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Constraints to Fertilizer Use in Nigeria

Insights from Agricultural Extension Service

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ABSTRACT

Fertilizer consumption rates in Nigeria remains among the lowest in the world despite decades of aggressive subsidization. The extension service in Nigeria has a double-edged impact on fertilizer use in the country; not only can their activities increase farmers' demand for fertilizer, but also the organizational framework of the service, Agricultural Development Programs, is the major source of fertilizer for farmers. To provide insights on the reasons for the low fertilizer use in Nigeria, this paper presents an analysis of the extension service as well as some perspectives of village extension agents. We find that the reach of the extension service is severely limited by low staff. The main technology transmitted is the use of improved seeds. Fertilizer technology is seldom transmitted and very rarely is irrigation taught. Furthermore, extension agents are found to have gaps in their knowledge of fertilizer technology. Extension agents routinely distribute agricultural inputs and many see their advisory role as secondary to this function. Extension agents identified the primary constraint to fertilizer use in Nigeria as the physical absence of the product at the time that it is needed, rather than lack of affordability or farmers' lack of knowledge about the benefits or the use of fertilizer.

Keywords: extension, Nigeria, Africa, fertilizer, subsidies

ABBREVIATIONS AND ACRONYMS

ADP	agricultural development projects
CAN	calcium ammonium nitrate
FCT	Federal Capital Territory
FFD	Federal Fertilizer Department
FMSP	Federal Market Stabilization Program
GDP	Gross Domestic Product
IFDC	International Fertilizer Development Center
ISFM	integrated soil fertility management techniques
Kg/ha	kilograms per hectare
Mt/ha	metric tons per hectare
NBS	National Bureau of Statistics
NEEDS	National Economic Empowerment and Development Strategy
NPK	nitrogen, phosphorus, and potassium
PPP	Purchasing Power Parity
SFG	small farmer groups
SSP	single super phosphate
VEAs	village extension agents
WIA	Women in Agriculture Initiative

1. INTRODUCTION

Nigeria's agroecology sustains the cultivation of a wide variety of crops, including staples like millet, sorghum, maize, cassava, yam, and cowpeas and cash crops like cocoa, groundnuts, rubber, and oil palm. Farming and livestock rearing are the main sources of livelihood for more than 70 percent of households and in 2009, agriculture contributed 42 percent of the country's $357 billion economy - significantly higher than the 16 percent derived from petroleum and natural gas production, which dominate the country's export revenue (Nigeria, NBS 2008 and 2010; CIA 2009).[1] Nevertheless, Nigeria's promising agricultural potential has yet to be realized. Between 1960 and 2005, Nigeria's cereal yield per hectare has only grown by about 40 percent. This pales in comparison with a 150 percent increase in India, and a 200 percent increase in Pakistan, countries that had similar levels of productivity at the beginning of that period (Nationmaster.com 2010).[2] To meet its growing food needs, Nigeria imports staples like rice, maize, and cassava and since 2006, the country has spent about $3 billion per year on food and agricultural imports (U.S. & Foreign Commercial Service 2008; Anuforo 2009). In recognition that Nigeria's low agricultural productivity has serious food security and poverty implications the current National Economic Empowerment and Development Strategy (NEEDS) emphasizes the importance of agriculture and includes ambitious targets that require vast increases in agricultural productivity (Federal Ministry of Agriculture and Rural Development 2007).

While fertilizer is not a panacea, there has always been a "sharp increase in the use of chemical fertilizer" (Morris et al. 2007, p. 9) in countries that have successfully increased agricultural productivity. In Nigeria, consumption of fertilizer was only 7 kilograms per hectare (kg/ha) of arable land in 2005, significantly lower than India's rate of about 121 kg/ha or Pakistan's 184 kg/ha (World Resources Institute 2010). This low fertilizer application rate persists despite the fact that the Nigerian government has been prominently engaged in procuring and distributing fertilizer since the early 1970s. Both state and federal governments have also subsidized fertilizer, sometimes at rates as high as 95 percent (Nagy and Edun 2002). However, the subsidy programs have been plagued by pervasive problems of late delivery of fertilizer, and delivery of inappropriate quantities and types of fertilizer. Rent-seeking activities and political manipulation have also resulted in diversion of subsidized fertilizer from the intended beneficiaries. Even though the subsidy programs absorbed large proportions of the national budget, the impact of the programs on agricultural productivity has been mixed at best. The programs have not created sustained increases in fertilizer consumption and fertilizer use has mirrored the ebb and flow of federal and state government subsidies and the almost annual changes in procurement and distribution rules (Nagy and Edun 2002).

Despite the systemic inefficiencies of the government programs, scaling back of the subsidies in the early 1990s resulted in a precipitous fall in fertilizer consumption from about 460,000 metric tons (MT) in 1994 to less than 100,000 MT in 1999 (Chude 2006). After the government's decades-long monopoly, the private fertilizer sector was inexperienced and undeveloped and could not compensate for the federal government's sudden exit from the sector (Nagy and Edun 2002). Complete liberalization the fertilizer sector in 1997 therefore did not result in increases in consumption or a more efficient private-based market. Among the alternatives to address these challenges, the federal government chose to resume subsidizing fertilizer in 1999.

There are various reasons factors leading to low fertilizer use in Nigeria that are not addressed by direct price subsidies. One constraint is the poor road and transportation system, which raises farm-gate prices for fertilizer and also affects the profitability of using fertilizer by limiting farmers' access to markets to sell their output (Donovan 2004). It is also argued that with rain fed agriculture and without complementary improved seed to respond to fertilizer, farmers find fertilizer too risky to adopt, despite its possible profitability (Pender, Nkonya, and Rosegrant 2004). Another identified constraint to fertilizer

[1] Henceforth, all dollars are in US dollars.

[2] Average cereal yield in Nigeria in 2005 was 1.05 metric tons per hectare (mt/ha), compared with 2.4 mt/ha in India and 2.6 mt/ha in Pakistan.

adoption is that farmers lack knowledge about how to use it (Donovan 2004; Chude 2006). This latter issue can be directly addressed by an effective national extension system.

In Nigeria, extension workers have a double-edged impact on fertilizer consumption. First, extension agents can increase demand for fertilizer by educating farmers about its use and about its benefits. Second, the extension service influences farmers' access to fertilizer as Agricultural Development Programs (ADPs), through which extension service is provided, are also the major source of fertilizer (O. Adeyemi, personal communication, 13 August, 2009).[3] In this paper, we investigate the state of the extension service in Nigeria in view of its role in both the demand and supply of fertilizer. We first explore the nature of the extension service to determine the capacity of the system in terms of number of staff, activities of extension agents and the types of technologies transmitted. Second, we elicit the views of the segment of the extension service that is in the most direct contact with farmers, village extension agents (VEAs), on the major constraints to fertilizer use. Recognizing the heterogeneity among Nigerian states in terms of ecology, demographics, and state fertilizer subsidy levels, our empirical analysis is based on eight states that are representative of the variation in a typological categorization of Nigerian states along these dimensions.

Our overview of the extension service shows that it is highly stretched and that only a small proportion of farmers can plausibly access extension services. Nevertheless, we find that VEAs appear to be dedicated to their work and all report working outside the required work hours. The principal technology transmitted to farmers is use of improved seeds. The evidence shows that only rarely do agents transmit information about fertilizer and irrigation technologies - complementary technologies that are also necessary to increase productivity. Furthermore, VEAs have significant gaps in their knowledge of fertilizers and their application rates. VEAs report that lack of access to agricultural inputs such as seeds and fertilizers is a major constraint for male and female farmers alike. However, in their perception, the most important constraint to fertilizer use is not the high price of fertilizer, but the lack of availability of fertilizer; 42 percent of VEAs did not agree that subsidies are required for farmers to utilize fertilizer. VEAs, especially those in the southern states, spend a significant proportion of their time distributing agricultural inputs like seed and fertilizer and this activity may have compromised their primary mandate of providing advisory services. In an analysis of the market prices for fertilizer across the states, we find evidence to support the commonly stated assertion that subsidized fertilizer is diverted by arbitragers to the private fertilizer retailers.

The rest of the paper is organized as follows. In Section 2, we describe the primary data on which the analysis is based. Section 3 presents an overview of the agricultural extension service in the surveyed states. In section 4, we consider the extension agents' perspectives on constraints to fertilizer use and the most salient challenges for farmers in their states. In Section 5, we investigate the prices of fertilizers in the surveyed states. In Section 6, we raise some of the concerns about the external validity of our analysis and discuss how they are addressed. Section 7 concludes the paper.

[3] Mr. O. Adeyemi was at the time the deputy head of the Rural and Institutional Development component of the Federal Capital Territory Agricultural Development Program and was knowledgeable about the fertilizer supply chain in Nigeria as well as the activities of extension agents.

2. METHODOLOGICAL STRATEGY AND DATA

The analysis in this paper is based on primary data collected by the authors in eight Nigerian states. The following describes the basis of the selection of the sampled the states.

Since 1999 (except in 2000), under the Federal Market Stabilization Program (FMSP), the federal government has procured fertilizer for sale to states at a subsidy of 25 percent.[4] State governments typically further subsidize this fertilizer. Several states also procure fertilizer outside of the FMSP. Table 1 shows the state fertilizer subsidy rates in 2008 and the amount of fertilizer that each state purchased through the FMSP. This data was assembled from records of the Federal Fertilizer Department (FFD) in Abuja, Nigeria. Also shown in Table 1 are estimates of the amount of subsidized fertilizer that each household employed in agriculture would receive if the fertilizer procured through the FSMP was shared equally between such households.[5] There is no state level data of farming population available for 2008. As such estimates of number of agricultural households are based on state level population and employment activity in 2005, obtained from the Nigeria National Bureau of Statistics. Average subsidy rates are highest in the north of the country where states procure the highest amounts of fertilizer both in terms of total amount and amount per agricultural household.

The 36 Nigerian states and the FCT were categorized based on five criteria that are expected to present direct challenges to farming in each state. These criteria were the state fertilizer subsidy rate; the amount of fertilizer procured through the FMSP per agricultural household, state poverty head count, agroecological zone, geographic location of the state, and whether there was a state fertilizer blending plant.

The average and the median state fertilizer subsidy rate was 16.5 and 16.8 percent respectively. States with subsidy rates below 15 percent were categorized at "low" subsidy states, those with rates between 15 and 25 percent were categorized as "medium" subsidy states, and those with subsidy rates above 25 percent were categorized as "high" subsidy rates. By this categorization, 16 Nigerian states and the FCT had "low" state subsidies, 5 had "medium" state subsidies, and 14 had "high" state subsidies.

