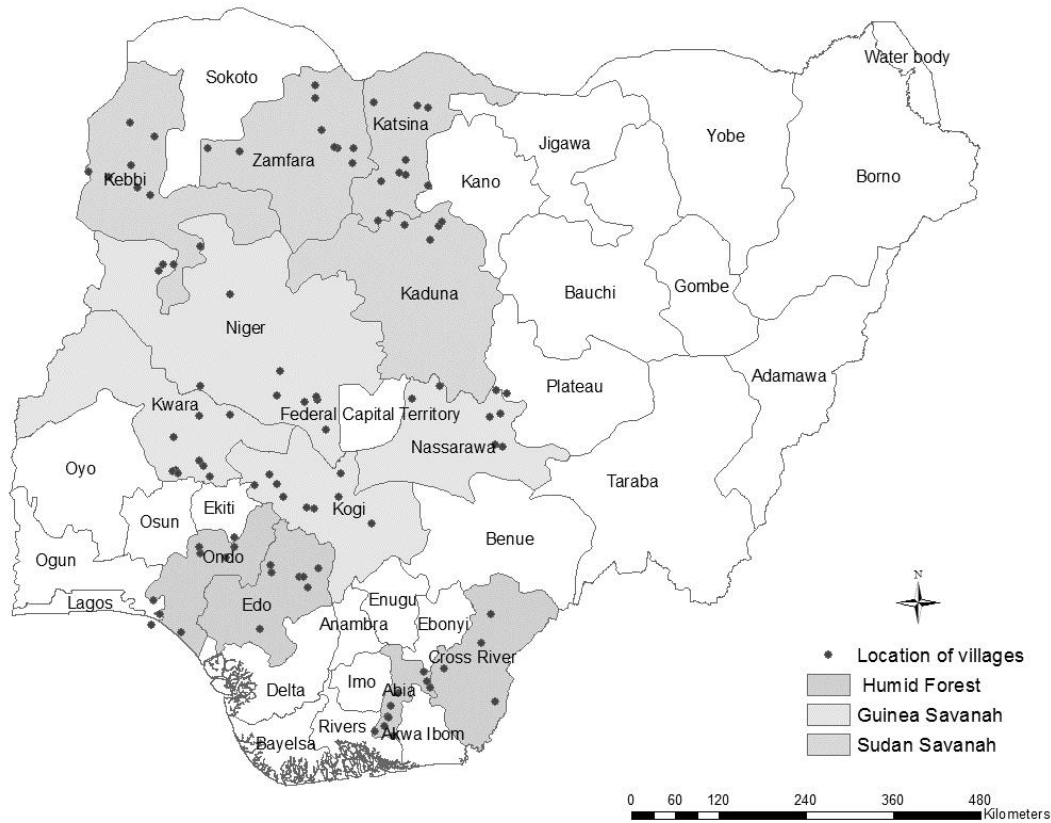
The Fadama III placement was not entirely random across states and within states across local government authorities (Nkonya et al. 2013). However, the Fadama III midline survey sample offers comprehensive geographic coverage of the country.<sup>2</sup> To obtain the sample for the new village survey, we adopted a stratified sampling approach by first selecting 12 states, based on levels of poverty and natural resource pressure (measured by the number of conflicts over the use of community common natural resources). Each of the three main agroecological zones (AEZs) (Sudan Savannah, Guinea Savannah, and Humid Forest) were represented by four states (Figure 3.1). The northeastern states were excluded from the sampling due to security concerns. In each of the 12 states, we randomly selected 6 to 10 villages from the eligible villages in the Fadama III midline survey sample.<sup>3</sup> Our final sample comprises 102 villages: 34 in Humid Forest, 36 in Guinea Savannah, and 32 in Sudan Savannah (Figure 3.1).

---

<sup>2</sup> The midline survey of the Fadama III study covered all states of Nigeria and included 1,161 community focus groups and a total of 9,176 households, divided into two groups: treatment group (participation in Fadama III) and control group (nonparticipation in Fadama III).

<sup>3</sup> Eligibility of villages was determined based on the following criteria: First, only those villages with more than six households included in the Fadama III midline household survey were eligible for our random sampling of villages. Since the Fadama III study did not select households proportional to the size of village populations, we do not expect sample selection bias by selecting only villages that included more than six households surveyed in the Fadama III study. Second, villages with no crop production were not considered because many of the ES we assess are related to crop production. Third, since the Fadama III midline survey included both participating and nonparticipating local government authorities, our village sampling accounted for this factor by selecting villages proportionally to Fadama III project participation rate within corresponding local government authorities.

**Figure 3.1 Surveyed villages in 12 states across three agroecological zones**



Source: Authors' creation.

Note: Two villages in the Cross River state are not shown in this map because of erroneous GPS coordinate recording.

## Survey Questionnaire and Implementation

As the identification of ES is motivated by human well-being, stakeholder involvement is particularly important in order to understand people's values and needs (Menzel and Teng 2009). In this study, farmers' perceptions of ES were elicited using structured group interviews (see Appendix A for survey questionnaire). Local traditions permitting, we encouraged women's participation and collective voice. To keep the group size manageable, we limited the number of active participants to no more than 15 when practical. The survey was conducted in local dialects in most cases, and interpreters were used in a few incidents.

The questionnaire included 29 ES (Swinton and Zhang 2005) grouped into three categories following Millennium Ecosystem Assessment's (MEA 2005) categorization: 10 provisioning services, 11 regulating and supporting services, and 8 cultural services (Figure 4.1). In addition, open-answer options were given as "Other (specify)" to allow the inclusion of additional services. Each group of farmers was asked a set of questions related to their awareness and appreciation of the 29 services as well as which land uses provided each ES. Here villages are proxies for landscapes, and nine land uses in the villages represent common landscape elements: cultivated land, unused land, residential area, forest, agroforest, lowland floodplain, grazing land, woodland, and water. The "Other (specify)" option allowed communities to include additional land use types.

To test the suitability of the structured interview design, we conducted a pretest of the interview in September 2012. Based on findings of the pretest, that most farmers were unable to name the crop pests and beneficial insects, a field guide for insect pests, natural enemies, and pollinators of 15 main crops in

Nigeria was developed to assist farmers in the identification of insect species. We selected the main crops for each state based on historical planted areas and production levels of crops, which were then vetted by the local collaborators to ensure local relevancy. The guide includes color photos of insects that were identified by local experts as having high relevance in local systems along with a brief description of their effects, compiled from literature sources and Internet sites.

## Data Analysis

We first used descriptive analysis to characterize general patterns in communities' land uses and perceptions and knowledge of ES. Specifically, we considered awareness of ES, perceived importance of ES to communities, degree of satisfaction with the level of provision, perceived trends of provision and associated drivers of change, and actions taken to address the provision of ES. To assess communities' knowledge about insect-based services, we surveyed communities' awareness of insect pollinators and natural enemies of crop pests with regard to their benefits to crop production and linkage to different land uses as habitat. Finally, we explored communities' views on the usefulness of payment for environmental services (PES) in resource and environmental management. While the number of observations on the PES topic was too low to draw any statistically meaningful conclusions, the findings shed light on communities' stated preferences for the PES concept as a potential approach for managing ES and environmental externalities.

We then use multiple regression models to examine the relationships between communities' awareness of ES and community-level land uses and socioeconomic factors. For the dependent variables, we developed and used four ES awareness indexes: (1) the total number of ES identified over the total number of ES across categories listed in the survey (29), (2) the number of provisioning services identified over the total number of provisioning ES listed in the survey (10), (3) the number of regulating and supporting services identified over the total number of regulating and supporting ES listed in the survey (11), and (4) the number of cultural services identified over the total number of cultural ES listed in the survey (8).

Given the cross-sectional data that are available for the analysis, the models address associative relationships, as opposed to causal effects, between the dependent and independent variables. We estimated two models: an ordinary least squares (OLS) model and a generalized linear model (GLM).<sup>4</sup> The dependent variables, ES awareness indexes, are fractional response variables bounded between zero and one; and one drawback of a linear model is that the predicted values from an OLS regression can never be guaranteed to lie in the unit interval, although it is a common practice to include it as an approximation. An alternative is to use the method proposed by Papke and Wooldridge (1996), which estimates a GLM with a logit (logistic regression) link function that follows a binomial distribution in Stata (StataCorp LP 2013). We obtained standard errors that were robust to misspecification and intragroup (within-cluster) correlation in both the OLS and GLM models. AIC was used to facilitate the selection of preferred GLM models across alternative specifications (Akaike 1974).

Some independent variables can be interesting to look at but were omitted from the analysis due to (1) the lack of variations across observations (for example, land tenure for cultivated, unused, and residential land); (2) a large number of missing values (for example, enactment of regulations for community natural resource management); or (3) concern over degrees of freedom (for example, institutions used to resolve conflicts over common resource use, which only apply when there is positive response on the occurrence of conflicts). Also, due to multicollinearity concerns, we did not include the poverty rate at the local government level in the regressions because it is highly correlated with some of the welfare indicators we included.

---

<sup>4</sup> Additionally, we estimated a two-limit tobit model. The results from the tobit model are almost identical to those from the GLM model, so we do not present tobit model results in this paper.

## 4. RESULTS

### Communities' Demographics and Land Uses

The surveyed villages in the Humid Forest had the largest average population size (58,391), followed by those in the Guinea Savannah (16,938) and Sudan Savannah (10,266). The seven dominant ethnic groups covered in the study are Hausa, Fulani, Nupe, Ibo, Yoruba, Ebera, and Ibibio. Migration, measured as percentage of village population migrating for urban jobs in the previous year, was highest in the Sudan Savannah (8.62 percent), followed by the Guinea Savannah (6.86 percent) and Humid Forest (4.55 percent).

Table 4.1 reports how total land area was allocated among different uses in the communities, based on estimates of survey participants and perceived trends of change in land uses over the previous five years. Land use patterns differed considerably across the AEZs. In the Sudan Savannah, the three predominant land uses were cultivated, residential, and lowland floodplain. Land use appeared to be more diverse in the Humid Forest and Guinea Savannah, encompassing cultivated, unused, forest, lowland floodplain, residential area, and woodland. Cultivated land was the predominant land use in the communities of the Sudan Savannah and Guinea Savannah, on average occupying one-half and one-third of the total land areas, respectively. Unused land was the most common land use in the Humid Forest (36.5 percent) and the second predominate land use in the Guinea Savannah (next to cultivated land) (22.7 percent), though its presence in Sudan Savannah was marginal. Forest covered almost one-fifth of the village land area in the Humid Forest and was also common in the Guinea Savannah (12.2 percent). While residential area occupied 18.2 percent and 13.5 percent of the village land area in the Sudan Savannah and Guinea Savannah, respectively, it accounted for only 6.2 percent of the area in the Humid Forest communities.

**Table 4.1 Community land uses: Percentage of village land area and percentage of villages reporting trend of change in land use in the last five years (N = 102)**

Land use types	Humid Forest (N=34)			Guinea Savannah (N=36)			Sudan Savannah (N=32)					
	% of total area <sup>2</sup>	Trend <sup>1</sup>			% of total area <sup>2</sup>	Trend <sup>1</sup>			% of total area <sup>2</sup>	Trend <sup>1</sup>		
		↓	↔	↑		↓	↔	↑		↓	↔	↑
Cultivated	20.4	1	0	33	32.9	6	5	24	52.9	28	2	2
Unused land	36.5	33	0	0	22.7	22	3	0	0.9	2	2	1
Residential	6.2	0	0	34	13.5	6	1	28	18.2	1	4	26
Forest	19.9	30	2	0	12.2	17	5	1	3.0	1	8	0
Agroforest	0	0	0	0	0.4	0	1	0	0	0	0	0
Lowland floodplain	8.6	31	1	2	8.7	20	11	4	14.9	16	6	7
Grazing land	0	0	0	0	1.1	5	2	0	2.5	4	7	0
Woodland	6	19	1	0	6	12	3	3	1.2	3	3	0
Water	2.7	0	6	0	2.6	8	8	1	6.5	17	5	9
Total	100				100				100			

Source: Authors' calculations.

Notes: <sup>1</sup> Trend: ↓ denotes decline; ↔ denotes no change; ↑ denotes increase. <sup>2</sup> % of total area: reported percent of the total area of the village.

In terms of perceived trends of change in land uses over the last five years (Table 4.1), the use of land for cultivation was reportedly increasing in the majority of the villages in the Humid Forest and Guinea Savannah but declining in most Sudan Savannah communities. While the area of unused land was reported as declining by the villages in the Humid Forest and Guinea Savannah, the majority of the villages experienced an increase in the area of residential land across all AEZs. Decline of lowland floodplain area was reported by the majority of villages across AEZs, likely related to the intensified use of floodplains to support dry season farming. Both the Humid Forest and Guinea Savannah seemed to have experienced decline in the area coverage of forest and woodland. These reported trends reveal

possible tension among competing land uses. In the Sudan Savannah, where historically cultivated land had occupied a high proportion of land area with little unused land available, rapid population growth may have driven the expansion of residential area at the cost of cultivated land and lowland floodplain area. In contrast, communities in the Humid Forest and Guinea Savannah appeared to have been undergoing expansion of cultivated and residential area, likely at the cost of unused land, forest, lowland floodplain, and woodland. This trend of change appeared to be stronger in the Humid Forest. Finally, it is worth noting that a significant proportion of the surveyed villages in the Sudan Savannah, and to a lesser extent Guinea Savannah, reported a decline in the area of water body, revealing a concerning trend of arid area getting more stressed about water scarcity.

