AFRICA GROWTH INITIATIVE
WORKING PAPER 2 | APRIL 2012

Africa Growth Initiative
at BROOKINGS

EXTENDING THE LEARNING COMMUNITY
RURAL RADIO, SOCIAL LEARNING AND FARM PRODUCTIVITY IN GHANA

Olumide Taiwo and Emmanuel Asmah

Africa Growth Initiative
at BROOKINGS

Olumide Taiwo is an Africa research fellow with the Africa Growth Initiative at the Brookings Institution.

Emmanuel Asmah is a lecturer at the Department of Economics, University of Cape Coast in Ghana.

Abstract

This paper examines the potential role of indigenous knowledge sharing through rural FM radio stations in Ghanaian agriculture. To identify social learning effects, we examine crop productivity trends and their association with participation in radio programs, and compare the strength of these associations before and after the emergence of rural radio. Our analysis shows stronger conditional correlations between participation intensity and noncash crop yields, which are consistent with the expectation that noncash crop farmers will more likely adjust farming practice as a result of social learning. The results suggest the potential for agricultural research to have an impact on effective farming by taking advantage of rural FM radio stations.

CONTENTS

Introduction 1

Background and Literature Review 3

Methodology 5

Descriptive Statistics 6

Results 10

Conclusion 16

Appendix 17

References 18

Endnotes 20

LIST OF TABLES

Table 1: Summary Statistics 8

Table 2: Mean Characteristics of Surveyed Areas 9

Table 3: Determinants of Cocoa Yield (Output Per Acre) 12

Table 4: Determinants of Non-Cocoa Crop Yield (Output Per Acre) 14

Table 5: Determinants Of Non-Cocoa Crop Yield (Output Per Acre)—Pooled Sample 15

EXTENDING THE LEARNING COMMUNITY
RURAL RADIO, SOCIAL LEARNING AND FARM PRODUCTIVITY IN GHANA

Olumide Taiwo and Emmanuel Asmah

INTRODUCTION

Agricultural productivity remains a crucial factor in poverty reduction and rural transformation in Africa. After a long period of decline and stagnation, there have recently been reports of improved performance by the agricultural sector in many if not all countries on the continent. Mugera and Ojede (2011) provide a good survey of the literature on this subject and show that a variety of changes have made this progress possible. The studies cited in their survey emphasize the impact of remarkable changes in farm inputs such as crop varieties, fertilizer, pesticides and water resources (rainfall and irrigation), and the infrastructural changes that have made these gains possible, such as market reforms and extension services. However, whereas changes in inputs and markets are well captured, changes in extension services are muted in these reports, to the effect that credit is given to the effectiveness of orthodox agricultural extension.[1] To the contrary, a survey of attitudes toward and experiences with orthodox extension services shows that farmers have largely been abandoning those services since the beginning of the last decade.

The implication is that the credit given to extension services is largely misplaced, and the analyses omit a crucial *change* in the form of the knowledge to which farmers are adapting and the ways in which this knowledge is being disseminated. The literature on knowledge systems clearly distinguishes between formal or explicit knowledge that is based on scientific evidence and informal or tacit knowledge that is experimental and is acquired after a given practice has proved fruitful (Roling 1992). Whereas orthodox extension services focus on application of the former, there is evidence that farmers are instead shifting to the latter. In a survey of farmers' perspectives on agricultural extension in the East Akim District of Ghana reported by Boateng (2006), two-thirds of farmers surveyed expressed dissatisfaction with orthodox extension services. Among the dissatisfied majority, the main reasons cited were the unreliability of the service (47 percent) and the enormous costs of applying the new techniques (47 percent). In their responses to other questions in the survey, the farmers unanimously declared extension services as unreliable because "they were not involved in the development of technologies passed on to them by the experts" (Boateng 2006, 24). This attitude toward orthodox extension services is not a "new millennium" experience. Conley and Udry (2010) found from a survey conducted between 1996 and 1998 among pineapple farmers in three villages in southern Ghana that only one in three farmers took advice from an extension agent from the Ghanaian Ministry of Food and Agriculture. They found from their data that average fertilizer use is less than one-tenth of the 400 kilograms per hectare recommended by extension officers. Their analysis and findings show that farmers adjust fertilizer use not after the recommendations of the extension officers but following the experiences of other farmers in their neighborhood.[2]