The amount of fertilizer procured through the FMSP in 2008 ranged from 600 MT in Lagos state to 44,200 MT in Bauchi. The estimated amount per agricultural household ranged from five kilograms (Kg) in Ondo state to 208 Kg in the FCT. The average amount of fertilizer procured under the FSMP per agricultural household was 55 Kg or just over one standard bag of fertilizer. States which procured less than the median amount of 32 Kg per agricultural household were categorized to have "low" FSMP procurement, states with between 32 and 60 Kg per agricultural household were categorized to have "medium" procurement and all other states were categorized to have "high" FSMP procurement. The average and median state poverty head count ratio in Nigeria in 2005 were 55 percent and 52 percent respectively and ranged from 21 percent in Oyo state in southwest Nigeria, to 91 percent in Jigawa in the north east. States with poverty rates below 50 percent were categorized as "low" poverty states, those with rates between 51 and 65 percent were categorized as "medium" poverty states, and those with rates above 65 percent were categorized as "high" poverty states.

Seven agroecological zones were identified in Nigeria according to USDAFAS (2002) and a state was categorized into the one in which the majority of its land area fell based on a visual inspection of a map of Nigeria. If the state land area was split equally between two zones, the state was categorized into both ecological zones. States in the arid savanna were described as being located in the "north" and all other states grouped as being in the "south". Bauchi , Borno, Gombi, Kano, Katsina, Zamfara and Ebonyi had functional state fertilizer blending plants as of 2008. In that year, there were blending plants that were not functional in Benue, Edo, Kebbi, Nassarawa, Niger, Sokoto, and Yobe.

[4] The most common types of fertilizers purchased by states are nitrogen, phosphorus, and potassium (NPK) 20-10-10 and NPK solutions, urea, single super phosphate (SSP), and calcium ammonium nitrate (CAN).

[5] The calculated amount does not take into account fertilizer procured from outside the FSMP for state governments that procure fertilizer outside the FSMP. Records of these amounts could not be obtained.

Table 1. Amount of fertilizer procured through the Federal Market Stabilization Program (FMSP) and state government fertilizer subsidy rates in 2008

Region/state	Metric tons procured under FMSP [a]	Kilograms per agricultural household [b]	State subsidy (%) [a]
North-East			
Adamawa*	26,700	87	18.41
Bauchi	44,200	162	24.08
Borno*	9,330	20	19.29
Gombe*	29,100	142	22.85
Taraba*	28,200	117	24.40
Yobe*	5,070	56	18.71
North-West			
Jigawa*	13,560	32	48.51
Kaduna	9,870	27	17.66
Kano*	32,207	97	40.04
Katsina*	6,300	15	42.08
Kebbi*	35,036	122	12.36
Sokoto*	16,590	53	50.00
Zamfara*	32,800	115	11.35
North-Central			
Benue*	23,130	39	50.00
Federal Capital Territory	8,000	208	0.00
Kogi	40,560	118	17.36
Kwara*	3,930	26	22.50
Nassarawa	24,000	100	14.58
Niger*	27,990	76	16.63
Plateau*	27,000	87	17.36
South-East			
Abia	6,000	13	17.23
Anambra	2,270	6	11.80
Ebonyi*	2,589	9	1.96
Enugu	8,359	30	2.77
Imo*	6,963	12	10.86
South-West			
Ekiti	7,600	47	18.50
Lagos	600	14	0.00
Ogun*	3,600	11	10.05
Ondo*	2,550	5	12.25
Osun*	8,998	38	10.55
Oyo	8,200	23	0.00
South- South			
Akwa-Ibom*	9,650	30	18.43
Bayelsa	4,800	54	0.00
Cross-River	9,330	19	5.86
Delta*	2,760	7	0.00
Edo	8,400	20	14.05
Rivers*	7,800	13	0.00

Source: Authors' survey.
[a] Federal Fertilizer Department 2009. [b] Authors' calculations. Number of agricultural household is estimated as the product of number of households and percentage of state labor force in agriculture reported in Nigeria, NBS (2008).
Notes: In states marked with an asterisk, the state procures fertilizer from other sources in addition to the amount procured from the federal government.

The eight states selected to provide a representative mix of Nigeria states based on this typology are shown in Table 2. Half of the sample states have a high poverty head count ratio, and medium and low poverty head count ratio states are represented by two states each. Bayelsa and Edo were chosen as contrasting states in southern Nigeria. Although both have relatively low poverty head count ratios, an agricultural household in Bayelsa, which provides no state subsidy, receives more than two times the amount of federally subsidized fertilizer as in Edo, where the government has a subsidy rate of almost 15 percent. Neither of these states procures fertilizer outside the FSMP. The two states chosen from the middle agricultural belt of the country are Plateau and Taraba. The economies of these states are highly agriculture-based, and they procured similar amounts of federally subsidized fertilizer in 2008. The state fertilizer subsidy rates are also comparable. Jigawa, Sokoto,Yobe, and Zamfara were selected from northern Nigeria because of their high poverty rates, the dominance of agriculture as the livelihood of their inhabitants, and the relatively higher amounts of fertilizer used in the region. Sokoto has a state subsidy rate of 50 percent, while the rate in neighboring Zamfara is only 11 percent. However, Zamfara procures two times more fertilizer per agricultural household through the FSMP than does Sokoto. Similarly, Yobe, which has a subsidy rate of 19 percent, procures two times more fertilizer per agricultural household through the FSMP than Jigawa, which has a subsidy rate of 48 percent.

Table 2. Characteristics of states surveyed within the classification framework

State	State fertilizer subsidy (%)[a]	Fertilizer procured per agricultural household (Kg)[b]	Agroecological zone [c]	Poverty head count ratio in 2004 (%)[d]	Location	Fertilizer blending facility[a]
Bayelsa	0 (low)	37 (medium)	Mangrove forest	33 (low)	South	No
Edo	14 (low)	12 (low)	Rain forest	47 (low)	South	No
Jigawa	48 (high)	27 (medium)	West sudanian savanna	91 (high)	North	No
Plateau	17 (medium)	58 (medium)	Cameroonian highland forest/ Guinean forest-savanna mosaic	55 (medium)	South	No
Sokoto	50 (high)	38 (medium)	West sudanian savanna	75 (high)	North	Yes
Taraba	24 (medium)	95 (high)	Guinean forest-savanna mosaic	58 (medium)	South	Yes
Yobe	18 (medium)	136 (high)	West sudanian savanna	78 (high)	North	Yes
Zamfara	11 (low)	114 (high)	West sudanian savanna	76 (high)	North	Yes

Sources:[a] Federal Fertilizer Department (2009). [b] Authors' calculations based on Nigeria, NBS (2008). [c] USDAFAS (2002). [d] Ojowu et al (2007).

Each Nigerian state has an Agricultural Development Program (ADP) through which the state extension service operates. Each state has an ADP headquarters, but there may also be several zonal ADP offices. The ADP zones are themselves divided into blocks, each typically composed of multiple villages. In the typical ADP personnel hierarchy, the program manager is the highest ranking official, followed by zonal managers, block extension officers, and finally village extension agents (VEAs). The members of the extension staff who come into contact with the farmers are block extension agents and VEAs.[6] Aside from these employment categories, the extension service also has nonfield staff such as agricultural extension officers, research officers, and certain staff of special programs being run by the ADP. The

[6] In a typical village, farmers may come into contact with a village extension agent and the agent's associated block extension supervisor.

Women in Agriculture Initiative (WIA) is one such special program hosted by the ADP. The WIA program typically has extension agents, often female, who are specifically affiliated with it. Table 3 summarizes the staff of the extension services of the eight sampled states.

Table 3. Extension services of eight selected states in Nigeria, male and female staff

	Extension staff disaggregated by gender and function											
State	Total staff		Village extension agents		Women in Agriculture Program		Block extension supervisor		Zonal Extension officer		Director	
	M	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**
Bayelsa	n. a.	n. a.	8	4	n. a	n. a.	n. a	n. a	n. a	n. a	n. a	n. a.
Edo	24	3	n. a.	n. a.	n. a	n. a.	n. a.	n. a.	n. a.	n. a.	n. a.	n. a.
Jigawa	279	46	218	20	0	20	54	2	3	0	7	0
Plateau	98	67	71	44	0	0	22	23	5	0	0	0
Sokoto	80	5	61	4	0	1	6	0	13	0	0	0
Taraba	124	23	96	16	0	5	26	2	2	0	0	0
Yobe	231	18	198	6	0	0	33	12	0	0	0	0
Zamfara	155	9	n. a.	n. a.	n. a.	n. a.	n. a.	n. a.	n. a.	n. a.	n. a.	n. a.

Source: Authors' survey.
Note: n. a. implies staff function information could not be obtained

VEAs were identified as the extension staff in most direct contact with farmers, and this segment of the extension staff was therefore targeted as survey respondents. Twenty VEAs were selected by gender stratified random sampling for face-to-face interviews in each state. The exception was Bayelsa, where the total state VEA population was only 12 and so all were interviewed. Throughout the paper, the state-level analysis is based on 20 observations in all states except for Bayelsa and Edo where there are 12 and 18 observations respectively.

3. AN OVERVIEW OF THE EXTENSION SERVICE

Demographics of the Extension Service

The extension service is male-dominated. At least 83 percent of the staff in each state is male and the percentage of women in managerial positions is even lower than in the general staff population. The high ratio of male to female staff may have implications on the gender of farmers that receive extension service, especially in northern Nigeria where social norms limit women's ability to interact with males. Another notable observation of the demographics of the extension service is the advanced age of the staff; this may impact the workers' ability to perform the physically taxing aspects of extension activities. In all surveyed states, the average and the median age of the VEAs is higher than 44 years: in Edo, the average age is 48 years. The relatively advanced age of the agents is also worrisome because in the near future, the extension service will lose many experienced workers to retirement. VEAs typically have a high number of years of education. At least 85 percent of VEAs in each of the sampled states had a college certificate or diploma. However, very few report having an area of specialization in extension knowledge - the vast majority describes their knowledge as "general agriculture." VEAs describe their extension work is their sole occupation, though a small minority also reported being farmers. The interviewed VEAs all hail from the states in which they work and were familiar with the local languages. This suggests that a language and cultural barrier is not an area of concern in the capacity of the extension service.