Customary land tenure was the predominant tenure type for cultivated, unused, residential, and lowland floodplain land (Table 4.2). For cultivated land, customary tenure was reported by 82.3 percent of the villages, followed by communal land tenure at only 5.9 percent. In contrast, forest was most common on communal land (33 percent), followed by customary land (27 percent). A similar pattern was also observed for woodland. Other land tenures, such as leasehold, rented, borrowed, and freehold, are uncommon across all land use types.

**Table 4.2 Percentage of villages reporting land tenure type by land use type (N = 102)**

Land use	Land tenure (% of villages)			
	Leasehold or certificate of occupancy	Customary	Common land or community land	Freehold
Cultivated area	2	82.3	5.9	3.9
Unused land	1	53.5	6.9	1
Residential	1	84.3	7.8	4.9
Forest	2	27	33	1
Agroforest	—	—	1	—
Lowland floodplain	1	67	24	4
Grazing land	—	1	15.7	1
Woodland	—	14.9	27.7	—
Water	2	4.9	47.1	—

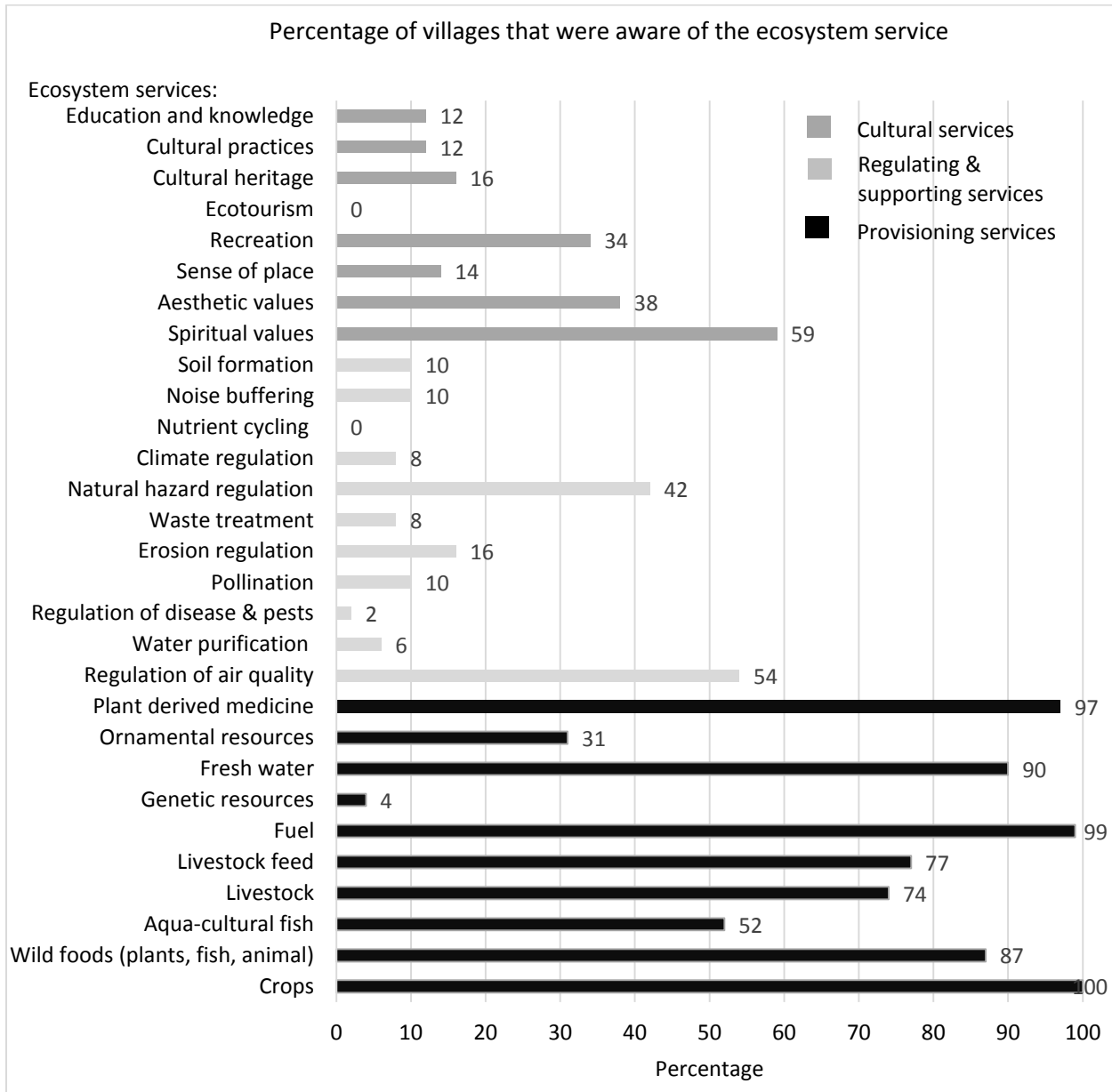
Source: Authors' calculations.

## Communities' Perceptions and Knowledge of ES

### *Awareness and Perceptions of ES*

Many cultures have ties to their surrounding natural environments, as reflected by the varying degrees to which they identify specific ES in relation to land uses. Figure 4.1 presents the distribution of villages based on the identified ES. Provisioning services were generally easier for the villages to identify as compared to the other two categories of ES, which is consistent with findings from previous studies (for example, Rodriguez et al. 2006; Muhamad et al. 2014). More than 87 percent of the villages were aware of such provisioning ES as crops, biofuel, freshwater, natural and plant-derived medicine, and wildlife, confirming the high relevance of these services to the rural communities in Nigeria.

**Figure 4.1 Awareness of ES by villages for each ecosystem service (N = 102)**



Source: Authors' creation.

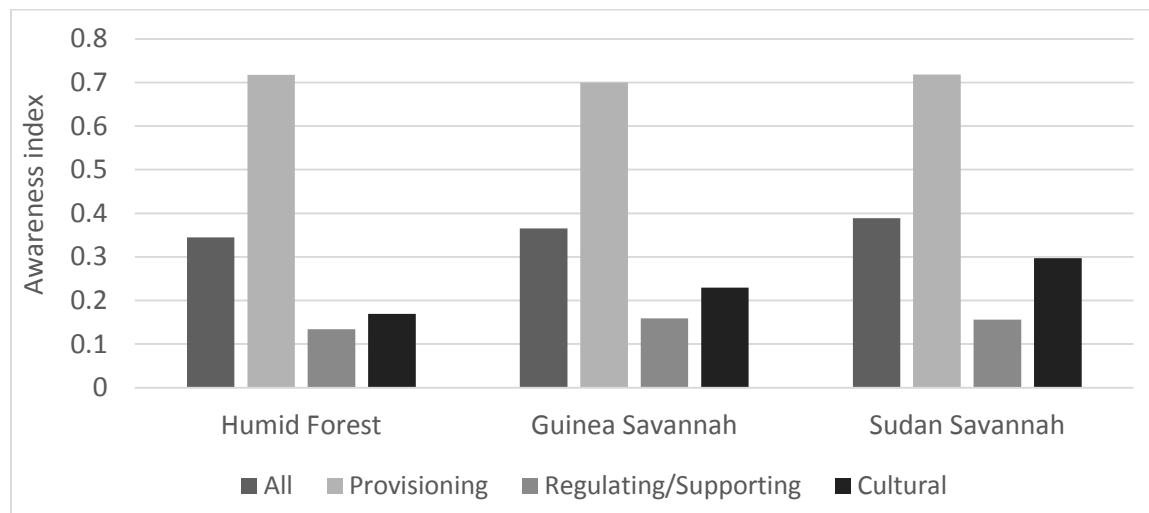
Awareness of regulating and supporting services by villages was generally low in our study (Figure 4.1). In particular, services that were important for farming, such as soil formation, nutrient cycling, regulation of disease and pests, and pollination, were not known to most village groups. Interestingly, regulation of air quality and natural hazard regulation were identified by relatively high portions of the villages, at 54 percent and 42 percent, respectively. This is somewhat counterintuitive, as one would expect that ES that are rendered at the field or farm scale and thus are more tangible to farmers be more recognizable, as compared with those ES that are public goods and provided at larger scales (such as landscape or watershed). The popularity of tree planting against desertification in the Sudan Savannah could be a reason for the high degree of awareness of the air quality and natural hazard regulation services by communities in the area. Another probable reason behind this finding could be

related to environmental consciousness, linked mostly to the high degree of petroleum extraction that has contributed to soil pollution and gas flaring in the Niger delta (Eregha and Irughe 2009; Dung, Bombom, and Agusomu 2008). The widely publicized petroleum impact on the environment could have potentially introduced a bias.

Among the cultural ES, spiritual value was appreciated by 59 percent of the villages, followed by aesthetic and recreational values at 38 percent and 34 percent, respectively (Figure 4.1). Rural communities appeared to appreciate the cultural services more than the regulating and supporting ES. This may be due to the fact that regulating and supporting services seem to be more abstract and intangible as compared with cultural services.

Figure 4.2 shows the relative levels of ES awareness by villages, using awareness indexes, across AEZs. Villages in the Sudan Savannah had the highest awareness index value, of 0.39 (derived by dividing the average number of services that were identified by the villages in the Sudan Savannah, 11.28, by the total number of services given in the questionnaire, which is 29), followed by the villages in the Guinea Savannah (0.36) and Humid Forest (0.34). While the awareness of provisioning services and regulation and supporting services was similar among the three AEZs, cultural services were considerably more appreciated by villages in the Sudan Savannah (0.30), as compared with the Guinea Savannah (0.23) and Humid Forest (0.17). The implication is that communities in the Sudan Savannah, with limited natural resources, were able to appreciate more services, especially the cultural services, as compared with their counterparts in the Humid Forest and Guinea Savannah.

**Figure 4.2 Levels of ES awareness by villages across the agroecological zones**



Source: Authors' creation.

Table 4.3 shows the linkages villages made between ES and land uses. Villages were not able to relate regulating and supporting ES to specific land uses well. This is not surprising considering the intangible nature of many of the benefits of such ES. While experience about cultural ES in relation to land uses tends to be subjective, it is worth noting that cultivated land was viewed by many as an important source of cultural services such as spiritual and aesthetic values. Many communities also derived recreational service from water and forestland uses (for example, swimming and fishing competitions and hunting).

**Table 4.3 Percentage of villages that identified services by types of land use (N = 102)**

Ecosystem services	Land Use								
	Cultivated	Unused	Residential	Forest	Agroforestry	Lowland floodplain	Grazing	Woodland	Water
<b>Provisioning services</b>									
1. Crops	93	28	36	33	19	79	19	14	14
2. Wild foods	67	65	25	65	17	45	20	14	22
3. Aquacultural fish	10	28	17	15	12	16	12	9	44
4. Livestock	19	47	47	35	19	19	19	14	26
5. Livestock feed	66	53	22	45	20	41	28	14	13
6. Fuel	66	59	40	53	20	53	26	20	23
7. Genetic resources	4	0	4	4	0	0	0	0	3
8. Fresh water	33	44	30	43	18	40	18	14	58
9. Ornamental resources	25	21	8	25	0	10	0	0	6
10. Natural/plant-derived medicines	76	62	52	61	19	58	25	18	17
<b>Regulating and supporting services</b>									
11. Regulation of air quality	20	26	36	20	18	18	17	11	14
12. Water purification	5	3	3	6	0	1	0	0	3
13. Regulation of diseases & pests	1	1	0	2	0	0	0	0	0
14. Pollination	8	7	2	6	0	2	0	0	1
15. Erosion regulation	8	9	4	8	4	5	4	1	1
16. Waste treatment	5	6	2	1	0	2	0	0	0
17. Natural hazard regulation	33	20	31	15	18	15	18	13	11
18. Climate regulation	4	5	2	4	2	3	2	0	0
19. Nutrient cycling	0	0	0	0	0	0	0	0	0
20. Noise buffering	3	7	4	7	1	5	1	1	1
21. Soil formation	7	7	0	2	0	1	0	0	0
<b>Cultural services</b>									
22. Spiritual values	45	25	31	21	13	22	15	10	14
23. Aesthetic values	25	17	21	11	16	14	17	10	10
24. Sense of place	4	7	7	7	1	2	1	1	2
25. Recreation	2	13	9	15	14	10	13	9	27
26. Ecotourism	0	0	0	0	0	0	0	0	0
27. Cultural heritage	3	10	5	12	0	5	0	0	1
28. Cultural practices	6	7	5	9	1	5	1	1	3
29. Education and knowledge system	8	6	2	4	0	3	0	0	0

Source: Authors' calculations.

Cultivated lands have multiple uses in rural communities. Farm lands represent not only the storage and sources of food and income but also the soul and investments of the entire household. The provisioning services derived from cultivated land were usually more than food and crops. It was not uncommon to have stands of medicinal plants and economic (or beneficial) trees within cultivated areas for such benefits as medicinal use, wild foods, fuel, shades to farmers, and place to rest. These medicinal plants and economic trees were typically not planted by farmers but have been preserved by farmers during clearing of forested or woodland area for cultivation purposes. Cultivated land also served as source of game, such as bushfowls, hares, giant rats, cane rats, and antelope, which were hunted or trapped and used as wild food or sold for income. Crop residues or stalks of crops such as maize and sorghum were collected and used as fuel for cooking or fodders.