Recent developments in communication and socialization infrastructure have extended the sphere of social learning beyond village borders. In the Ghanaian context, the rural radio phenomenon has successfully moved the borders of social learning from the village to the range of radio broadcasts. “Rural radio stations,” a term used interchangeably with “community radio stations,” are FM radio stations that have been established with the aim to broadcast to a rural audience that is predominantly engaged in agriculture. These new stations are not mere extensions of national FM radio stations to rural areas but are new FM stations that are owned and situated in rural areas. As noted by Girard (2001, 6), “In 1985 the term ‘rural radio’ usually referred to a division within the national broadcaster that produced programs in the capital and broadcast them to the countryside. Now rural radio is local radio.” A study by Chapman and others (2003) suggests that the community element of rural radio encourages the active participation of the audience, the engagement of the community’s intellectual resources, and community ownership of the radio station. In particular, community radio stations are set up with the aim to “enable marginalised communities and groups to generate and share their knowledge and experience” (Quarmyne 2001).[3] In terms of their programs, they focus on livelihood and development issues, transmit most of their events in local dialects and cater strongly to occupational segments such as farmers and fishermen.[4] The main advantage is that the uneducated rural population in those communities can and does participate in these programs. Radio Ada, the first community radio station in Ghana, started operations in February 1998, shortly after the liberalization of the Ghanaian airwaves in 1996.[5] At the end of 2005, there were seven operational community radio stations in Ghana with broadcast ranges covering large swaths of seven of the country’s ten regions. It is estimated that community radio stations reached between a quarter and two-fifths of the country’s area as of that time (Whaites 2005).

The development of rural radio has brought about a change in the content of radio transmission that is accessible to rural audiences. McKay (2003, 4), in his qualitative study of radio participation in a fishing community, cited a fishmonger’s account:

> The first [radio we bought] was 16 years ago. Back then we tuned to the radio a little, but we mainly played cassettes. My husband is educated, so he liked tuning to where they spoke English. But if my husband was not in the house, then we put the cassette in the tape player and played gospel songs. Now we listen to Radio Ada, because of the Dangme being spoken.

Whereas learning from neighbors is confined to members of the same village, rural radio stations enable individuals to learn from more distant counterparts. McKay (2003, 3) cited a fisherman who was knowledgeable about the development occurring among fishmongers in his Anyakpor community as saying:

> Anyakpor women, when they’ve finished smoking, use a certain grass named lale giving colour to the fish here. With a programme from another community along the coast here, I learned that there’s

> another grass which is called zue which is used in giving the fish colour and it is better than the lale the Anyakpor fishmongers are using. So the women here are changing to use zue.

In Ghana, rural radio has been used to promote the adoption of a high-yield rice seed named New Rice for Africa. The impact of this promotion, as documented by the Bill and Melinda Gates Foundation (2010), is a doubling of demand for the seed among farmers between 2008 and 2009. However, the report shows that the adoption of the seed variety is made possible by having farmers talk to themselves on the radio. Citing a 46-year-old female rural rice farmer, Faustina, who experienced a turnaround on her rice farm, the report makes the case that it is often more convincing to learn about a new yield-improving technology from a farmer than from an extension agent. “Hearing about the rice from other farmers made it more convincing,” says Faustina.

In this paper, we attempt to evaluate the impact of social learning through rural radio on crop yields in Ghana. We lay the theoretical foundation and examine the literature in the next section and follow with a section describing our identification strategy and examining the data. We then present descriptive statistics and our results, discuss the results, and offer conclusions.

BACKGROUND AND LITERATURE REVIEW

Leading theories of economic growth and productivity are founded on production functions that combine human capital with other kinds of capital. While human capital could be defined to include other components such as health, knowledge possessed by workers remains a very important component. In the neoclassical setting, economic efficiency is driven by two distinct forms of knowledge, namely, cutting-edge (or frontier) production practices and market conditions. The idea is that farmers will be more productive when they have access to knowledge about the technology frontier. Holding inputs constant, the adoption of superior technology leads to higher productivity. In addition, farmers will be more productive when they are knowledgeable about agricultural produce and factor markets, and consequently are able to allocate input factors more efficiently. The neoclassical models assume that new knowledge diffuses instantly and is “under competition available to all” (Borts and Stein 1964, 8). In other words, all production systems are automatically on the frontier.

The assumption of an immediate diffusion of knowledge is perhaps the most unrealistic among the many assumptions that implicitly underlie the neoclassical theory. The reality of spatial barriers to knowledge diffusion informed the need for deliberate efforts to connect locations of invention or innovation with the rest of the world. In agricultural settings, the bedrock of such efforts are extension services, whereby well-trained agents carry the findings in one setting to another or transmit the findings in laboratory experiments to producers on their farms. Beginning in the early 1960s, independent African countries vigorously pursued a strategy of extension based on the premise that technology existed elsewhere and only needed to be brought home. Thus, additional extension agents were only needed to persuade farmers to adopt better technologies. In pursuance of this objective, Eicher and Rukuni (2003) note that African countries expanded agricultural extension by adding 36,000 agents between 1959 and 1980.