Capacity of the Extension Service

In the sample of states, the number of extension staff who are likely to be in contact with farmers ranges from 12 in Bayelsa to 238 in Jigawa indicating that the size of the extension staff varies considerably across Nigerian states. To provide a measure of the reach of the extension service, we compare this extension staff size to the number of staff that would be required if every farmer were to receive extension service at least once a year. The results in Table 4 show that across Nigeria, the extension service is severely stretched and that extension agents cannot plausibly serve a majority of farmers in their state. While the capacity of the extension service in terms of number of staff is constrained across all states, there is also significant variation among states. In Edo and Bayelsa, at the 2009 staff levels, one extension agent would have to interact with an estimated 50,000 farmers in a year for all farmers to have one interaction. However, in Yobe, the equivalent number per VEA extension agent is estimated at about 2,000. These estimates are highly sensitive to our estimate of the number of farmers in the state and the number of extension staff who actually interact with farmers. Nevertheless, our conclusion that the extension service is severely stretched based on these estimates is corroborated by results from the authors' survey. In Edo and Bayelsa, more than 75 percent of VEAs said that the number of extension workers was not adequate to provide services to all of the farmers who desired it. In the remaining sampled states, on average 65 percent of VEAs interviewed stated that the extension service had limited capacity in terms of the number of staff - the exception was Jigawa, where only 30 percent of VEAs felt that the extension staff size was inadequate.

Table 4 also shows a variation in the number of farmers that a single VEA actually reaches per year. Despite the fact that the estimated number of farmers in Taraba and Zamfara is similar, a VEA in Zamfara reported meeting on average 10 times more farmers than a VEA in Taraba. Table 4 shows that in general, VEAs in the northern states tend to meet with more farmers than those in the southern states. However, there is significant variation in the number of farmers served per VEA even within the same region. The average number of farmers a VEA in Sokoto meets is only about a quarter of that of a VEA in the neighboring state of Zamfara.

Table 4. Work burden per extension staff person

State	Estimated average number of farmers an extension agent must meet if all farmers are to be reached[a]	Actual average number of farmers met in past year per extension agent[b]
Edo	51,018	637
Bayelsa	46,916	260
Plateau	9,927	696
Taraba	8,497	158
Sokoto	18,052	460
Zamfara	7,817	1,623
Yobe	2,123	903
Jigawa	7,020	1,227

Source: Based on responses in authors' survey.

[a] This estimate is based on the average household size in the state as reported in Nigeria, NBS 2008. It assumes that each member of farming household is a farmer. The number of farming households is estimated as the product of the number of households in the state and the percentage of the working population engaged in agriculture.

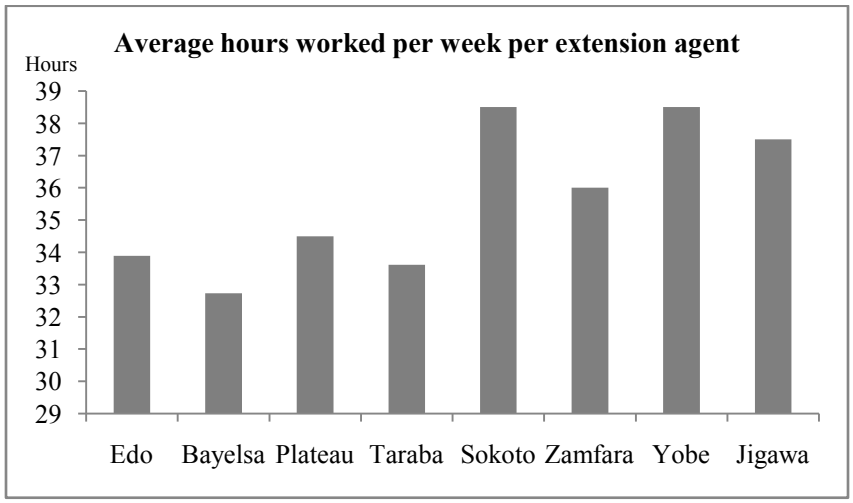
[b] Includes all settings in which village extension agents interact with farmers.

It is important to analyze not only the number of farmers VEAs interact with, but also the gender of these farmers. In much of sub-Saharan Africa, female farmers are disadvantaged in terms of their access to extension services (Saito et al 1994). In the surveyed states, the VEAs did not have accurate records of the number of female farmers they had interacted with and so we used as a measure of reach to female farmers, the percentage of VEAs who report interacting with at least one female headed household in the previous 12 months. This measure provides evidence that female farmers are rarely recipients of extension services. As many as 30 percent of extension agents in Jigawa, Taraba, and Yobe report having had no contact with female farmers in the previous 12 months. Lahai, Goldey, and Jones (2000) show that extension agents in Nigeria are more likely to provide extension services to farmers of the same gender. The low number of female extension staff is also indicative that a lower number of female farmers are reached than male farmers.

In all states, VEAs work more hours in the wet season than in the dry season. As can be seen in Figure 1 (showing wet-season hours), the average number of hours VEAs report working varies across the states. The average number of hours worked per VEA in the southern part of the country tends to be lower than in the northern states, where each extension agent reached more farmers. This difference may explain in part the variation in the average number of farmers each VEA serves. Nevertheless, in all states, almost 100 percent of VEAs report that they provide advisory services to farmers outside of their official work time.

Other factors that are also likely to influence the number of farmers reached per VEA include geographic dispersion of farmers, availability of transportation to access farmers, whether farmers are reached individually in home visits or in small groups of farmers, and how extension agents distribute their time across activities. Ease of accessing farmers appears to be a notable constraint. In Bayelsa, which has one of the lowest rates of VEA interaction with farmers, only 27 percent of agents say they have access to a vehicle to do their work, compared with 65 percent of VEAs in Zamfara and 85 percent in Jigawa. Agents in Zamfara and Jigawa are able to reach five-to-six times more farmers than an agent in Bayelsa. The mode of interacting with farmers, whether in small farmer group (SFG) settings or in individual home visits, does not appear to be a driver of the difference in number of farmers reached per VEA. There is no correlation between the number of farmers seen per VEA and the percentage of VEAs who report group meetings as their main mode of providing extension.

Figure 1. Average number of hours worked per week per VEA agent during the wet season



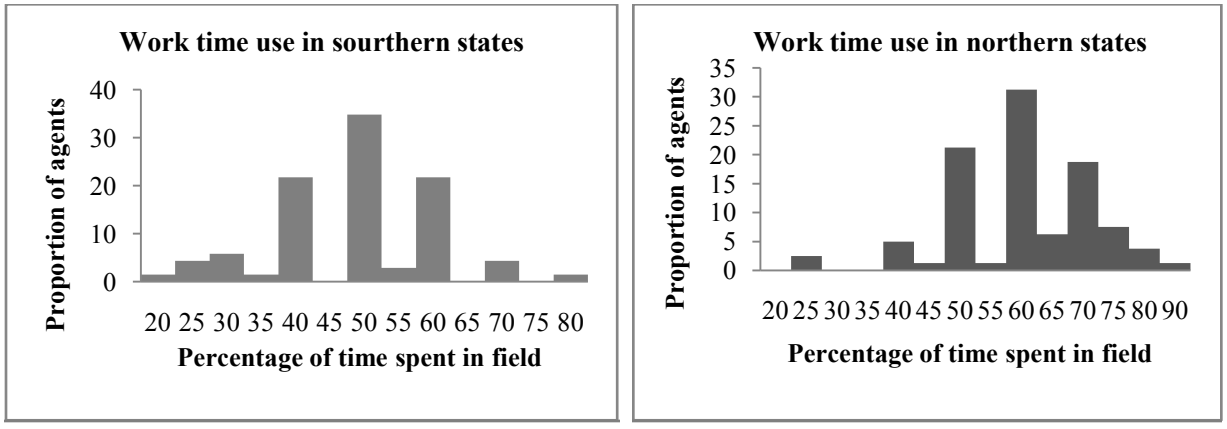
Source: Authors' calculations.

How Extension Agents Spend Their Time

We found that VEAs' work time was divided into activities in five main categories: interacting with farmers in the field, receiving in-service training from their employer or another institution, report writing and meetings that require them to stay in the office, distributing inputs, and a catch-all category for all other activities. [7]

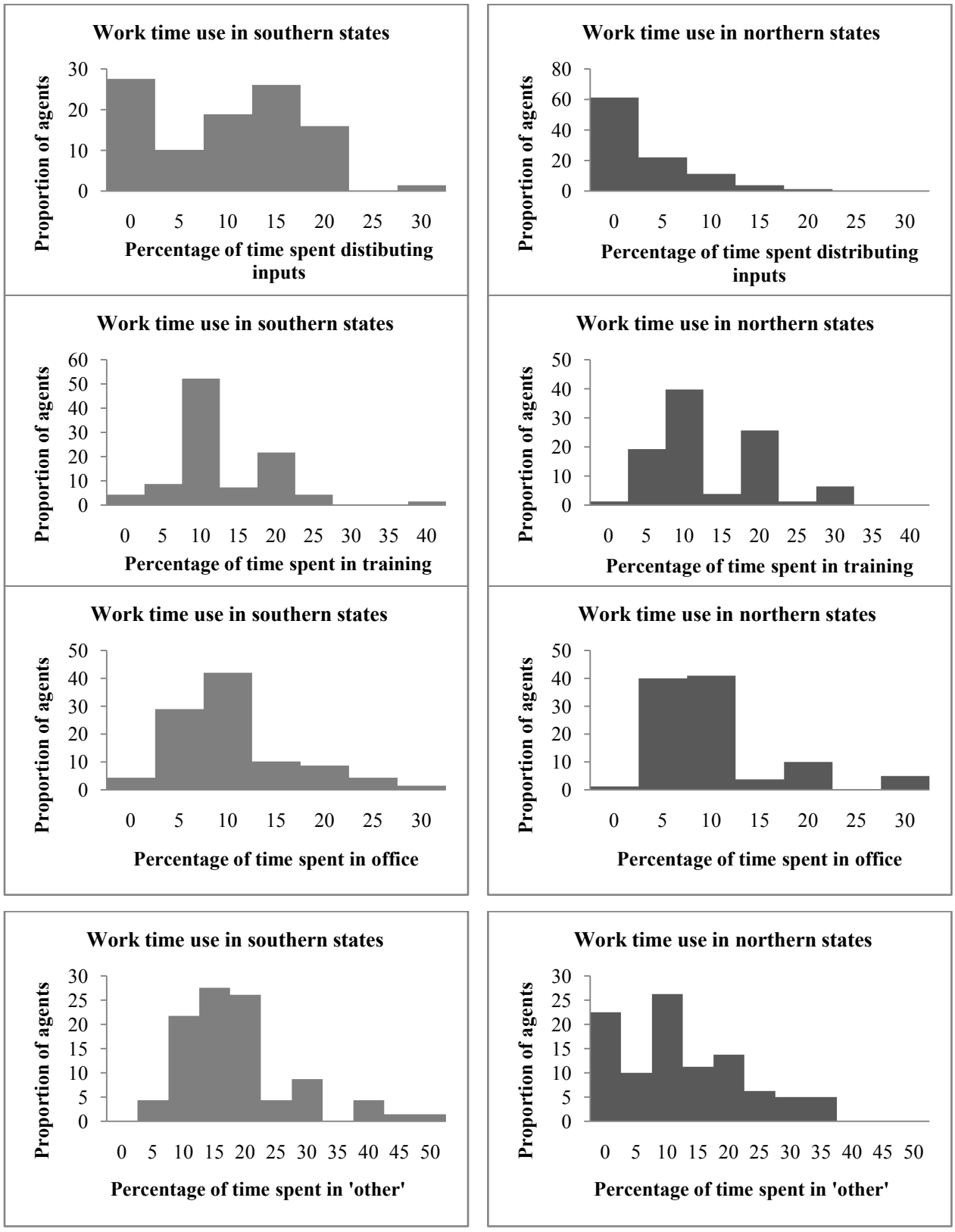
Figure 2 shows the distribution of VEAs' time in each of these categories, disaggregated by location of the state (northern or southern Nigeria). State-level details are presented in the Appendix, Tables A1 to A5. Across all states, extension agents indicated that the majority of their time is spent in the field, interacting with farmers. However, VEAs in the states in the northern part of the country generally spend more time in the field than those in the southern states. In Jigawa, Sokoto,Yobe, and Zamfara, between 85 and 100 percent of VEAs reported spending 50 percent or more of their work time in the field. In Edo and Plateau, about 80 percent of VEAs spent 50 percent or more of their work time in the field. However in Bayelsa and Taraba, only 45 and 15 percent respectively of VEAs reported spending 50 percent or more of their work time in the field.