In addition to cultivated land, crops were planted and managed on other types of land. Backyard gardens on residential lands (close to homestead), practiced mostly by women, provided leafy vegetables and fruits for the family. Lowland floodplains were the *fadama* land suitable for dry-season as well as year-round crop production. It was not uncommon to plant perennials, such as plantains, pineapple, and papaws, on unused land. These perennials not only provided food but also served as ownership markers to prevent trespassing during fallow. In some communities (for example, in northern Kogi State in the Guinea Savannah), cashew trees were planted in the woodland due to their drought- and fire-resistance feature, with the fruits being counted as a “crop” service.

With respect to perceived trends of change in ES provision by type of land use, we focus on the 14 services that were identified by more than 30 percent of the villages (Appendix B, Table B.1). Villages reported a declining supply of most of the provisioning services over the past five years. Specifically, crops derived from cultivated land and lowland floodplain; fuel derived from cultivated, forest, and unused land; and wild food derived from forest and cultivated land were reported to have considerably declined in supply over the period. While the majority of the villages did not respond on the trend of change for air quality and natural hazard regulation services, villages were far more outspoken about changes in some of the cultural services they value. Many villages reported that the spiritual and aesthetic values derived from forest and cultivated land had declined over the period. It was found that a majority of the villages were unable to identify the drivers of change in the supply of ES, although a small fraction of the villages reported that changes in land use, population pressure, and spiritual belief were underlying factors for the changes.

Despite the widely perceived importance of ES (Appendix Table B.2) and declining trend for service provision, very little action has been taken by villages to maintain the service provision or halt or reverse decline (Appendix Table B.3). For crops, promotion of sustainable land management (SLM) was identified by more than 20 percent of the villages as a way to maintain production levels. Around 10 percent of the villages reported using tree planting to help manage the provision of natural and plant-derived medicines and natural hazard regulation service. Community natural resource management practices, such as enactment and enforcement of user bylaws, were mentioned by only a few villages in our study. The result on the one hand indicates the lack of actions by communities. On the other hand, participants may have difficulty linking natural resource management practices to the provision of specific ES. Note that actions taken to address certain ES may contribute favorably to other services, which didn't seem to emerge from our data.

### ***Knowledge about Natural Pest Control and Pollination Services***

Less than one-fifth (18 percent) of the villages reported that they knew what natural enemies of crop pests were. Among them, most villages either did not think natural enemies were important for controlling crop pests or were unable to make any connection in terms of importance. Although one-third of the villages reported that they knew what pollinators were, the majority of them were unable to link crop yields with pollination services or pollinator populations. Earlier in the survey, the study elicited responses on awareness of natural pest control and pollination, two regulating and supporting services. It was found

that only 2 percent and 10 percent of the villages, respectively, were able to identify them (Figure 4.1).<sup>5</sup> Despite the inconsistency, a clear message is that farmers' knowledge and awareness of the pest control and pollination services or the benefits they derive from these services were generally low, even though some of the farmers were aware of the service-providing agents.

Important crops identified by farmers for which insect pollination activities are important include fruit trees (16 villages), cowpea (13 villages), and melon (11 villages). The majority of the villages were not aware of farm-related cultural practices that enhance pollinator populations, with the exceptions of 7 villages that reported that establishing field margins with flowering plants can increase pollinator population and 4 villages that linked beekeeping (apiary) in the community to pollinator abundance. Also, only 2 villages cited the negative effect of chemical insecticides use on pollinator abundance. By and large, villages in our study were unable to link the provision of pest control and pollination services to habitats and other resources provided by land uses.

### ***Payment for Environmental Services***

PES is a market-based approach to conservation financing (Pagiola and Platais 2007). The application of PES in Africa south of the Sahara, and particularly in Nigeria, has been relatively limited. We explored farmers' receptiveness of this conservation financing method, focusing on understanding farmers' stated preference of PES in resolving natural resource or environmental issues in their communities.

Nearly one-third of the villages believed that PES can be useful for reducing natural resource conflict and improving natural resource management. However, philosophical and practicability reasons were adduced by the majority who were opposed to the use of PES as an acceptable tool. Philosophically, villages preferred settling conflicts based on negotiated terms and government intervention over private financial means. A popular belief was that it is not socially just to pay people to do the "right" thing as people have equal right to the common resources and such financial compensations may encourage "bad" behavior or exploitation of the system. Technically, contract breach and lack of financial resources to make such payment were also stated as concerns for impracticability.

When asked what they would do in a hypothetical case in which the quality of the community's drinking water is affected by upstream communities, 15 percent of the villages responded that they would consider paying the upstream communities to change behavior. For those villages who rejected the financial approach, more than 68 percent preferred negotiation with upstream communities (but would not offer financial incentive) and more than 25 percent chose to request local government to intervene.

### **Regression Results**

We report regression results from the preferred GLM models (selected based on AIC scores) and corresponding OLS models, which had the same specifications as the selected GLM models. Parameter estimates for selected key independent variables are reported in Tables 4.4–4.7 for each of the four dependent variables on the awareness of ES: indexes of awareness for all services, provisioning services, regulating and supporting services, and cultural services. Full regression results are shown in Appendix B, Tables B.4–B.7. Overall, estimates from the GLM and OLS models are consistent and qualitatively similar, which indicates that the relationships identified in the analysis are robust and not sensitive to the estimation methods used. The GLM models were able to show more significant associations, which is not surprising considering that the nonlinear model tends to provide a better fit for fractional response data.

---

<sup>5</sup> Percentages of villages that acknowledged awareness of the services of disease and pest regulation and pollination are much lower than those for knowing about natural enemies and pollinators. This may be due to (1) possible upward contamination of the responses on knowledge of natural enemies and pollinators because of likely exposure to the discussion of associated ES, which appeared earlier in the survey; and (2) participants may find service-providing agents (such as natural enemies of crop pests) more relatable than services themselves, which could be seen as conceptually abstract.

## Relationship between Communities' Land Uses and Awareness of ES

Land uses in communities are important factors explaining the variations in the level of ES awareness by villages in our analysis. Land use variables are measured by proportions of area under given land uses in total village land area, which are based on participants' estimates during the group interviews. Since only one village reported the presence of agroforest, we combined agroforest with forest area. Proportional area of cultivated land was excluded from regressions to avoid multicollinearity and was used as reference land use for result interpretation.

Results consistently show statistically significant and strong associations between forestland use and awareness of ES. Specifically, proportional area of forest, relative to cultivated land, is positively correlated with all awareness indexes except the one for provisioning services (Tables 4.4–4.7). This implies that villages with a larger proportion of forest area tend to be aware of more regulating and supporting services, more cultural services, and more of all services combined.

**Table 4.4 Key parameter estimates for the awareness index for all services combined**

Variable	GLM1	GLM2	GLM3	OLS1	OLS2	OLS3
Main ethnicity: Hausa	0.411*** (0.126)	0.426*** (0.129)	0.434*** (0.127)	0.088*** (0.031)	0.090*** (0.032)	0.092*** (0.032)
Main ethnicity: Yoruba	0.319 (0.282)	0.310 (0.280)	0.316 (0.282)	0.073 (0.072)	0.071 (0.073)	0.073 (0.073)
Unused land (area %)	0.013** (0.005)	0.013** (0.005)	0.013** (0.005)	0.003** (0.001)	0.003** (0.001)	0.003** (0.001)
Residential land (area %)	0.008** (0.004)	0.009** (0.004)	0.009** (0.004)	0.002** (0.001)	0.002** (0.001)	0.002** (0.001)
Forest (area %)	0.015*** (0.005)	0.016*** (0.005)	0.016*** (0.005)	0.003*** (0.001)	0.003*** (0.001)	0.003*** (0.001)
Floodplain (area %)	0.019*** (0.005)	0.020*** (0.005)	0.019*** (0.005)	0.004*** (0.001)	0.004*** (0.001)	0.004*** (0.001)
Grazing land (area %)	0.006 (0.008)	0.008 (0.008)	0.005 (0.008)	0.001 (0.002)	0.002 (0.002)	0.001 (0.002)
Woodland (area %)	0.012* (0.007)	0.013* (0.007)	0.013* (0.007)	0.003 (0.002)	0.003 (0.002)	0.003 (0.002)
Water (area %)	-0.009** (0.004)	-0.009** (0.004)	-0.009** (0.004)	-0.002** (0.001)	-0.002** (0.001)	-0.002** (0.001)
% of households food-insecure	-0.003* (0.002)	-0.004** (0.002)	-0.003* (0.002)	-0.001 (0.000)	-0.001 (0.000)	-0.001 (0.000)
% of adult literacy	-0.002 (0.002)	-0.003 (0.002)	-0.002 (0.002)	-0.001 (0.001)	-0.001 (0.001)	-0.001 (0.001)
No. of conflicts over common resource use			0.005 (0.003)			0.001 (0.001)
Distance to roads		0.003 (0.003)			0.001 (0.001)	
Constant	-2.215*** (0.398)	-2.244*** (0.394)	-2.240*** (0.400)	0.004 (0.096)	-0.001 (0.096)	-0.001 (0.097)
Observations	101	101	101	101	101	101
R-squared				0.446	0.449	0.449
Adjusted R-squared				0.290	0.284	0.285
AIC	1.319	1.338	1.338			
Log likelihood	-43.60	-43.59	-43.59	104.4	104.6	104.7

Source: Authors' calculations.

Notes: AIC = Akaike Information Criterion; GLM = generalized linear model; OLS = ordinary least squares.

Robust standard errors in parentheses. \*\*\* p < 0.01, \*\* p < 0.05, \* p < 0.1. Results on dummy variables for states not reported here. Reference variable for main ethnicities is "Other ethnicity." Reference variable for proportion areas of land uses is "Cultivated land (area %)."

**Table 4.5 Key parameter estimates for the awareness index for provisioning services**

Variables	GLM1	GLM2	GLM3	GLM1	GLM2	GLM3
Main ethnicity: Hausa	0.367 (0.261)	0.338 (0.256)	0.407 (0.255)	0.085 (0.063)	0.080 (0.063)	0.094 (0.063)
Main ethnicity: Yoruba	0.313 (0.421)	0.329 (0.416)	0.307 (0.417)	0.063 (0.097)	0.067 (0.097)	0.062 (0.097)
Unused land (area %)	0.005 (0.008)	0.004 (0.008)	0.005 (0.008)	0.001 (0.002)	0.001 (0.002)	0.001 (0.002)
Residential land (area %)	0.008 (0.006)	0.006 (0.006)	0.008 (0.006)	0.001 (0.001)	0.001 (0.001)	0.002 (0.001)
Forest (area %)	-0.007 (0.008)	-0.007 (0.008)	-0.007 (0.008)	-0.001 (0.002)	-0.002 (0.002)	-0.001 (0.002)
Floodplain (area %)	<b>0.023***</b> (0.008)	<b>0.022***</b> (0.009)	<b>0.022***</b> (0.009)	<b>0.005**</b> (0.002)	<b>0.004**</b> (0.002)	<b>0.005**</b> (0.002)
Grazing land (area %)	-0.005 (0.013)	-0.009 (0.015)	-0.008 (0.014)	-0.001 (0.003)	-0.001 (0.003)	-0.001 (0.003)
Woodland (area %)	0.015 (0.012)	0.013 (0.012)	0.016 (0.012)	0.003 (0.003)	0.003 (0.003)	0.003 (0.003)
Water (area %)	-0.013 (0.009)	-0.013 (0.009)	-0.013 (0.009)	-0.002 (0.002)	-0.002 (0.002)	-0.002 (0.002)
% of households food-insecure	0.001 (0.003)	0.002 (0.004)	0.000 (0.003)	0.000 (0.001)	0.000 (0.001)	0.000 (0.001)
% of adult literacy	-0.003 (0.004)	-0.003 (0.004)	-0.003 (0.004)	-0.001 (0.001)	-0.001 (0.001)	-0.001 (0.001)
No. of conflicts over common resource use			0.010 (0.007)			0.002 (0.001)
Distance to roads		-0.005 (0.005)			-0.001 (0.001)	
Constant	0.259 (0.664)	0.308 (0.661)	0.215 (0.666)	0.576*** (0.156)	0.584*** (0.156)	0.566*** (0.157)
Observations	101	101	101	101	101	101
R-squared				0.320	0.324	0.326
Adjusted R-squared				0.128	0.122	0.125
AIC	1.267	1.286	1.286			
Log likelihood	-40.99	-40.96	-40.96	67.66	67.95	68.10

Source: Authors' calculations.

Notes: AIC = Akaike Information Criterion; GLM = generalized linear model. Robust standard errors in parentheses.

\*\*\* p < 0.01, \*\* p < 0.05, \* p < 0.1. Results on dummy variables for states not reported here. Reference variable for main ethnicities is "Other ethnicity." Reference variable for proportion areas of land uses is "Cultivated land (area %)."