Figure 2. Use of village extension agents' work time



[7] The category "time spent in the field" captures agents' visits to farmers and monitoring of other field activities such as demonstration plots.

Figure 2. Continued

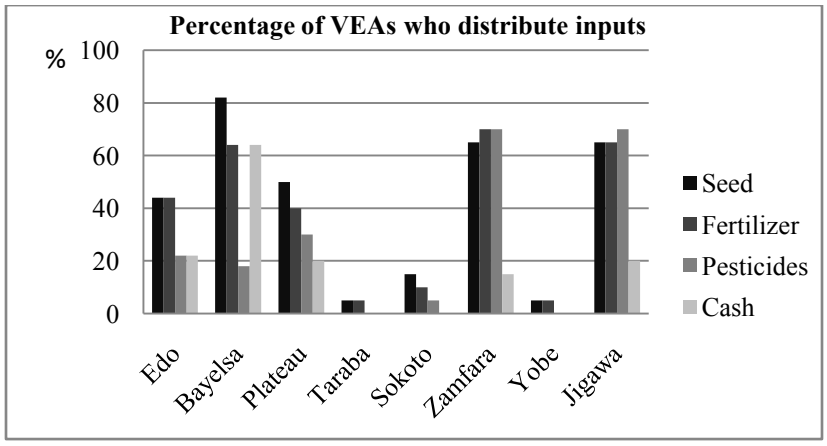


Source: Authors' calculations.

In the southern states, the VEAs typically spend more time distributing inputs in the than those in the northern states - the average percentage of VEAs' work time spent distributing inputs is almost 10 percent, compared with only two percent in the northern states (driven largely by almost no input distribution in Sokoto and Yobe). There is however variation across states within the same geographic location; for instance VEAs in Taraba spend comparatively less time distributing inputs than agents in Bayelsa, Edo, and Plateau. In all the surveyed states, the average proportion of extension agents' time spent on receiving training is about 13 percent. Training topics included crop protection techniques, how to organize farmers into groups, and how to run field demonstrations. 100 percent of the agents who received training described it as "very useful." Time spent on office duties across all states averaged about 10 percent in each state. The similarities between the time spent in "training", "office", and "other" by agents in southern and northern Nigeria suggests that the main driver of the lower proportion of VEA work time spent in the field in the southern states is a result of VEAs in these states spending more of their work time distributing inputs.

In all of the surveyed states, some VEAs were involved in distributing subsidized inputs such as seed and fertilize. However, there is significant state variation in the proportion of VEAs who distribute inputs (Figure 3). In Yobe, only 5 percent of surveyed agents said they distribute fertilizer, but in the neighboring state of Jigawa, 65 percent of agents distribute fertilizer. Similarly, only 10 percent of agents in Sokoto distribute fertilizer, but the proportion of agents in neighboring Zamfara who do so is 70 percent. In the northern states of Zamfara and Jigawa, a high proportion of agents report distributing various kinds of inputs but on average they spend relatively less of their time doing it than in the southern states of Bayelsa, Edo, and Plateau.

Figure 3. Percentage of Village Extension Agents (VEAs) who distribute inputs to farmers



Source: Author's calculations.

Even though distributing inputs is relevant to the adoption of agricultural technology, the time commitment required for that activity may compromise extension agents' primary mandate of providing advisory services. Remarkably, when probed about the challenges they face in distributing inputs, less than one percent of the extension agents interviewed mentioned that it distracts from their main advisory role. This may reflect extension agents' view that distributing inputs is the focal part of their job. The top two challenges identified by agents were shortages of inputs and late arrival of inputs (40 percent of agents); the third most mentioned challenge was difficulty in handling and transporting inputs (17 percent of agents).

Extension Agents' Interactions with Farmers

In all states, the majority of extension agents reported that their most important mode of interaction with farmers is in small farmer group (SFG) settings (Table 5). The majority also stated that membership

fees were required of farmers who wanted to join an SFG. This situation is tantamount to farmers paying for extension services and may limit the poorest farmers' access to extension advice. The SFG is also an important mode for farmers to access agricultural inputs. Even though more than 95 percent of extension agents in each state reported that the primary reason for forming SFGs is to provide extension services to farmers, many agents say that a secondary reason for forming SFGs is to give farmers access to subsidized fertilizers and credit.

Table 5. Village extension agents' (VEAs') interactions with small farmer groups (SFGs)

State	VEAS consider SFG is most important mode of farmer interaction (% of VEAs)	Money is required for SFG membership (% of SFGs)	Average number of SFGs in VEA's jurisdiction	Range of SFG sizes (members)
Bayelsa	91	100	86	15 - 26
Edo	61	78	29	19 – 37
Jigawa	55	75	21	18 - 60
Plateau	85	90	37	27-Dec
Sokoto	75	80	14	19 - 46
Taraba	50	55	9	21 - 42
Yobe	60	80	9	17 - 39
Zamfara	45	65	24	16 - 34

Source: Authors' survey

Despite the fact that the SFG setting is the most important way for farmers to access extension advice, when asked to name the most important service that farmers receive from membership in an SFG, a significant proportion of extension agents stated access to agricultural inputs rather than access to extension advice (Table 6). In Bayelsa and Zamfara, more than 70 percent of extension agents identified access to inputs as the most important service that SFGs provide to farmers. With the exception of Plateau and Taraba, 40 percent or more of extension agents view the SFGs' most important role as access to subsidized inputs. This suggests that extension agents do not recognize the primary importance of their role as sources of extension advice.

Table 6. Village extension agents' (VEAs) perception of most important service that farmers receive from membership in a small farmer group,

State	Access to extension service (% of VEAs reporting)	Access to subsidized inputs or cash credit (% of VEAs reporting)
Bayelsa	27	73
Edo	50	50
Jigawa	45	40
Plateau	90	10
Sokoto	30	45
Taraba	95	5
Yobe	50	35
Zamfara	21	73

Source: Authors' survey
Note: Percentages do not add to 100 because some agents mentioned other services.

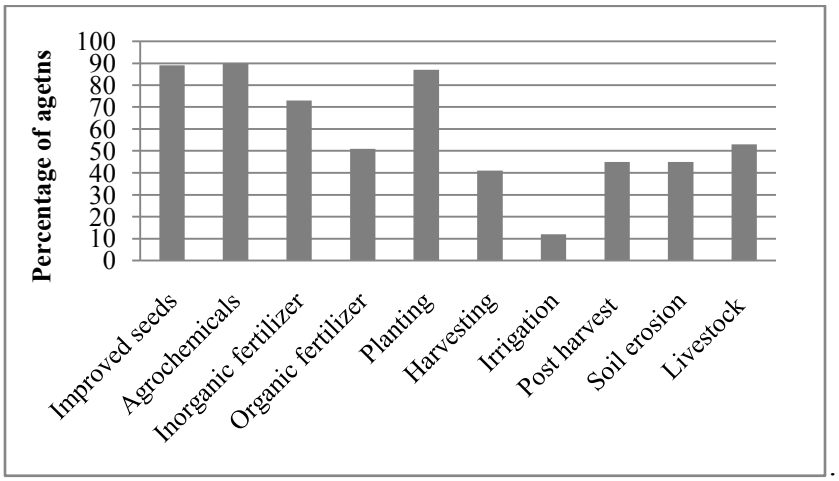
Technologies Transmitted

There is a heavy focus on use of improved seed in the extension messages transmitted in the sampled states and 56 percent of the VEAs interviewed mentioned this topic as the most common extension message they transmit. Just under one fifth of VEAs report that the extension message they most often transmit is related to inorganic fertilizer use. Use of agricultural chemicals, and planting techniques, are

each cited by 10 percent of VEAs as the technology they transmit the often. Extension topics such as use of organic fertilizer, harvesting techniques, irrigation methods, postharvest and food processing techniques, soil erosion control and livestock management are cited by less than one percent of VEAs as being the extension message they most often transmit.

Figure 4 provides a measure of how often and how widely various technologies are passed on to farmers. It shows the percentage of VEAs who report transmission of a particular technology to at least one farmer in the previous 12 month period. The data shows several important types of technologies are seldom broached. It is striking that more than a quarter of the interviewed VEAs have not provided a single farmer any fertilizer-related advice in the previous 12 months. The evidence also shows the rarity of irrigation technology transmission by VEAs; in Bayelsa, Edo, Plateau, Taraba, and Yobe, none of extension agents report teaching irrigation techniques even once over a 12-month period.

Figure 4. Percentage of VEAs who have taught technology at least once in 12 months



Source: Authors' calculations

We find evidence that the knowledge that extension agents themselves have on the agricultural technologies needs to be improved. Fewer than 80 percent of extension agents were able to provide fertilizer information on three crops even when they were allowed to choose the crops with which they were most familiar (Table 7). In some states, almost 20 percent of VEAs were unable to provide information for a single crop. The fact that a high proportion of surveyed VEAs were unable to venture information on fertilizer technology suggests a broader problem of limited knowledge capacity of the extension service.