**Table 4.6 Key parameter estimates for the awareness index for regulating and supporting services**

Variable	GLM1	GLM2	GLM3	OLS1	OLS2	OLS3
Main ethnicity: Hausa	0.938*** (0.283)	1.014*** (0.292)	0.964*** (0.293)	0.092** (0.040)	0.094** (0.041)	0.092** (0.041)
Main ethnicity: Yoruba	0.698 (0.919)	0.672 (0.897)	0.696 (0.922)	0.087 (0.099)	0.085 (0.100)	0.087 (0.100)
Unused land (area %)	0.035** (0.016)	0.036** (0.016)	0.035** (0.016)	0.004* (0.002)	0.004* (0.002)	0.004* (0.002)
Residential land (area %)	0.023** (0.010)	0.026** (0.011)	0.023** (0.010)	0.003* (0.001)	0.003* (0.001)	0.003* (0.001)
Forest (area %)	0.052*** (0.012)	0.053*** (0.012)	0.052*** (0.013)	0.006*** (0.002)	0.006*** (0.002)	0.006*** (0.002)
Floodplain (area %)	0.027** (0.013)	0.030** (0.014)	0.027** (0.014)	0.002 (0.002)	0.002 (0.002)	0.002 (0.002)
Grazing land (area %)	0.024 (0.017)	0.031 (0.019)	0.024 (0.017)	0.003 (0.002)	0.003 (0.003)	0.003 (0.003)
Woodland (area %)	0.032* (0.019)	0.036* (0.020)	0.033* (0.019)	0.003 (0.002)	0.003 (0.002)	0.003 (0.002)
Water (area %)	-0.057*** (0.022)	-0.062*** (0.024)	-0.058*** (0.022)	-0.002 (0.001)	-0.002 (0.001)	-0.002 (0.001)
% of households food-insecure	-0.011** (0.005)	-0.013** (0.005)	-0.011** (0.005)	-0.001 (0.001)	-0.001* (0.001)	-0.001 (0.001)
% of adult literacy	-0.012** (0.005)	-0.013** (0.005)	-0.012** (0.005)	-0.002** (0.001)	-0.002** (0.001)	-0.002** (0.001)
No. of conflicts over common resource use			0.005 (0.010)			0.000 (0.001)
Distance to roads		0.008 (0.006)			0.000 (0.001)	
Constant	-6.144*** (1.406)	-6.301*** (1.419)	-6.177*** (1.411)	-0.277** (0.132)	-0.281** (0.132)	-0.277** (0.133)
Observations	101	101	101	101	101	101
R-squared				0.339	0.340	0.339
Adjusted R-squared				0.153	0.143	0.142
AIC	1.030	1.049	1.050			
Log likelihood	-29.00	-28.96	-29.00	68.50	68.58	68.50

Source: Authors' calculations.

Notes: AIC = Akaike Information Criterion; GLM = generalized linear model; OLS = ordinary least squares. Robust standard errors in parentheses. \*\*\* p < 0.01, \*\* p < 0.05, \* p < 0.1. Results on dummy variables for states not reported here. Reference variable for main ethnicities is "Other ethnicity." Reference variable for proportion areas of land uses is "Cultivated land (area %)."

**Table 4.7 Key parameter estimates for the awareness index for cultural services**

Variable	GLM1	GLM2	GLM3	OLS1	OLS2	OLS3
Main ethnicity: Hausa	0.577** (0.278)	0.680** (0.286)	0.610** (0.278)	0.086 (0.059)	0.098 (0.060)	0.091 (0.059)
Main ethnicity: Yoruba	0.386 (0.935)	0.336 (0.909)	0.380 (0.939)	0.067 (0.163)	0.059 (0.162)	0.067 (0.164)
Unused land (area %)	0.028** (0.014)	0.029** (0.014)	0.028** (0.014)	0.004* (0.002)	0.004* (0.002)	0.004* (0.002)
Residential land (area %)	0.011 (0.007)	0.015** (0.007)	0.011 (0.007)	0.002 (0.001)	0.002 (0.001)	0.002 (0.001)
Forest (area %)	0.037*** (0.011)	0.039*** (0.010)	0.037*** (0.011)	0.006*** (0.002)	0.006*** (0.002)	0.006*** (0.002)
Floodplain (area %)	0.043*** (0.013)	0.046*** (0.013)	0.043*** (0.013)	0.007*** (0.002)	0.007*** (0.002)	0.007*** (0.002)
Grazing land (area %)	0.012 (0.020)	0.023 (0.022)	0.010 (0.020)	0.002 (0.004)	0.004 (0.004)	0.001 (0.004)
Woodland (area %)	0.015 (0.018)	0.019 (0.019)	0.015 (0.019)	0.001 (0.003)	0.002 (0.003)	0.002 (0.003)
Water (area %)	-0.011 (0.016)	-0.013 (0.016)	-0.011 (0.016)	-0.001 (0.002)	-0.000 (0.002)	-0.001 (0.002)
% of households food-insecure	-0.009* (0.005)	-0.012** (0.005)	-0.010* (0.005)	-0.001 (0.001)	-0.002* (0.001)	-0.001 (0.001)
% of adult literacy	0.005 (0.007)	0.002 (0.007)	0.005 (0.007)	0.001 (0.002)	0.001 (0.002)	0.001 (0.001)
No. of conflicts over common resource use			0.007 (0.007)			0.001 (0.002)
Distance to roads		0.014*** (0.005)			0.002** (0.001)	
Constant	-5.443*** (1.070)	-5.665*** (1.067)	-5.482*** (1.075)	-0.326** (0.153)	-0.349** (0.152)	-0.331** (0.154)
Observations	101	101	101	101	101	101
R-squared				0.379	0.396	0.380
Adjusted R-squared				0.203	0.215	0.194
AIC	1.175	1.190	1.194			
Log likelihood	-36.32	-36.11	-36.31	50.96	52.35	51.04

Source: Authors' calculations.

Notes: AIC = Akaike Information Criterion; GLM = generalized linear model; OLS = ordinary least squares.

Robust standard errors in parentheses. \*\*\* p < 0.01, \*\* p < 0.05, \* p < 0.1. Results on dummy variables for states not reported here. Reference variable for main ethnicities is "Other ethnicity." Reference variable for proportion areas of land uses is "Cultivated land (area %)."

We found that the relative share of lowland floodplain area is positively correlated with ES awareness and that this association is consistent across all four awareness indexes. Although not as powerful as the share of forest area in explaining the variations in the level of awareness for regulating and supporting services (Table 4.5), shares of floodplain area and forest area are similarly important in explaining the variations in the levels of awareness for cultural services and all services combined (Tables 4.4 and 4.7).

Communities' access to unused land is also important in predicting ES awareness. We found statistically strong and positive correlations between the proportional area of unused land and all awareness indexes except the index for provisioning services. Moreover, evidence is weak (at 90 percent confidence level) that villages with a larger share of woodland area are aware of more regulating and supporting services (Table 4.5) and more of all services combined (Table 4.4). Villages with a larger proportion of residential land, relative to cultivated land, tend to be aware of more regulating and supporting services (Table 4.6), more of all services combined (Table 4.4), and arguably more cultural services as well (Table 4.7). Interestingly, water land use, relative to cultivated land, is associated with lower awareness for regulating and supporting services and all services combined (Tables 4.4 and 4.6). One probable explanation for this finding is that most communities in our study do not derive their livelihoods from water resources and therefore are less likely to attach much value to such land use type.

Communities' awareness of provisioning services was not associated with allocations of land among the different uses, except for floodplain, relative to cultivated area (Table 4.5). Results show that villages with a larger share of floodplain area are generally aware of more provisioning services. This is not surprising given the common multiple uses of floodplain by villages for crop cultivation and collection of wild foods, livestock feeds, fuel, freshwater, and natural and plant-derived medicines (Table 4.3). However, this should not be interpreted that floodplains are the only important source of provisioning services. As Table 4.3 shows, more than half of the surveyed villages identified forest and unused land as sources of provisioning services of wild foods, fuel, and natural and plant-derived medicines. Similarly, woodland (where grazing sometimes takes place) was identified as a source of livestock feed by 53 percent of the villages. Instead, the result should be interpreted in terms of relative importance of floodplain, as compared with the other land uses, in explaining the variations in the awareness index for provisioning services.

### ***Other Factors That Are Associated with ES Awareness***

The analysis identified several other important factors, in addition to land uses, that have significant associative relationships with the levels of ES awareness.

Villages in which the main ethnic group was Hausa were found to be aware of more regulating and supporting services, more cultural services, and more of all services combined (Tables 4.4, 4.6 and 4.7), as compared to villages in which the main ethnic group was Yoruba or "other" (that is, none of Hausa and Yoruba). While further investigation is needed to understand the mechanism underlining the relation, the result underscores the importance of understanding local contexts when designing ES management programs and projects because livelihood choices and strategies, crop choices, and certain preferences towards ES by communities may differ among ethnic groups.

Percentage of households within a village that were food-insecure was negatively correlated with all awareness indexes except the index for provisioning services. Specifically, villages that reported a higher incidence of food insecurity were less aware of regulating and supporting services, of cultural services, and of all services combined (Tables 4.4, 4.6 and 4.7). The adult literacy rate in villages had no associations with the awareness of provisioning services, cultural services, and all services combined, but it had a negative relationship with the awareness of regulating and supporting services. This implies that literacy education had little or no influence on people's experience with nature and how they appreciate their interdependence with nature. Finally, the combined distance to tarmac road and all-weather road was positively correlated with the awareness of cultural services (Table 4.7). This implies that cultural services may be more important for people who reside more remotely from main centers of populations.

Next we present a number of results from models that did not perform as well as the ones reported in Tables 4.5–4.7. Since they were not the selected models, we do not report the results here but can make them available upon request. First, the proportion of farmers using chemical insecticides to control crop pests in the village was positively correlated with the awareness of regulating and supporting services. Since the prevalence of chemical insecticide use by households within villages appeared to be positively correlated with the presence of a retail store that sells chemical insecticides in the village or negatively correlated with the distance to the nearest store if none exists in the village, this result implies that more convenient access to agrochemicals such as insecticides tends to be positively correlated with farmers' awareness of regulating and supporting services.

Second, as mentioned earlier, there are little variations in the data on land tenure for cultivated, unused and residential land across villages, for which customary is the predominant tenure type. Thus land tenure was not included in the main analysis as reported in Tables 4.5–4.7. However, both customary tenure and communal land tenure are common for forest and floodplain land. We therefore ran two separate regressions for villages that had forest or floodplain land to examine how customary tenure and communal land tenure may relate to the awareness of ES differently. While the two tenure types do not seem to be statistically different in terms of their association with ES awareness levels, results show that villages with customary tenure for their floodplain land, as compared with communal land tenure, are aware of more provisioning services.

A final point is that farmers' participation in agricultural extension programs was not significant in the models estimated for provisioning, cultural, and all services combined. The exception is the awareness of regulating and supporting services, which is positively associated with farmers' participation in agricultural extension programs. The result highlights the limited role that government extension has played as an information source to farmers.

## 5. DISCUSSION

We highlight several policy-relevant implications of our findings. Our findings demonstrate the importance of direct experience and local context in shaping people's perceptions toward ES. For instance, exposure to forest and lowland floodplain was positively correlated with people's level of awareness of ES. Such considerations should be taken into account when designing policies aimed at addressing natural resources and environmental management issues. Efforts and interventions to protect and conserve forests and floodplains in those communities are likely to be more effective in terms of their receptiveness and adoption by farmers and more promising in enhancing ES derived from those land resources.

Land use preferences are influenced by a variety of motives, attitudes, and values intrinsic to every individual's decisionmaking (Morris and Potter 1995; Rogers 2003; Willock et al. 1999). Knowledge about the benefits of ES and the land uses that provide these services can affect farmers' attitudes and behavioral intentions, changing the way they use their land and farm their crops for higher productivity and fewer negative externalities. Our study demonstrates that much remains to be done to increase awareness and knowledge in farming communities about ES as well as the resource base that underlines the provision of services. In our analysis, agricultural extension was not found to play a significant role in influencing communities' level of awareness of ES, pointing to a crucial entry point for intervention. Our survey reveals that extension services in Nigeria have been narrowly focused on promoting conventional external inputs such as improved seeds and chemical fertilizer with little or no attention on other management practices such as pest management and pollination. It is plausible to expand the portfolio of advisory services to include more "soft" skills and management know-how. Additionally, targeted effort by extension agency is recommended to mainstream ES-based approaches to sustainable agricultural and natural resource management into advisory support programs.

Enhancing ES education through formal school curricula may offer a promising entry point for intervention. In our study, knowledge about pollination was generally low among farmers. It was noted that such knowledge is typically acquired in biology class at secondary or high school in Nigeria. This means that farmers who did not attend secondary or high school would likely miss out on the opportunity to learn about pollination. Including key messages about ES in the primary school curriculum therefore may bring about rewarding results on raising knowledge about ES among the youth. Similarly, Munyuli (2011) suggested the need to revise and incorporate in the school curriculum new concepts such as pollination to better educate the young people about the importance of pollination services in Uganda.

Finally, findings from our assessment of communities' attitudes toward PES highlight the need to respect local communities' preferences, norms, and traditions when designing policy that encourages natural resources management.

## APPENDIX A: SECTION E OF THE VILLAGE SURVEY QUESTIONNAIRE<sup>6</sup>

### E. Community Natural Resources and the Ecosystem Services (ES) They Provide

Please introduce the concept of ecosystem services first.