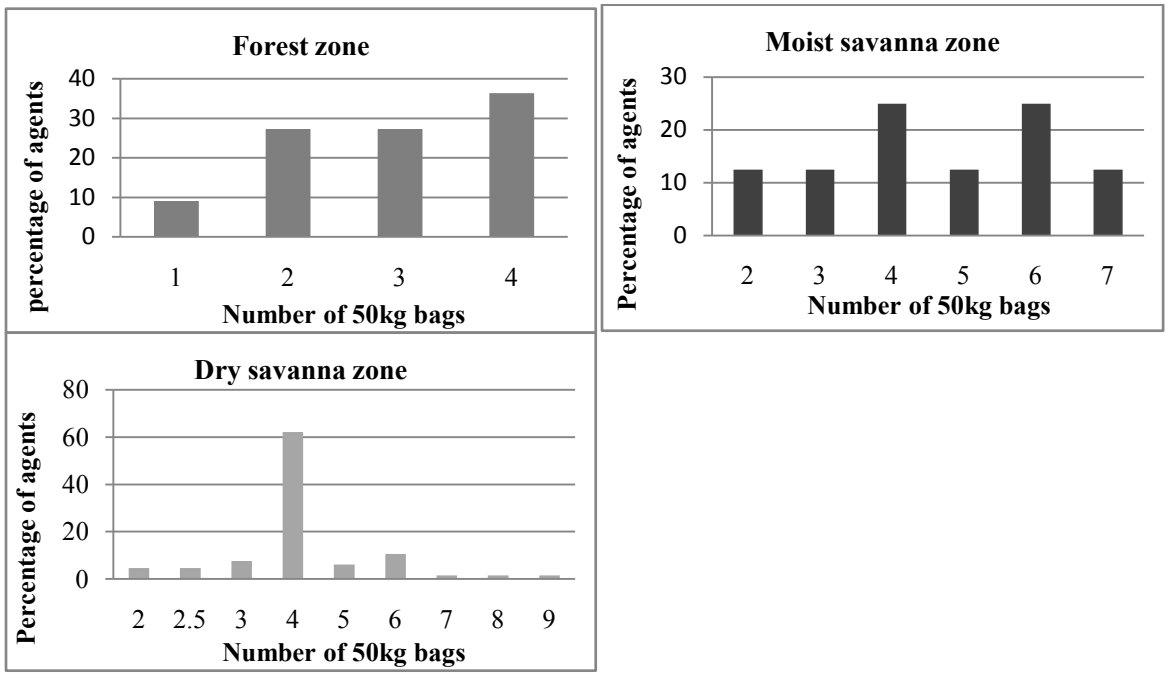
Table 7. Percent of VEAs who could provide fertilizer application rates

State	No crop	One crop only	Two crops only	Three crops
Bayelsa	18		18	64
Edo	17		11	72
Jigawa	5	10		85
Plateau		5	45	50
Sokoto			10	90
Taraba		10	25	65
Yobe			5	95
Zamfara			5	95
All sampled	4	3	15	78

Source: Authors' survey.

The recommended type of fertilizer and application rates of fertilizer provided by VEAs also reveals lapses in agents' knowledge of fertilizer technology. The official recommended application of NPK 20:10:10 on maize is 7 (50kg) bags in Bayelsa and Edo (moist forest zone), 13 bags in Plateau and Taraba (moist savannah zone), and 6 bags in Jigawa, Sokoto, Yobe, and Zamfara (dry savannah zone) (FFD and the Federal Ministry of Agriculture and Water 2002). The distribution of rates proffered by extension agents for application of NPK 20:10:10 on maize is shown in Figure 5. The wide variation in the answers shows that many extension agents do not know the correct recommended amounts. In our reading of official planting manuals, we found that the recommended fertilizer rates are typically given in terms of elemental nutrient weights (for example, N, P, K). However, virtually all extension agents who provided recommended application rates did so in terms of number of 50 kg bags of common fertilizers. This suggests a disconnect between the format of research-backed recommendations and the format in which extension agents require it. The nutrient weight recommendations must first be converted into an equivalent number of bags of fertilizer products available on the market before they are useful to farmers and extension agents. This step may be making it more difficult for extension agents to remain up to date in their knowledge of recommended rates.

Figure 5. Distribution of VEAs' recommended application rates of NPK 20:10:10 on maize



Source: Authors' survey.

We also find evidence that extension agents lack knowledge about which types of fertilizer are appropriate. The majority of agents (more than 70 percent) mentioned NPK 20:10:10 as the type of fertilizer they would recommend, suggesting low familiarity with the other types of fertilizers available in Nigeria, such as muriate of potash, single super phosphate (SSP), and urea. Despite scientific research, which recommends use of urea or SSP for top dressing and NPK for basal application, 40 percent of the interviewed agents recommended NPK 20:10:10 for top dressing,

4. PERCEPTIONS OF EXTENSION AGENTS

On Constraints to Farmers Fertilizer Use

Table 8 summarizes VEAs' perceptions on demand for fertilizer, farmers' knowledge about fertilizer, the supply, affordability, and the quality of fertilizer. The vast majority of extension agents in all surveyed states indicated that the demand for fertilizer is high. Extension agents reported that farmers understand the benefits of fertilizer and would use it if they had access to it. In all surveyed states (with the exception of 85 percent in Yobe), 100 percent of the VEAs said that farmers believe fertilizer is important for increasing their output. From the VEAs' point of view, farmers have adequate knowledge about fertilizer technology. There is, however, some variation across states in the proportion of VEAs who hold this view. In Plateau only 40 percent and in Yobe 50 percent of surveyed agents agreed that farmers know the recommended application rates of fertilizer. In the remaining surveyed states, this percentage ranged from 61 percent in Edo to 75 percent in Jigawa and Zamfara.

Table 8. Summary of extension agents' perceptions of farmers' fertilizer use

Statement	Percentage of village extension agents who agree (entire sample)
Statements regarding farmers' demand for fertilizer	
Farmers in my area of operation believe that using fertilizer is important in increasing their output	98
Farmers in my area of operation who do not use fertilizer would use it if they had access to fertilizer	97
Farmers in my area of operation believe that using fertilizer is important for managing the fertility of their land	95
Statements regarding farmers' knowledge of fertilizer	
Farmers in my area of operation generally know the kind of fertilizer they need to apply to the particular crops they are growing	84
Farmers in my area of operation can easily identify the different kinds of fertilizer and tell the difference between them and which one is relevant to their crops	82
Farmers in my area of operation know the recommended application rate of fertilizers	64
Statements regarding affordability of fertilizer	
Farmers in my area of operation can afford to use fertilizer	66
Statements regarding quality of fertilizer	
The quality of fertilizer that is available in my area of operation is high	88
Statements regarding supply of fertilizer	
Farmers in my area of operation have easy access to adequate amounts of fertilizer	25
Fertilizer is available at the correct time that it is needed for application	25

Source: Authors' survey.

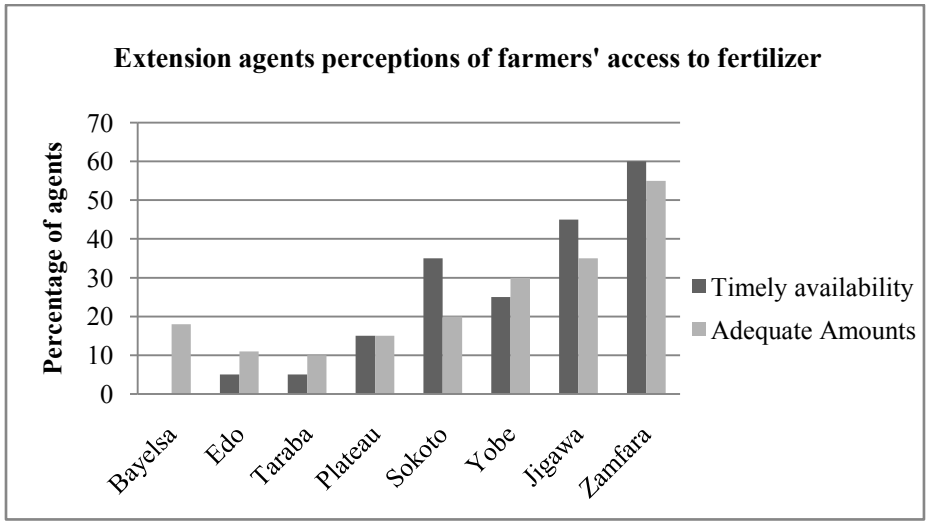
Extension agents' opinions on the affordability of fertilizer also vary across states. In all states, more than 50 percent of extension agents believe that farmers can afford to use fertilizer. In Bayelsa, Edo, and Jigawa, the percentage of agents who believe this is more than 80 percent.

Despite the fact that low fertilizer quality is often described as a major constraint to farmers' use of fertilizer (Chude 2006), the VEAs interviewed almost unanimously describe the quality of fertilizer in

their area as high. The views of these extension agents may reflect a broader disparity between the concerns of policymakers and front-line personnel.

Based on the VEAs' responses, low and untimely supply of fertilizer are the most significant constraints to farmers' fertilizer use. On average, only 25 percent of VEAs agree that fertilizer is available at the time that it is needed—just as few agents agree that farmers in their area of operation have access to adequate amounts of fertilizer. There is, however, a regional divide in terms of VEAs' views on this matter, with agents in the southern states perceiving a worse situation about the supply of fertilizer supply (Figure 6). A higher percentage of the agents in the northern states tend to agree that fertilizer is available at the time that it is needed and that it is available in adequate amounts, but this percentage is typically lower than 45 percent.

Figure 6. Extension agents' perceptions of farmers' access to fertilizer



Source: Authors' calculations.

The answers given by VEAs demonstrate that there are problems of fertilizer shortage and late delivery of fertilizer. Both of these issues are common features of subsidized fertilizer and government intervention in fertilizer marketing (Morris et al. 2007). The VEAs suggest that absence of fertilizer is the major reason for its low adoption rate. The low access to fertilizer and late delivery reveal inefficiencies in the distribution system for subsidized fertilizer in Nigeria pointing to the need for more efficient methods for distributing subsidized fertilizer.

A new fertilizer subsidy paradigm calls for government managed procurement and distribution systems to be replaced by the use of vouchers as a mechanism for simultaneously targeting subsidies and developing demand in private fertilizer markets (Gregory 2006; Minot and Benson 2009). This mechanism has been piloted in some Nigerian states since 2004 and preliminary evidence shows that it has improved the timeliness of fertilizer delivery and increased the quantity of fertilizer available to the program beneficiaries (Gregory 2008).

Challenges to Farming in General

VEAs were asked to provide their views on the most important challenges that farmers face. In recognition that male and female farmers may face different challenges, or the same challenge to different degrees, VEAs were asked to name the greatest challenge for male and female farmers separately. According to their responses shown in Table 9, VEAs perceive that the types of challenges faced by female and male farmers are the same. The most often cited primary challenge for both male and female farmers is limited access to credit; cited by more than 55 percent of extension agents. Other often-cited

challenges are high prices of inputs other than fertilizer and an inadequate supply of fertilizer. However, it is notable that high prices of fertilizer are cited as the primary challenge to farming by only 3 to 5 percent of extension agents. This is in contrast to the discourse of policymakers who suggest that the principal challenge that farmers face is high fertilizer prices.

Table 9. Extension agents' perceptions of challenges to farming

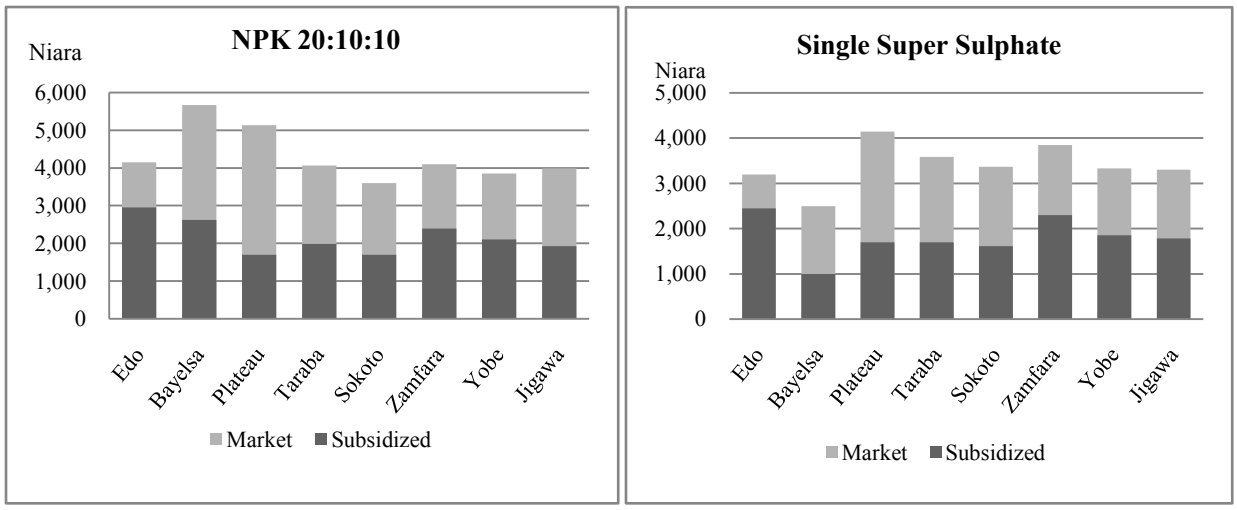
Primary Challenge to farming: Percentage of village extension agents reporting about		
	Female farmers	**Male farmers**
Limited access to credit	55	59
High prices of inputs other than fertilizer and seeds	11	10
Inadequate supply of fertilizer	8	8
Lack of access to seeds and other planting material	3	5
High fertilizer prices	5	5
Secondary Challenge to farming: Percentage of village extension agents reporting about		
	Female farmers	**Male farmers**
Pests attacking crops	13	17
High fertilizer prices	17	14
High prices of inputs other than fertilizer and seeds	11	14
Limited access to credit	11	14
Lack of access to seeds and other planting material	7	9
Bad weather	6	6
Inadequate supply of fertilizer	6	3

Source: Authors' survey.

5. A SPECIAL ANALYSIS OF FERTILIZER PRICES

The fact that VEAs identify high fertilizer prices as a constraint (albeit not the most significant) to farming suggests that the federal and state subsidies are not being fully transmitted to farmers. Nagy and Odun (2002) estimate that only 30 percent of subsidized fertilizer reaches small farmers at the subsidized price. Parallel sales of subsidized and "market" fertilizer provide an opportunity for lower priced subsidized fertilizer to be diverted for sale at higher market prices. An analysis of the market prices of fertilizer in the surveyed states provides some evidence to support the hypothesis that the arbitrage opportunities created by the presence of fertilizer from subsidized sources are exploited. We find that in states with high state subsidies, "unsubsidized" fertilizer is also cheaper, despite other state factors that are expected to increase fertilizer costs. An IFDC analysis of farm-gate fertilizer prices in several African countries finds that in-country transportation costs contribute about 20 percent of the total price (Chemonics and IFDC 2007). It is therefore reasonable that the market price for fertilizer in the northern states is higher, because transportation costs from the port (even of bulk mixing ingredients) are higher. However, prices in the northern states are generally lower than prices in the south (Figure 7).

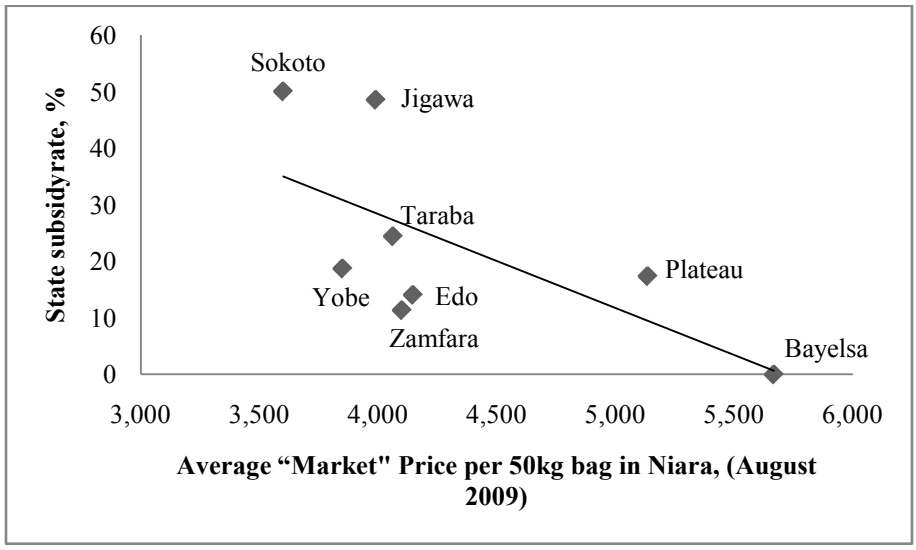
Figure 7. Fertilizer prices in Nigerian states, August 2009



Source: Author's survey.

Economies of scale from the higher amount of fertilizer used in the northern states may partially explain the lower prices in the northern states surveyed compared with the southern states. However, there are significant price differences among northern states, and within the region, states with higher state subsidies also have lower market prices for fertilizer. Zamfara is the only sampled state that had a functional blending plant in 2009, which should have given it an advantage in terms of increased supply of fertilizer, putting downward pressure on unsubsidized fertilizer. Yet market prices in that state tended to be higher than in the nearby states with higher subsidy rates. As shown in Figure 8, there is a strong negative correlation between the state subsidies on state-procured fertilizer and the market prices for fertilizer: the correlation coefficients between the market price and subsidy rate for NPK 20:10:10 is -0.7 and that for urea is -0.6.

Figure 8. Relationship between market prices of NPK 20:10:10 and state subsidy rates



Source: Authors' survey.

The fact, that higher state subsidies on fertilizer mitigate other factors that should increase the market price of fertilizer suggests that fertilizer is leaking from subsidized sources into the "unsubsidized" fertilizer market.

6. HOW MUCH CAN THESE FINDINGS BE GENERALIZED?

With the remarkable heterogeneity in Nigerian states, one could reasonably be concerned about the external validity of any findings within a sample of states. We sought to address this challenge by first categorizing all Nigerian states along dimensions that can be expected to influence the challenges farmers face in general and in their fertilizer use in particular, before determining the sample of states. However, there remains a possibility that sample averages are not reflective of the national experience. Nevertheless, the nature of the extension service and identified constraints to fertilizer use in the individual surveyed states can be used as a basis for making conjectures about the situation in the states that were not surveyed.

One could also argue that despite the gender-stratified random sampling strategy used to select respondents, the perceptions of VEAs interviewed are not representative of VEAs in the surveyed states. We do not consider this a credible concern; the responses of the selected agents show such similarity that it is likely that they reflect the prevailing views of VEAs in the state. Furthermore, the number of interviewed VEAs for each state was chosen so as to result in calculated percentages that have a confidence interval of 20 percent or lower at a 95 percent confidence level.

The usefulness of VEAs views depends on whether they are authorities on the subject on which they are commenting. In this paper, we made an implicit assumption that due to their direct interaction with farmers, and their input distribution roles, VEAs are uniquely placed to provide valuable insights. However, our analysis has shown some evidence that raise concerns about this assumption. For instance, the gaps in extension agents' knowledge of fertilizer technology suggest weaknesses in other areas of extension knowledge. This reduces one's trust in the extension agents' assertion that farmers have adequate knowledge about fertilizer technology. Regardless of such concerns, we believe that extension agents have valuable perspective on the constraints to fertilizer use that can only be gained through front-line activities.