*Ecosystem services* are benefits that people obtain from ecosystems. They are generally classified into 4 categories:

*Provisioning services* are the products obtained from ecosystems, including wild foods, crops, fibre, fuel, genetic resources, biochemicals/pharmaceuticals and natural medicines, ornamental resources, fresh water, plant-derived medicines and other natural resources.

*Regulating services* are the benefits obtained from the regulation of the physical, chemical and biological processes between organisms and their environments. These include the regulation of air quality, climate, erosion, and diseases/pests, pollination, natural hazard regulation (e.g., mangroves), and water purification/waste treatment.

*Supporting services* are those that are necessary for the production of all other ES. For example, nutrient cycling, photosynthesis and soil formation. Supporting services differ from the others in that their impacts on people are often indirect or occur over a very long time, whereas changes in the other categories have relatively direct and short-term impacts. Some services, like erosion regulation, can be categorized as both a supporting and a regulating service, depending on the time scale and immediacy of their impacts on people.

*Cultural services* are the nonmaterial benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experiences. For example, these include recreation, ecotourism, spiritual and aesthetic values, sense of place, social relations (such as differing between fishing and agrarian communities), cultural heritage, cultural practices, education and knowledge systems.

---

<sup>6</sup> This appendix is taken directly from the original survey questionnaire.

**E1. What ecosystem services does each of these land uses provide? Please check all that apply.**

#	Ecosystem services	Cultivated area	Unused land	Residential area	Forest	Agro-forest	Lowland floodplain	Grazing land	Wood-land	Water	Other (Specify)
<b>Provisioning services:</b>											
1	Crops										
2	Wild foods (plants, fish, animal)										
3	Aqua-cultural fish										
4	Livestock										
5	Livestock Feed										
6	Fuel										
7	Genetic resources										
8	Fresh water										
9	Ornamental resources										
10	Natural/plant-derived medicines										
11	Other (specify)										
<b>Regulating &amp; supporting services:</b>											
12	Regulation of air quality										
13	Water purification										
14	Regulation of diseases & pests										
15	Pollination										
16	Erosion regulation										
17	Waste treatment										
18	Natural hazard regulation										
19	Climate regulation										
20	Nutrient cycling										
21	Noise buffering										
22	Soil formation										
23	Other (specify)										

#	Ecosystem services	Cultivated area	Unused land	Residential area	Forest	Agro-forest	Lowland floodplain	Grazing land	Wood-land	Water	Other (Specify)
<b>Cultural services:</b>											
24	Spiritual values										
25	Aesthetic values										
26	Sense of place										
27	Recreation										
28	Ecotourism										
29	Cultural heritage										
30	Cultural practices										
31	Education & knowledge systems										
32	Other (specify)										

## E2. Perceptions about ecosystem services, their trends, and drivers of changes

1. Please rate the importance of each ecosystem service to your livelihood and welfare

#	Ecosystem services	Importance of ecosystem services (1=Not Important; 2=Somehow important; 3=Very important; 4=Don't know)
<b>Provisioning services:</b>		
1	Crops	
2	Wild foods (plants, fish, animal)	
3	Aqua-cultural fish	
4	Livestock	
5	Livestock Feed	
6	Fuel	
7	Genetic resources	
8	Fresh water	
9	Ornamental resources	
10	Natural/plant-derived medicines	
11	Other (specify)	
<b>Regulating &amp; supporting services:</b>		
12	Regulation of air quality	
13	Water purification	
14	Regulation of diseases & pests	
15	Pollination	
16	Erosion regulation	
17	Waste treatment	
18	Natural hazard regulation	
19	Climate regulation	
20	Nutrient cycling	
21	Noise buffering	
22	Soil formation	
23	Other (specify)	

#	Ecosystem services	Importance of ecosystem services (1=Not Important; 2=Somehow important; 3=Very important; 4=Don't know)
<b>Cultural services:</b>		
24	Spiritual values	
25	Aesthetic values	
26	Sense of place	
27	Recreation	
28	Ecotourism	
29	Cultural heritage	
30	Cultural practices	
31	Education & knowledge systems	
32	Other (specify)	

2. **On the scale of 1 to 5**, please rate how satisfied you are with the level of ecosystem service as provided by each type of land use, with 1 being “not satisfied at all” and 5 being “very satisfied.” Enter 99 for “Don’t know.”

#	Ecosystem services	Cultivated area	Unused land	Residential area	Forest	Agro-forest	Lowland floodplain	Grazing land	Wood-land	Water	Other (Specify)
<b>Provisioning services:</b>											
1	Crops										
2	Wild foods (plants, fish, animal)										
3	Aqua-cultural fish										
4	Livestock										
5	Livestock Feed										
6	Fuel										
7	Genetic resources										
8	Fresh water										
9	Ornamental resources										
10	Natural/plant-derived medicines										
11	Other (specify)										
<b>Regulating &amp; supporting services:</b>											
12	Regulation of air quality										
13	Water purification										
14	Regulation of diseases & pests										
15	Pollination										
16	Erosion regulation										
17	Waste treatment										
18	Natural hazard regulation										
19	Climate regulation										
20	Nutrient cycling										
21	Noise buffering										
22	Soil formation										
23	Other (specify)										

#	Ecosystem services	Cultivated area	Unused land	Residential area	Forest	Agro-forest	Lowland floodplain	Grazing land	Woodland	Water	Other (Specify)
<b>Cultural services:</b>											
24	Spiritual values										
25	Aesthetic values										
26	Sense of place										
27	Recreation										
28	Ecotourism										
29	Cultural heritage										
30	Cultural practices										
31	Education & knowledge systems										
32	Other (specify)										

3. Please indicate the trends of ecosystem services provision associated with each type of land use in the past 5 years (1 = Declining; 2 = No change; 3 = Increasing/improving; 4=Don't know)

#	Ecosystem services	Cultivated area	Unused land	Residential area	Forest	Agro-forest	Lowland floodplain	Grazing land	Wood-land	Water	Other (Specify)
<b>Provisioning services:</b>											
1	Crops										
2	Wild foods (plants, fish, animal)										
3	Aqua-cultural fish										
4	Livestock										
5	Livestock Feed										
6	Fuel										
7	Genetic resources										
8	Fresh water										
9	Ornamental resources										
10	Natural/plant-derived medicines										
11	Other (specify)										
<b>Regulating &amp; supporting services:</b>											
12	Regulation of air quality										
13	Water purification										
14	Regulation of diseases & pests										
15	Pollination										
16	Erosion regulation										
17	Waste treatment										
18	Natural hazard regulation										
19	Climate regulation										
20	Nutrient cycling										
21	Noise buffering										
22	Soil formation										
23	Other (specify)										

#	Ecosystem services	Cultivated area	Unused land	Residential area	Forest	Agro-forest	Lowland floodplain	Grazing land	Wood-land	Water	Other (Specify)
<b>Cultural services:</b>											
24	Spiritual values										
25	Aesthetic values										
26	Sense of place										
27	Recreation										
28	Ecotourism										
29	Cultural heritage										
30	Cultural practices										
31	Education & knowledge systems										
32	Other (specify)										

4. Please describe the most important driver for the trend of change indicated above for each ecosystem service as provided by each type of land use.

**Drivers of change:** 1= Changing agro-chemical input use; 2= Changing labor input; 3= Changing land use; 4=Change in spiritual beliefs (e.g., rise of Islam and Christianity, decline in traditional belief); 5=Infrastructure development; 6=Easier access to information & technology; 7=New policies; 8=New rules & regulations; 10=Changing income; 11=Climate change; 12=Changing population; 13=Changing market demand; 14= Changing market supply; 15=Better access to market; 16=Don't know; 99=Other (specify)

#	Ecosystem services	Cultivated area	Unused land	Residential area	Forest	Agro-forest	Lowland floodplain	Grazing land	Wood-land	Water	Other (Specify)
<b>Provisioning services:</b>											
1	Crops										
2	Wild foods (plants, fish, animal)										
3	Aqua-cultural fish										
4	Livestock										
5	Livestock Feed										
6	Fuel										
7	Genetic resources										
8	Fresh water										
9	Ornamental resources										
10	Natural/plant-derived medicines										
11	Other (specify)										
<b>Regulating &amp; supporting services:</b>											
12	Regulation of air quality										
13	Water purification										
14	Regulation of diseases & pests										
15	Pollination										
16	Erosion regulation										
17	Waste treatment										
18	Natural hazard regulation										
19	Climate regulation										
20	Nutrient cycling										
21	Noise buffering										
22	Soil formation										

#	Ecosystem services	Cultivated area	Unused land	Residential area	Forest	Agro-forest	Lowland floodplain	Grazing land	Woodland	Water	Other (Specify)
23	Other (specify)										
<b>Cultural services:</b>											
24	Spiritual values										
25	Aesthetic values										
26	Sense of place										
27	Recreation										
28	Ecotourism										
29	Cultural heritage										
30	Cultural practices										
31	Education & knowledge systems										
32	Other (specify)										

E3. What actions has the village taken to maintain or enhance ecosystem services, or halt or reverse the decline?

**Actions taken:**1= Enact byelaw to regulate use or access; 2= Enforcement of user byelaws; 3= Water harvesting; 4= Promotion of sustainable land management (SLM) or Integrated soil fertility management (ISFM); 5= Planting trees/pasture; 6= Promotion of early maturing or drought tolerant crop varieties;7=Don't know; 99= Other (specify)

#	Ecosystem services	Cultivated area	Unused land	Residential area	Forest	Agro-forest	Lowland floodplain	Grazing land	Wood-land	Water	Other (Specify)
<b>Provisioning services:</b>											
1	Crops										
2	Wild foods (plants, fish, animal)										
3	Aqua-cultural fish										
4	Livestock										
5	Livestock Feed										
6	Fuel										
7	Genetic resources										
8	Fresh water										
9	Ornamental resources										
10	Natural/plant-derived medicines										
11	Other (specify)										
<b>Regulating &amp; supporting services:</b>											
12	Regulation of air quality										
13	Water purification										
14	Regulation of diseases & pests										
15	Pollination										
16	Erosion regulation										
17	Waste treatment										
18	Natural hazard regulation										
19	Climate regulation										
20	Nutrient cycling										
21	Noise buffering										
22	Soil formation										

#	Ecosystem services	Cultivated area	Unused land	Residential area	Forest	Agro-forest	Lowland floodplain	Grazing land	Wood-land	Water	Other (Specify)
23	Other (specify)										
<b>Cultural services:</b>											
24	Spiritual values										
25	Aesthetic values										
26	Sense of place										
27	Recreation										
28	Ecotourism										
29	Cultural heritage										
30	Cultural practices										
31	Education & knowledge systems										
32	Other (specify)										

E4. In the area of jurisdiction of the village, how many major common resource use conflicts occurred in the last 12 months? Mention the parties involved in the conflict. Please focus the discussion on large conflicts that involved large groups of people, e.g. pastoralists vs. crop farmers.

Types of common resources	No. of conflicts	Parties involved in the conflict <sup>1</sup> Mention at most three			Institutions used to resolve conflict <sup>2</sup>			Status of conflict <sup>3</sup>		
		Confl1	Confl2	Confl3	Inst1	Inst2	Inst3	Confl1	Confl2	Confl3
1.Common forest										
2.Lowland floodplain										
3.Common grazing land										
4.Common woodlands										
5. Irrigation infrastructure &/or irrigation water										
6.Water for animals										
99. Others (specify)										

<sup>1</sup>**Parties involved:** 1=Crop producers only; 2= Livestock keepers only; 3= Crop producers and livestock keepers; 4= Fisher folks and crop farmers; 5=Fisher folks only; 6= All community members in the area; 7=Don't know; 99=Other (specify)

<sup>2</sup>**Institutions:** 1=Customary institutions; 2=Local gov't; 3=State gov't; 4=Federal gov't; 5=Religious institutions; 6=Economic groups; 7=Fadama Community Associations; 8=Courts; 9=Police; 10=Don't know; 99=Others (specify)

<sup>3</sup>**Status of the conflict:** 1= On-going conflict but stable; 2= On-going conflict with increasing severity; 3=On-going conflict but with decreasing severity; 4=Conflict has been resolved; 5=Don't know; 99=Other (specify)

E5 Are there regulations that have been enacted to ensure sustainable management of common resources and to reduce resource degradation in the village? (1=Yes; 0=No) \_\_\_\_\_

**If no, proceed to section F.**

**1. If yes, complete the following table for up to 3 regulations.**

Regulation	Type of common resources <sup>1</sup>	Year enacted	Who enacted? <sup>2</sup>	Community awareness <sup>3</sup>	Community compliance <sup>4</sup>	Method of enforcement <sup>5</sup>	How are proceeds from legal harvest of common resources used? <sup>6</sup>

<sup>1</sup>**Type of common resources:** 1=Common forest; 2= Lowland floodplain; 3= Common grazing land; 4= Common woodlands; 5= Irrigation infrastructure &/or irrigation water; 6= Water for animals; 7=Other (specify)

<sup>2</sup>**Who enacted?** 1 = Local government council; 2 = State government; 3 = Federal government; 4 = Customary institution; 5 = Religious institution; 6 = Economic interest groups or Fadama Community Association; 8=Don't know; 99 = (specify)

<sup>3</sup>**Awareness of regulation:** 1 = Some are aware; 2 = Majority are aware; 3 = All are aware; 4=Don't know.

<sup>4</sup>**Compliance with regulation:** 1 = Nobody complies; 2 = Few comply; 3 = Majority comply; 4 = All comply; 5=Don't know

<sup>5</sup>**Method of enforcement:** 1=Jail or physical punishment; 2=Fines; 3=Exclusion/banning (ostracize); 4=Publicizing names of those who break the regulation; 5=Loss of access to common properties/services; 6=Don't know; 99=Others (specify); <sup>6</sup>**Use of proceeds:** 1=Used by individual farmers who harvest the resource; 2=Used for improving community; 3=No regulation on this; 4=Don't know; 99=Other (specify)

## APPENDIX B: SUPPLEMENTARY TABLES

**Table B.1 Trends of change in ecosystem services provision by land use types in the past five years for services identified by more than 30 percent of the villages (percentage of villages reporting trend, N = 102)**

Ecosystem services identified by >30% of the villages (see Figure 4.1)	Land use								
	Cultivated	Unused	Residential	Forest	Agroforestry	Lowland floodplains	Grazing	Woodland	Water
<b>Provisioning services</b>									
<b>1. Crops</b>									
Declining	39		14			21			
No change	28	15	6	4		3			14
Improving	3		4	1		2			1
Don't know		2	44	47	51	47	52	52	37
<b>2. Wild foods</b>									
Declining	24	15	7	20		3	2		5
No change	18	31	20	7		15	2	1	2
Improving		1		1				1	1
Don't know	15	4	30	29	50	33	49	9	49
<b>3. Aquacultural fish</b>									
Declining	4	3	1			3			15
No change			3						2
Improving	1	1	3						2
Don't know	4	5	6	9	9	7	9	8	4
<b>4. Livestock</b>									
Declining	11	19	11	1			1		
No change	1	2	2						
Improving	1	13	10						
Don't know	29	9	35	41	42	42	41	42	42
<b>5. Livestock feed</b>									
Declining	26	10		9		13	4		
No change	14	16	1	3		3			
Improving	2	2	1			2			
Don't know	19	18	42	36	43	41	43	43	43
<b>6. Fuel</b>									
Declining	53	25	9	24		8	5		5
No change	4	16	2	3		3		1	
Improving	1			1				2	
Don't know	7	11	46	27	50	50	49	50	46
<b>8. Freshwater</b>									
Declining	7	7	6	2		9	1		19
No change	15	14	2						1
Improving						1			2
Don't know	25	27	41	46	48	43	47	48	44

**Table B.1 Continued**

Ecosystem services identified by >30% of the villages (see Figure 4.1)	Land use								
	Cultivated	Unused	Residential	Forest	Agroforestry	Lowland floodplains	Grazing	Woodland	Water
<b>9. Ornamental resources</b>									
Declining	17	17	22	30	1		1	1	
No change	1	1							14
Improving	1	1							
Don't know	23	25	22	14	43		43	43	44
<b>10. Natural and plant-derived medicines</b>									
Declining	18	22	15	13	1		14	2	
No change	33	17	6	21			4	2	1
Improving	3	1	1						2
Don't know	13	11	46	23	49		49	50	50
<b>Regulating &amp; supporting services</b>									
<b>11. Regulation of air quality</b>									
Declining	7	3	14	1			2		
No change	5	2	5	2					
Improving	13	14	2						
Don't know	25	28	37	45	47		45	47	47
<b>17. Natural hazard regulation</b>									
Declining	7	3	5	1			1		
No change	6	1	6	2			1		
Improving	3		3					1	
Don't know	4	2	5	4	6		6	6	6
<b>Cultural services</b>									
<b>22. Spiritual values</b>									
Declining	20	18	5	21			16	1	3
No change	21	12	11	1			2	1	
Improving	4		3				3	1	
Don't know	15	18	41	27	49		33	48	49
<b>23. Aesthetic values</b>									
Declining	26	16	4	8	1		21	2	
No change	5	3	5						
Improving			1						
Don't know	18	21	35	32	39		24	39	40
<b>25. Recreation</b>									
Declining	2	2	1	2			3		6
No change		1	3	3				1	2
Improving			1						2
Don't know	4	4	3	4	7		3	7	7

Source: Authors' calculations.

**Table B.2 Perceived importance of ES identified by more than 30 percent of the villages to people's livelihood and welfare (percentage of villages reporting importance, N = 102)**

Ecosystem services identified by >30% of the villages (see Figure 4.1)		Not Important	Somehow Important	Very Important	Don't know
<b>Provisioning services</b>					
1	Crops	0	0.98	80.39	0
2	Wild foods	0	18.63	50.98	0
3	Aquacultural fish	8.82	17.65	42.16	0
4	Livestock	0	6.86	60.78	1.96
5	Livestock feed	33.33	3.92	27.45	8.82
6	Fuel	0	8.82	71.57	0
8	Freshwater	0	35.29	43.14	0
9	Ornamental resources	33.33	7.84	1.96	1.96
10	Natural/plant-derived medicines	0	10.78	59.22	7.84
<b>Regulating and supporting services</b>					
11	Regulation of air quality	0	15.69	15.69	37.25
17	Natural hazard regulation	0	6.86	10.78	42.16
<b>Cultural services</b>					
22	Spiritual values	13.73	13.73	18.63	24.51
23	Aesthetic values	5.88	20.59	22.55	11.76
25	Recreation	6.86	16.67	1.96	34.31

Source: Authors' calculations.

**Table B.3 Actions taken by the villages to maintain or enhance ecosystem services or halt or reverse the decline for services identified by more than 30 percent of the villages (percentage of villages reporting actions taken, N = 102)**

Ecosystem services identified by >30% of the villages (Figure 4.1)	Actions taken						
	Enact bylaw	Enforcement of user bylaw	Promotion of Sustainable land management	Planting trees, pasture	Don't know	Other (mostly did nothing)	
<b>Provisioning services</b>							
1	Crops		20.59	0.98	50.98	59.80	
2	Wild foods		0.98	2.94	50.98	51.96	
3	Aquacultural fish	1.96			9.80	21.57	
4	Livestock		0.98		43.14	55.88	
5	Livestock feed		4.90	2.94	44.12	55.88	
6	Fuel		2.94	4.90	51.96	60.78	
8	Freshwater		0.98		49.02	42.16	
9	Ornamental resources				44.12	40.20	
10	Natural/plant-derived medicines		5.88	2.94	9.80	50.98	58.82
<b>Regulating &amp; supporting services</b>							
11	Regulation of air quality		1.96	4.90	49.02	37.25	
17	Natural hazard regulation		0.98	0.98	8.82	9.80	12.75
<b>Cultural services</b>							
22	Spiritual value				50.00	54.90	
23	Aesthetic value			1.96	43.14	36.27	
25	Recreation		3.92		8.82	17.65	

Source: Authors' calculations.

**Table B.4 Parameter estimates for the awareness index for all services combined**

Variable	GLM1	GLM2	GLM3	OLS1	OLS2	OLS3
Main ethnicity: Hausa	0.411*** (0.126)	0.426*** (0.129)	0.434*** (0.127)	0.088*** (0.031)	0.090*** (0.032)	0.092*** (0.032)
Main ethnicity: Yoruba	0.319 (0.282)	0.310 (0.280)	0.316 (0.282)	0.073 (0.072)	0.071 (0.073)	0.073 (0.073)
Unused land (area %)	0.013** (0.005)	0.013** (0.005)	0.013** (0.005)	0.003** (0.001)	0.003** (0.001)	0.003** (0.001)
Residential land (area %)	0.008** (0.004)	0.009** (0.004)	0.009** (0.004)	0.002** (0.001)	0.002** (0.001)	0.002** (0.001)
Forest (area %)	0.015*** (0.005)	0.016*** (0.005)	0.016*** (0.005)	0.003*** (0.001)	0.003*** (0.001)	0.003*** (0.001)
Floodplain (area %)	0.019*** (0.005)	0.020*** (0.005)	0.019*** (0.005)	0.004*** (0.001)	0.004*** (0.001)	0.004*** (0.001)
Grazing land (area %)	0.006 (0.008)	0.008 (0.008)	0.005 (0.008)	0.001 (0.002)	0.002 (0.002)	0.001 (0.002)
Woodland (area %)	0.012* (0.007)	0.013* (0.007)	0.013* (0.007)	0.003 (0.002)	0.003 (0.002)	0.003 (0.002)
Water (area %)	-0.009** (0.004)	-0.009** (0.004)	-0.009** (0.004)	-0.002** (0.001)	-0.002** (0.001)	-0.002** (0.001)
% of HHs food-insecure	-0.003* (0.002)	-0.004** (0.002)	-0.003* (0.002)	-0.001 (0.000)	-0.001 (0.000)	-0.001 (0.000)
% of adult literacy	-0.002 (0.002)	-0.003 (0.002)	-0.002 (0.002)	-0.001 (0.001)	-0.001 (0.001)	-0.001 (0.001)
No. of conflicts over common resource use			0.005 (0.003)			0.001 (0.001)
Distance to roads		0.003 (0.003)			0.001 (0.001)	
st_Kaduna	1.257*** (0.417)	1.260*** (0.418)	1.193*** (0.414)	0.277*** (0.103)	0.278*** (0.105)	0.263** (0.103)
st_Katsina	1.581*** (0.430)	1.561*** (0.430)	1.562*** (0.427)	0.352*** (0.107)	0.348*** (0.108)	0.348*** (0.107)
st_Kebbi	0.807** (0.401)	0.807** (0.403)	0.808** (0.396)	0.179* (0.098)	0.179* (0.099)	0.179* (0.098)
st_Nasarawa	1.361*** (0.395)	1.380*** (0.396)	1.344*** (0.395)	0.297*** (0.097)	0.300*** (0.098)	0.293*** (0.098)
st_Niger	1.515*** (0.409)	1.529*** (0.411)	1.508*** (0.407)	0.335*** (0.101)	0.337*** (0.103)	0.333*** (0.101)
st_Ondo	0.605 (0.409)	0.613 (0.408)	0.616 (0.409)	0.130 (0.102)	0.131 (0.102)	0.132 (0.102)
st_Zamfara	1.504*** (0.423)	1.527*** (0.425)	1.511*** (0.420)	0.335*** (0.105)	0.339*** (0.107)	0.336*** (0.105)
st_Edo	0.899*** (0.299)	0.905*** (0.300)	0.906*** (0.298)	0.199*** (0.073)	0.200*** (0.074)	0.200*** (0.074)
st_Kogi	0.155 (0.290)	0.167 (0.292)	0.159 (0.289)	0.029 (0.066)	0.031 (0.067)	0.029 (0.066)
st_Kwara	0.360 (0.345)	0.364 (0.343)	0.368 (0.344)	0.076 (0.083)	0.076 (0.083)	0.078 (0.083)
st_Abia	0.027 (0.252)	0.027 (0.253)	0.028 (0.251)	0.008 (0.055)	0.008 (0.055)	0.008 (0.055)
Constant	-2.215*** (0.398)	-2.244*** (0.394)	-2.240*** (0.400)	0.004 (0.096)	-0.001 (0.096)	-0.001 (0.097)
Observations	101	101	101	101	101	101
R-squared				0.446	0.449	0.449
Adjusted R-squared				0.290	0.284	0.285
AIC	1.319	1.338	1.338			
Log likelihood	-43.60	-43.59	-43.59	104.4	104.6	104.7

Source: Authors' calculations.

Notes: AIC = Akaike Information Criterion; GLM = generalized linear model; OLS = ordinary least squares.