7. CONCLUSION

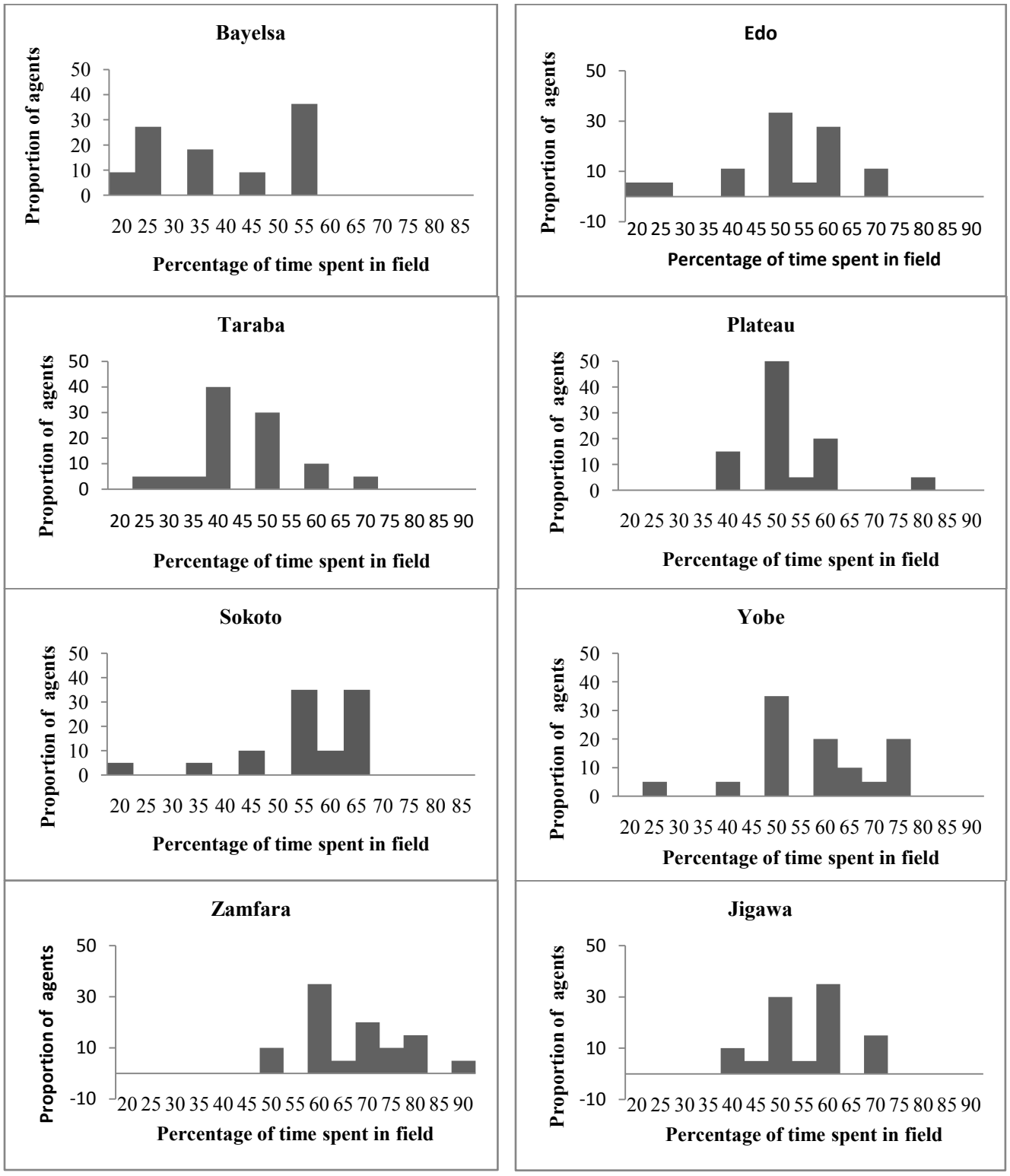
Low fertilizer use has been identified as a major challenge that must be overcome in order to increase Nigeria's agricultural productivity. Since the early 1970s, the federal and state governments have instituted subsidies aimed at promoting fertilizer use. However, there are several factors that contribute to low fertilizer use that are not addressed by direct price subsidies.

The extension service plays a critical role in driving demand for fertilizer through its transmission of information about fertilizer technology to farmers. In Nigeria, the extension service is also instrumental in providing farmers access to fertilizer. Therefore, this paper studied the extension service to provide insights on constraints to fertilizer use on both the demand and supply sides.

We find that the extension service in the eight sampled states has severe limitations in the number of farmers that it can reach. This situation is likely a symptom of the limited reach of the extension service across Nigeria. Additionally, extension agents appear to have relegated their advisory role to second place after their role in distributing inputs. Information about improved seeds is reported as the top technologies transmitted to farmers but there is limited transmission of fertilizer and irrigation technologies which are technologies required for increasing agricultural productivity. VEAs are found to have gaps in their knowledge of fertilizer technology implying a broader systemic lack of knowledge capacity in the extension service. From the perspective of VEAs, the primary constraint to fertilizer use in Nigeria is the physical absence of the product at the time that it is needed, rather than problems of affordability or farmers' lack of knowledge about the benefits or the use of fertilizer.

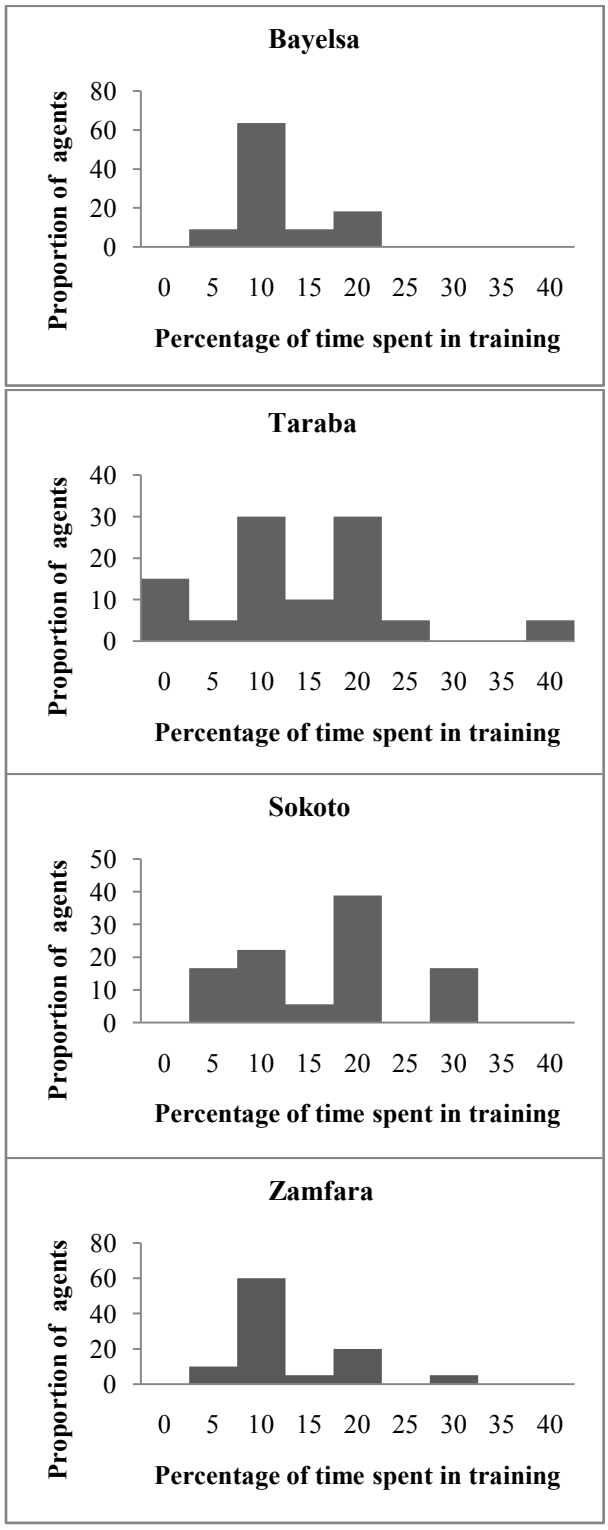
APPENDIX: SUPPLEMENTARY FIGURES

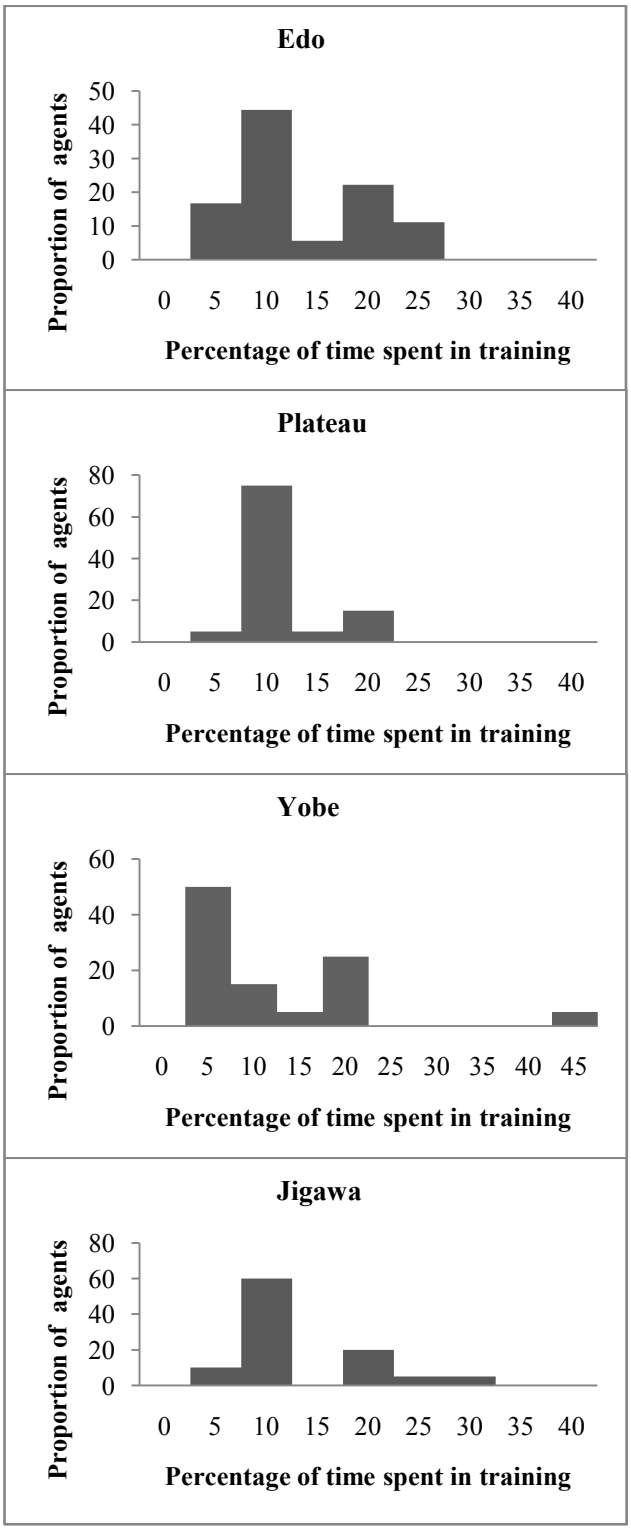
Table A.1. Distribution of VEAs' work time spent in the field



Source: Authors' calculations.