**Table B.5 Parameter estimates for the awareness index for provisioning services**

Variable	GLM1	GLM2	GLM3	GLM1	GLM2	GLM3
Main ethnicity: Hausa	0.367 (0.261)	0.338 (0.256)	0.407 (0.255)	0.085 (0.063)	0.080 (0.063)	0.094 (0.063)
Main ethnicity: Yoruba	0.313 (0.421)	0.329 (0.416)	0.307 (0.417)	0.063 (0.097)	0.067 (0.097)	0.062 (0.097)
Unused land (area %)	0.005 (0.008)	0.004 (0.008)	0.005 (0.008)	0.001 (0.002)	0.001 (0.002)	0.001 (0.002)
Residential land (area %)	0.008 (0.006)	0.006 (0.006)	0.008 (0.006)	0.001 (0.001)	0.001 (0.001)	0.002 (0.001)
Forest (area %)	-0.007 (0.008)	-0.007 (0.008)	-0.007 (0.008)	-0.001 (0.002)	-0.002 (0.002)	-0.001 (0.002)
Floodplain (area %)	0.023*** (0.008)	0.022*** (0.009)	0.022*** (0.009)	0.005** (0.002)	0.004** (0.002)	0.005** (0.002)
Grazing land (area %)	-0.005 (0.013)	-0.009 (0.015)	-0.008 (0.014)	-0.001 (0.003)	-0.001 (0.003)	-0.001 (0.003)
Woodland (area %)	0.015 (0.012)	0.013 (0.012)	0.016 (0.012)	0.003 (0.003)	0.003 (0.003)	0.003 (0.003)
Water (area %)	-0.013 (0.009)	-0.013 (0.009)	-0.013 (0.009)	-0.002 (0.002)	-0.002 (0.002)	-0.002 (0.002)
% of households food-insecure	0.001 (0.003)	0.002 (0.004)	0.000 (0.003)	0.000 (0.001)	0.000 (0.001)	0.000 (0.001)
% of adult literacy	-0.003 (0.004)	-0.003 (0.004)	-0.003 (0.004)	-0.001 (0.001)	-0.001 (0.001)	-0.001 (0.001)
No. of conflicts over common resource use			0.010 (0.007)			0.002 (0.001)
Distance to roads		-0.005 (0.005)			-0.001 (0.001)	
st_Kaduna	0.212 (0.760)	0.200 (0.743)	0.089 (0.764)	0.037 (0.176)	0.036 (0.174)	0.010 (0.180)
st_Katsina	0.705 (0.794)	0.758 (0.786)	0.664 (0.795)	0.130 (0.184)	0.138 (0.184)	0.121 (0.187)
st_Kebbi	-0.560 (0.716)	-0.570 (0.700)	-0.555 (0.716)	-0.132 (0.168)	-0.132 (0.166)	-0.131 (0.169)
st_Nasarawa	0.236 (0.725)	0.197 (0.716)	0.194 (0.737)	0.048 (0.168)	0.042 (0.168)	0.039 (0.173)
st_Niger	0.467 (0.724)	0.435 (0.708)	0.442 (0.727)	0.094 (0.167)	0.090 (0.165)	0.090 (0.170)
st_Ondo	0.696 (0.708)	0.685 (0.703)	0.715 (0.706)	0.126 (0.153)	0.123 (0.153)	0.130 (0.153)
st_Zamfara	0.497 (0.782)	0.452 (0.759)	0.506 (0.783)	0.089 (0.181)	0.081 (0.179)	0.091 (0.183)
st_Edo	0.349 (0.426)	0.340 (0.425)	0.361 (0.424)	0.074 (0.106)	0.073 (0.106)	0.077 (0.106)
st_Kogi	0.056 (0.484)	0.031 (0.485)	0.063 (0.480)	0.011 (0.121)	0.006 (0.122)	0.012 (0.120)
st_Kwara	0.091 (0.531)	0.087 (0.526)	0.109 (0.527)	0.022 (0.129)	0.021 (0.129)	0.026 (0.129)
st_Abia	-0.046 (0.408)	-0.048 (0.408)	-0.042 (0.406)	-0.008 (0.103)	-0.009 (0.103)	-0.007 (0.103)
Constant	0.259 (0.664)	0.308 (0.661)	0.215 (0.666)	0.576*** (0.156)	0.584*** (0.156)	0.566*** (0.157)
Observations	101	101	101	101	101	101
R-squared				0.320	0.324	0.326
Adjusted R-squared				0.128	0.122	0.125
AIC	1.267	1.286	1.286			
Log likelihood	-40.99	-40.96	-40.96	67.66	67.95	68.10

Source: Authors' calculations.

Notes: AIC = Akaike Information Criterion; GLM = generalized linear model.

**Table B.6 Parameter estimates for the awareness index for regulating and supporting services**

Variable	GLM1	GLM2	GLM3	OLS1	OLS2	OLS3
Main ethnicity: Hausa	0.938*** (0.283)	1.014*** (0.292)	0.964*** (0.293)	0.092** (0.040)	0.094** (0.041)	0.092** (0.041)
Main ethnicity: Yoruba	0.698 (0.919)	0.672 (0.897)	0.696 (0.922)	0.087 (0.099)	0.085 (0.100)	0.087 (0.100)
Unused land (area %)	0.035** (0.016)	0.036** (0.016)	0.035** (0.016)	0.004* (0.002)	0.004* (0.002)	0.004* (0.002)
Residential land (area %)	0.023** (0.010)	0.026** (0.011)	0.023** (0.010)	0.003* (0.001)	0.003* (0.001)	0.003* (0.001)
Forest (area %)	0.052*** (0.012)	0.053*** (0.012)	0.052*** (0.013)	0.006*** (0.002)	0.006*** (0.002)	0.006*** (0.002)
Floodplain (area %)	0.027** (0.013)	0.030** (0.014)	0.027** (0.014)	0.002 (0.002)	0.002 (0.002)	0.002 (0.002)
Grazing land (area %)	0.024 (0.017)	0.031 (0.019)	0.024 (0.017)	0.003 (0.002)	0.003 (0.003)	0.003 (0.003)
Woodland (area %)	0.032* (0.019)	0.036* (0.020)	0.033* (0.019)	0.003 (0.002)	0.003 (0.002)	0.003 (0.002)
Water (area %)	-0.057*** (0.022)	-0.062*** (0.024)	-0.058*** (0.022)	-0.002 (0.001)	-0.002 (0.001)	-0.002 (0.001)
% of households food-insecure	-0.011** (0.005)	-0.013** (0.005)	-0.011** (0.005)	-0.001 (0.001)	-0.001* (0.001)	-0.001 (0.001)
% of adult literacy	-0.012** (0.005)	-0.013** (0.005)	-0.012** (0.005)	-0.002** (0.001)	-0.002** (0.001)	-0.002** (0.001)
No. of conflicts over common resource use			0.005 (0.010)			0.000 (0.001)
Distance to roads		0.008 (0.006)			0.000 (0.001)	
st_Kaduna	3.870*** (1.436)	3.916*** (1.453)	3.823*** (1.455)	0.386*** (0.146)	0.386** (0.148)	0.384** (0.150)
st_Katsina	4.812*** (1.478)	4.797*** (1.489)	4.799*** (1.483)	0.491*** (0.148)	0.487*** (0.149)	0.491*** (0.150)
st_Kebbi	3.615*** (1.352)	3.625*** (1.362)	3.615*** (1.356)	0.363*** (0.131)	0.363*** (0.132)	0.363*** (0.132)
st_Nasarawa	4.570*** (1.398)	4.683*** (1.420)	4.561*** (1.404)	0.456*** (0.135)	0.459*** (0.136)	0.456*** (0.136)
st_Niger	4.869*** (1.426)	4.958*** (1.449)	4.873*** (1.431)	0.505*** (0.142)	0.507*** (0.143)	0.505*** (0.143)
st_Ondo	1.342 (1.453)	1.346 (1.443)	1.350 (1.456)	0.115 (0.138)	0.117 (0.138)	0.116 (0.139)
st_Zamfara	4.734*** (1.443)	4.851*** (1.460)	4.748*** (1.450)	0.475*** (0.144)	0.479*** (0.145)	0.476*** (0.145)
st_Edo	1.991* (1.105)	2.007* (1.117)	1.995* (1.105)	0.205** (0.088)	0.206** (0.089)	0.205** (0.089)
st_Kogi	0.192 (1.192)	0.207 (1.197)	0.192 (1.192)	-0.018 (0.074)	-0.016 (0.075)	-0.018 (0.075)
st_Kwara	0.970 (1.379)	0.966 (1.370)	0.972 (1.381)	0.075 (0.113)	0.076 (0.114)	0.076 (0.114)
st_Abia	0.023 (1.410)	0.002 (1.419)	0.019 (1.410)	0.014 (0.070)	0.014 (0.071)	0.014 (0.070)
Constant	-6.144*** (1.406)	-6.301*** (1.419)	-6.177*** (1.411)	-0.277** (0.132)	-0.281** (0.132)	-0.277** (0.133)
Observations	101	101	101	101	101	101
R-squared				0.339	0.340	0.339
Adjusted R-squared				0.153	0.143	0.142
AIC	1.030	1.049	1.050			
Log likelihood	-29.00	-28.96	-29.00	68.50	68.58	68.50

Source: Authors' calculations.

Notes: AIC = Akaike Information Criterion; GLM = generalized linear model; OLS = ordinary least squares.

**Table B.7 Parameter estimates for the awareness index for cultural services**

Variable	GLM1	GLM2	GLM3	OLS1	OLS2	OLS3
Main ethnicity: Hausa	0.577** (0.278)	0.680** (0.286)	0.610** (0.278)	0.086 (0.059)	0.098 (0.060)	0.091 (0.059)
Main ethnicity: Yoruba	0.386 (0.935)	0.336 (0.909)	0.380 (0.939)	0.067 (0.163)	0.059 (0.162)	0.067 (0.164)
Unused land (area %)	0.028** (0.014)	0.029** (0.014)	0.028** (0.014)	0.004* (0.002)	0.004* (0.002)	0.004* (0.002)
Residential land (area %)	0.011 (0.007)	0.015** (0.007)	0.011 (0.007)	0.002 (0.001)	0.002 (0.001)	0.002 (0.001)
Forest (area %)	0.037*** (0.011)	0.039*** (0.010)	0.037*** (0.011)	0.006*** (0.002)	0.006*** (0.002)	0.006*** (0.002)
Floodplain (area %)	0.043*** (0.013)	0.046*** (0.013)	0.043*** (0.013)	0.007*** (0.002)	0.007*** (0.002)	0.007*** (0.002)
Grazing land (area %)	0.012 (0.020)	0.023 (0.022)	0.010 (0.020)	0.002 (0.004)	0.004 (0.004)	0.001 (0.004)
Woodland (area %)	0.015 (0.018)	0.019 (0.019)	0.015 (0.019)	0.001 (0.003)	0.002 (0.003)	0.002 (0.003)
Water (area %)	-0.011 (0.016)	-0.013 (0.016)	-0.011 (0.016)	-0.001 (0.002)	-0.000 (0.002)	-0.001 (0.002)
% of households food-insecure	-0.009* (0.005)	-0.012** (0.005)	-0.010* (0.005)	-0.001 (0.001)	-0.002* (0.001)	-0.001 (0.001)
% of adult literacy	0.005 (0.007)	0.002 (0.007)	0.005 (0.007)	0.001 (0.002)	0.001 (0.002)	0.001 (0.001)
No. of conflicts over common resource use			0.007 (0.007)			0.001 (0.002)
Distance to roads		0.014*** (0.005)			0.002** (0.001)	
st_Kaduna	3.432*** (1.305)	3.532*** (1.284)	3.355*** (1.299)	0.429* (0.227)	0.431* (0.220)	0.415* (0.228)
st_Katsina	3.560*** (1.309)	3.549*** (1.281)	3.542*** (1.297)	0.440* (0.222)	0.420* (0.214)	0.436* (0.221)
st_Kebbi	2.749** (1.165)	2.805** (1.150)	2.754** (1.155)	0.314 (0.194)	0.314 (0.190)	0.314 (0.192)
st_Nasarawa	3.247*** (1.168)	3.441*** (1.150)	3.233*** (1.159)	0.390** (0.192)	0.404** (0.188)	0.385** (0.191)
st_Niger	3.325*** (1.183)	3.484*** (1.164)	3.320*** (1.172)	0.402** (0.195)	0.413** (0.191)	0.399** (0.193)
st_Ondo	1.646 (1.252)	1.685 (1.230)	1.661 (1.257)	0.155 (0.195)	0.162 (0.194)	0.157 (0.197)
st_Zamfara	3.573*** (1.254)	3.799*** (1.237)	3.589*** (1.243)	0.448** (0.209)	0.467** (0.205)	0.450** (0.207)
st_Edo	2.586*** (0.676)	2.623*** (0.692)	2.596*** (0.676)	0.345*** (0.073)	0.350*** (0.074)	0.346*** (0.073)
st_Kogi	1.319 (0.878)	1.372 (0.884)	1.326 (0.880)	0.115 (0.108)	0.126 (0.111)	0.116 (0.109)
st_Kwara	1.491 (1.219)	1.509 (1.197)	1.503 (1.222)	0.143 (0.189)	0.146 (0.188)	0.145 (0.191)
st_Abia	-0.166 (0.789)	-0.174 (0.804)	-0.165 (0.790)	0.019 (0.051)	0.020 (0.053)	0.020 (0.052)
Constant	-5.443*** (1.070)	-5.665*** (1.067)	-5.482*** (1.075)	-0.326** (0.153)	-0.349** (0.152)	-0.331** (0.154)
Observations	101	101	101	101	101	101
R-squared				0.379	0.396	0.380
Adjusted R-squared				0.203	0.215	0.194
AIC	1.175	1.190	1.194			
Log likelihood	-36.32	-36.11	-36.31	50.96	52.35	51.04

Source: Authors' calculations.

Notes: AIC = Akaike Information Criterion; GLM = generalized linear model; OLS = ordinary least squares.

## REFERENCES

- Abram, N. K., E. Meijaard, M. Ancrenaz, R. K. Runting, J. A. Wells, D. Gaveau, A. Pellier, K. Mengersen. 2014. "Spatially Explicit Perceptions of Ecosystem Services and Land Cover Change in Forested Regions of Borneo." *Ecosystem Services* 7:116–127.
- Acharya, G. 2000a. Approaches to valuing the hidden hydrological services of wetland ecosystems. *Ecological Economics* 35: 63–74.
- Acharya, G. 2000b. "The Value of Biodiversity in the Hadejia-Nguru Wetlands of Northern Nigeria." In *The Economics of Biodiversity Conservation in Sub-Saharan Africa*, edited by C. Perrings, 49–78. Cheltenham, UK: Edward Elgar Publishing Ltd.
- Acharya, G., and E. B. Barbier. 2000. "Valuing Groundwater Recharge through Agricultural Production in the Hadejia-Nguru Wetlands in Northern Nigeria". *Agricultural Economics* 22: 247–259.
- Acharya, G. 2002. "Using Domestic Water Analysis to Value Groundwater Recharge in the Hadejia-Jama'are Floodplain, Northern Nigeria." *American Journal of Agricultural Economics* 84 (2) (May): 415–426.
- Akaike, H. 1974. "A New Look at the Statistical Model Identification." *IEEE transactions on Automatic Control* 19: 716–723.
- Cowling, R. M., B. Egoh, A. T. Knight, B. Reyers, M. Rouget, D. Roux, and A. S. Welz. 2008. "An Operational Model for Mainstreaming Ecosystem Services for Implementation." *Proceedings of the National Academy of Science of the United States of America* 105 (28): 9483–9488.
- Dung, E. J., L. S. Bombom, and T. D. Agusomu. 2008. "The Effects of Gas Flaring on Crops in the Niger Delta." *Nigeria GeoJournal* 73 (4): 297–305.
- Eboh E., K. O. Oji, I. A. Achike, O. C. Ujah, U. S. Amakom, M. O. Oduh, C. Nzeh, and B. K. Larsen. 2005. "Sustainability of Economic Growth in Nigeria: The Role of Renewable Natural Resources." Unpublished, African Institute for Applied Economics Nigeria, Enugu.
- Eregha, P.B., and I. R. Irughe. 2009. "Oil Induced Environmental Degradation in the Nigeria's Niger-Delta: the Multiplier Effects." *Journal of Sustainable Development in Africa* 11 (4): 160–175.
- Etkin, N. L. 2002. "Local Knowledge of Biotic Diversity and Its Conservation in Rural Hausaland, Northern Nigeria." *Economic Botany* 56 (1): 73–88.
- FAO (Food and Agriculture Organization of the United Nations). 2011. *2011 State of the World's Forests*. Rome.
- Hauck, J., C. Görg, R. Varjopuro, O. Ratamáki, and K. Jax. 2013. "Benefits and Limitations of the Ecosystem Services Concept in Environmental Policy and Decisionmaking: Some Stakeholder Perspectives." *Environmental Science and Policy* 25:13–21.
- Hein, L., K. van Koppen, R. S. de Groot, and E. C. van Ierland. 2006. "Spatial Scales, Stakeholders and the Valuation of Ecosystem Services." *Ecological Economics* 57: 209–228.
- Kasina, J. M., J. Mburu, M. Kraemer, and K. Holm-Mueller. 2009. "Economic Benefit of Crop Pollination by Bees: A Case of Kakamega Small-Holder Farming in Western Kenya." *Journal of Economic Entomology* 102(2): 467–473. doi:10.1603/029.102.0201
- Lamarque, P., U. Tappeiner, C. Turner, M. Steinbacher, R. D. Bardgett, U. Szukics, M. Schermer, and S. Lavorel. 2011. "Stakeholder Perceptions of Grassland Ecosystem Services in Relation to Knowledge on Soil Fertility and Biodiversity." *Regional Environmental Change* 11: 791–804.
- Lugnot, M., and G. Martin. 2013. "Biodiversity Provides Ecosystem Services: Scientific Results versus Stakeholders' Knowledge." *Regional Environmental Change* 13: 1145–1155.
- Martín-López, B., I. Iniesta-Arandia, M. García-Llorente, I. Palomo, I. Casado-Arzuaga, D. Del Amo, E. Gómez-Baggethun, E. Oteros-Rozas, I. Palacios-Agundez, B. Willaarts, J. González, F. Santos-Martín, M. Onaindia, C. López-Santiago, C. Montes. 2012. "Uncovering Ecosystem Service Bundles through Social Preferences." *PLoS ONE* 7 (6): e38970. doi:10.1371/journal.pone.0038970

- MEA (Millennium Ecosystem Assessment). 2005. *Ecosystems and Human Well-Being: Synthesis*. Washington, DC: Island Press.
- Menzel, S., and J. Teng. 2009. "Ecosystem Services as a Stakeholder-Driven Concept for Conservation Science." *Conserv Biol* 24: 907–909.
- Morris, C., and C. Potter. 1995. "Recruiting the New Conservationists: Farmers' Adoption of Agri-Environmental Schemes in the U.K." *Journal of Rural Studies* 11: 51–63.
- Muhamad, D., S. Okubo, K. Harashina, Parikesit, B. Gunawan, and K. Takeuchi. 2014. "Living Close to Forests Enhances People's Perception of Ecosystem Services in a Forest-Agricultural Landscape of West Java, Indonesia." *Ecosystem Services* 8: 197–206.
- Munyuli, T. 2011. "Farmers' Perceptions of Pollinators' Importance in Coffee Production in Uganda." *Agricultural Sciences* 2 (3): 318–333. doi:10.4236/as.2011.23043
- Nkonya, E., D. Phillip, E. Kato, B. Ahmed, A. Daramola, S. B., Ingawa, I. Luby, E.A. Lufadeju, M. Madukwe, and A.G. Shettima. 2013. "Medium-Term Impact of Fadama III Project." Unpublished, International Food Policy Research Institute, Washington, DC.
- Oladele, O. I. 2012. "Knowledge Levels and Perceived Effect of Ecosystem Services and Valuation on Extension Delivery in North West Province, South Africa." *Journal of International Agricultural and Extension Education* 19 (1): 42–53. <http://bit.ly/1u4epYL> doi: 10.5191/jiaee.2012.19106
- Pagiola, S., and G. Platais. 2007. *Payments for Environmental Services: From Theory to Practice*. Washington: World Bank.
- Papke, L. E., and J. Wooldridge. 1996. "Econometric Methods for Fractional Response Variables with an Application to 401(k) Plan Participation Rates." *Journal of Applied Econometrics* 11: 619–632.
- Poppenborg, P., and T. Koellner. 2013. "Do Attitudes toward Ecosystem Services Determine Agricultural Land Use Practices? An Analysis of Farmers' Decisionmaking in a South Korean Watershed." *Land Use Policy* 31: 422–429.
- Reid, W. V., H. A. Mooney, D. Capistrano, S. R. Carpenter, K. Chopra, A. Cropper, P. Dasgupta, R. Hassan, R. Leemans, R. M. May, P. Pingali, C. Samper, R. Scholes, R. T. Watson, A. H. Zakri, Z. Shidong. 2006. "Nature: The Many Benefits of Ecosystem Services." *Nature* 443 (7113): 749–750.
- Rodríguez, J. P., T. D. Beard, Jr., E. M. Bennett, G. S. Cumming, S. Cork, J. Agard, A. P. Dobson, and G.D. Peterson. 2006. "Trade-offs across Space, Time, and Ecosystem Services." *Ecology and Society* 11 (1): 28.
- Rogers, E. M. 2003. *Diffusion of Innovations*. New York: Free Press.
- Sodhi, N. S., T. M. Lee, C. H. Sekercioglu, E. L. Webb, D. M. Prawiradilaga, D.J.,Lohman, N. E. Pierce, A. C. Diesmos, M. Rao, P. R. Ehrlich. 2010. "Local People Value Environmental Services Provided by Forested Parks." *Biodiversity Conservation* 19: 1175–1188.
- Swinton, S. M., and W. Zhang. 2005. "Rethinking Ecosystem Services from an Intermediate Product Perspective." Selected paper, the annual meeting of American Agricultural Economics Association, Providence, Rhode Island, July 24–27, 2005.
- TEEB (The Economics of Ecosystems and Biodiversity). 2010. "Mainstreaming the Economics of Nature: A Synthesis of the Approach, Conclusions, and Recommendations of TEEB." Accessed February 2, 2015. <http://www.teebweb.org/publication/mainstreaming-the-economics-of-nature-a-synthesis-of-the-approach-conclusions-and-recommendations-of-teeb/>.
- Titilola, S. T. 2008. "Environmental Degradation and Its Implications for Agricultural and Rural Development: The Issues of Land Erosion." *Journal of Sustainable Development in Africa* 10 (2): 116–146.
- Urgenson, L. S., H. E. Prozesky, and K. J. Esler. 2013. "Stakeholder Perceptions of an Ecosystem Services Approach to Clearing Invasive Alien Plants on Private Land." *Ecology and Society* 18 (1): 26.
- Vermeulen, S., and I. Koziell. 2002. "Integrating Global and Local Values: A Review of Biodiversity Assessment." Natural Resource Issues Paper. London: Institute for Environment and Development.

- Willock, J., I. J. Deary, G. Edwards-Jones, G. J. Gibson, M. J. McGregor, A. Sutherland, J. B. Dent, O. Morgan, and R. Grieve. 1999. "The Role of Attitudes and Objectives in Farmer Decisionmaking: Business and Environmentally Oriented Behaviour in Scotland." *Journal of Agricultural Economics* 50: 286–303.
- Zaccai, E. 2012. "Over Two Decades in Pursuit of Sustainable Development: Influence, Transformations, Limits." *Environmental Development* 1 (1): 79–90.





## RECENT IFPRI DISCUSSION PAPERS

For earlier discussion papers, please go to [www.ifpri.org/pubs/pubs.htm#dp](http://www.ifpri.org/pubs/pubs.htm#dp).  
All discussion papers can be downloaded free of charge.

1417. *2011 social accounting matrix for Senegal*. Ismaël Fofana, Mamadou Yaya Diallo, Ousseynou Sarr, and Abdou Diouf, 2015.
1416. *Firm heterogeneity in food safety provision: Evidence from Aflatoxin tests in Kenya*. Christine Moser and Vivian Hoffmann, 2015.
1415. *Mechanization outsourcing clusters and division of labor in Chinese agriculture*. Xiaobo Zhang, Jin Yang, and Thomas Reardon, 2015.
1414. *Conceptualizing drivers of policy change in agriculture, nutrition, and food security: The Kaleidoscope Model*. Danielle Resnick, Suresh Babu, Steven Haggblade, Sheryl Hendriks, and David Mather, 2015.
1413. *Value chains and nutrition: A framework to support the identification, design, and evaluation of interventions*. Aulo Gelli, Corinna Hawkes, Jason Donovan, Jody Harris, Summer Allen, Alan de Brauw, Spencer Henson, Nancy Johnson, James Garrett, and David Ryckembusch, 2015.
1412. *Climate change adaptation assets and group-based approaches: Gendered perceptions from Bangladesh, Ethiopia, Mali, and Kenya*. Noora Aberman, Snigdha Ali, Julia A. Behrman, Elizabeth Bryan, Peter Davis, Aiveen Donnelly, Violet Gathaara, Daouda Kone, Teresiah Nganga, Jane Ngugi, Barrack Okoba, and Carla Roncoli, 2015.
1411. *Information networks among women and men and the demand for an agricultural technology in India*. Nicholas Magnan, David J. Spielman, Kajal Gulati, and Travis J. Lybbert, 2015.
1410. *Measurement of agricultural productivity in Africa South of the Sahara: A spatial typology application*. Bingxin Yu and Zhe Guo, 2015.
1409. *Eliciting farmers' valuation for abiotic stress-tolerant rice in India*. Anchal Arora, Sangeeta Bansal, and Patrick S. Ward, 2015.
1408. *Understanding the policy landscape for climate change adaptation: A cross-country comparison using the net-map method*. Noora Aberman, Regina Birner, Eric Haglund, Marther Ngigi, Snigdha Ali, Barrack Okoba, Daouda Koné, Tekie Alemu, 2015.
1407. *Evolving public expenditure in Chinese agriculture definition, pattern, composition, and mechanism*. Bingxin Yu, Kevin Chen, Yumei Zhang, and Haisen Zhang, 2014.
1406. *Fertility, agricultural labor supply, and production*. Bjorn Van Campenhout, 2014.
1405. *Impact simulation of ECOWAS rice self-sufficiency policy*. Ismaël Fofana, Anatole Goundan, and Léa Vicky Magne Domgho, 2014.
1404. *Political economy of state interventions in the Bangladesh food-grain sector*. Nurul Islam, 2014.
1403. *Loan demand and rationing among small-scale farmers in Nigeria*. Aderibigbe S. Olomola and Kwabena Gyimah-Brempong, 2014.
1402. *Revisiting the labor demand curve: The wage effects of immigration and women's entry into the US labor force, 1960–2010*. Alan de Brauw and Joseph R. D. Russell, 2014.
1401. *Improving the food policy process: lessons from capacity strengthening of parliamentarians in Ghana*. Jagdeep S. Chhokar, Suresh Chandra Babu, and Shashidhara Kolavalli, 2014.
1400. *Business operations of agrodealers and their participation in the loan market in Nigeria*. Aderibigbe S. Olomola, 2014.
1399. *Irrigation Potential in Nigeria: Some Perspectives Based on Factor Endowments, Tropical Nature, and Patterns in Favorable Areas*. Hiroyuki Takeshima and Margaret Adesugba, 2014.
1398. *Droughts, distress, and policies for drought proofing agriculture in Bihar, India*. Avinash Kishore, Pramod Kumar Joshi, and Divya Pandey, 2014.
1397. *Aligning public expenditure for agricultural development priorities under rapid transformation: The case of China*. Bingxin Yu, Kevin Chen, and Haisen Zhang, 2014.

**INTERNATIONAL FOOD POLICY  
RESEARCH INSTITUTE**

**[www.ifpri.org](http://www.ifpri.org)**

**IFPRI HEADQUARTERS**

2033 K Street, NW  
Washington, DC 20006-1002 USA  
Tel.: +1-202-862-5600  
Fax: +1-202-467-4439  
Email: [ifpri@cgiar.org](mailto:ifpri@cgiar.org)