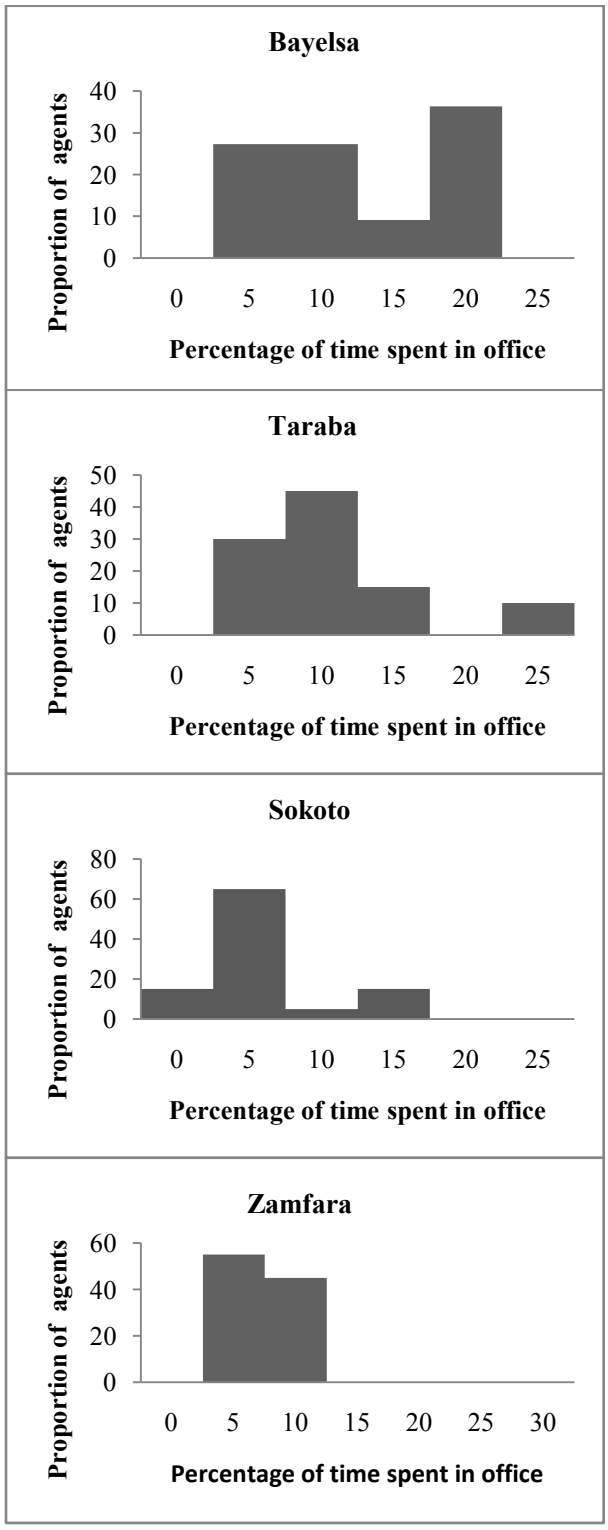
Table A.2. Distribution of extension agents' work time spent in training





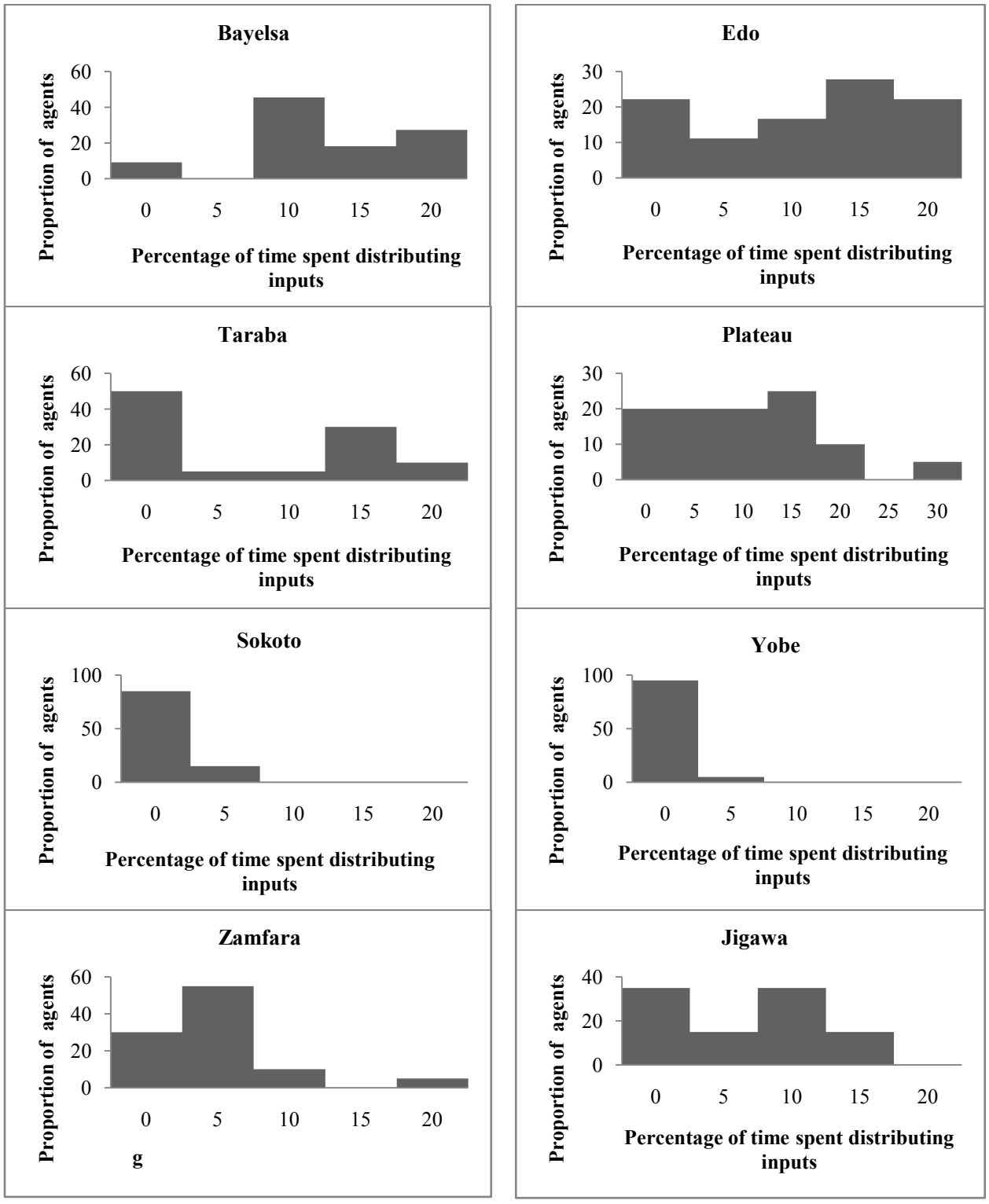
Source: Authors' calculations.

Table A.3. Distribution of VEAs' work time spent in the office



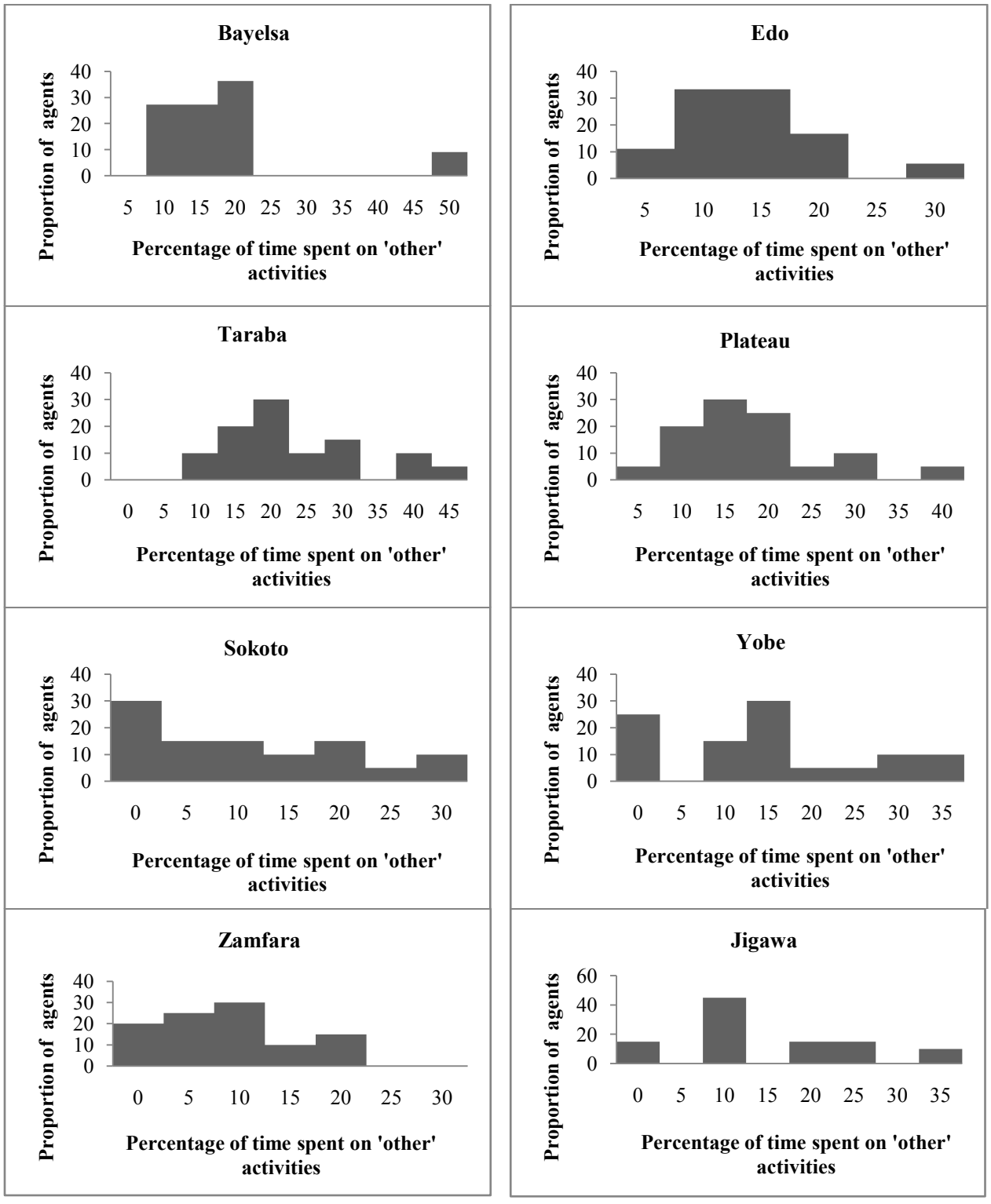
Source: Authors' calculations

Table A.4. Distribution of VEAs' work time spent distributing inputs



Source: Authors' calculations.

Table A.5. Distribution of VEAs' work time spent on other activities



Source: Authors' calculations.

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