Agricultural extension has yielded very little benefit to African farmers due to a host of factors. According to

Cleaver (1993, 65), the most common problems associated with extension are

> (a) extension staff are poorly trained and know little more than the farmers know; (b) extension staff are poorly paid and have little motivation to share whatever knowledge they do have with farmers; (c) management systems are poor, so that there is little pressure on staff or their managers to seek new knowledge or to serve farmers; (d) farmers are treated as ignorant recipients of information, rather than knowledgeable partners in technology transfer; (e) extension agents are not accountable to farmers; and (f) in some cases, operating facilities, vehicles and bicycles are so rare that the few motivated and knowledgeable extension staff cannot visit farmers regularly.

Out of these enumerated criticisms, the treatment of farmers as "ignorant recipients" of information rather than "knowledgeable partners" is perhaps the most compelling explanation for the dismal utility of extension services, at least in the Ghanaian context. For instance, an evaluation of the promotion of mud silos (a common crop storage facility) in Northern Ghana by Bediako, Nkegbe and Iddrisu (2005) led to the conclusion that extension officers may to a large extent exacerbate the lack of adoption of technology by resource-poor farmers. Eicher and Rukuni (2003) reported that despite the addition of 36,000 agents to agricultural extension from 1959 to 1980, food production only grew at half the rate of population growth from 1970 to 1985.

The failure of orthodox agricultural extension efforts has stimulated a shift toward capitalizing on successful tacit knowledge—that is, building on the farmers' own knowledge.[6] Farmers can learn from their own experiences with a technology (learning by doing), from other farmers in the same locality, or from the media. Using relatively elaborate models, Foster and Rosenzweig (1995) and Munshi (2004), examining data from the Indian green revolution, and Udry and Conley (2010), examining data from southern Ghana, found evidence of social learning among farmers in village settings. They observed that farmers adjust their production techniques based on the experiences of their neighbors.

However, social learning through rural radio enlarges the learning community beyond the village by allowing farmers to also learn from other farmers in distant villages and communities. But few studies have examined the impact of learning through radio on farm productivity. Indeed, existing studies of social learning through the media have focused mainly on deliberate attempts by development agencies to disseminate knowledge to rural farmers rather than evaluating the effects of farmers learning from one another through organized media (e.g., see Ray 1978; Sangare 2000). This paper makes a first attempt to fill this void in the literature.

Two major issues arise in connection with the enlarged information networks that are associated with rural radio transmission. First, by widening the sphere of social learning, virtual links between farmers in participating communities are more complex compared with neighborhood learning. Second, the possibility that farmers will adopt a cutting-edge practice is higher through radio than through person-to-person learning. By learning about many other farmers' experiences by listening to the radio, a farmer is likely to be able to pick the best practice rather than merely adopt the neighbor's practice.

Intuitively, we expect that the shift from scientific to tacit knowledge in transforming agriculture will be more pronounced and beneficial for the cultivation of nontree crops than for farming tree crops, for two reasons. First, there are marked differences between tree and nontree crops in investments and fruit-bearing lifetime. Risk-averse farmers may be less willing to adopt tacit knowledge in tree cropping than nontree cropping, and the set of technological changes that can be applied to a tree crop when it is already fully grown is relatively limited. Second, more advanced research systems exist for tree crops than nontree crops in Ghana. An examination of agricultural research institutes and extension service providers in Ghana reveals that formal extension services are focused on tree crops—mainly oil palm, rubber and cocoa—and, much more recently, have focused on livestock. This biased focus dates back to the colonial era. Eicher and Rukuni (2003) note that most colonial governments devoted agricultural research efforts primarily to export crops while food crops and livestock were treated as secondary. As part of efforts to promote agricultural productivity, government and donor organizations have provided increasing amounts of funding and, in effect, intensified tree-crop research and extension. Conversely, nontree crop farmers intensively engage in social learning.

METHODOLOGY

An appropriate model for evaluating the learning effect of radio transmission would be very complicated and is beyond the scope of this paper. In the present effort, we adopt a simple model that relies on the variation in intensity of learning through radio within local areas in identifying social learning effects. We measure learning intensity by averaging over a given locality the frequency with which individuals in households listen to the radio. Our main assumption is that the likelihood that a farmer selects the best practice is positively and linearly related to the intensity of participation in rural radio in the given locality.

Knowledge socialization on the radio started in 1998. We use data from surveys conducted before and after the commencement of rural radio to estimate the potential effect of change in rural radio content on productivity. We proceed by estimating the effect of radio listenership intensity on crop yields in the 1991 and 2006 data sets, and compare the change in the estimated effect on noncocoa crop yield with the change in the estimated effect on cocoa yield during the 15-year period. The rationale for this comparison is the expectation that the shift will have little or no effect on cocoa yield, so that unobserved changes that might be correlated with the estimates are isolated using the noncocoa minus cocoa estimates, leaving us with the differential effect on noncocoa crops. To check robustness, we estimate similar models using the participation intensities of other forms of media and compare the results.

The production function incorporates the knowledge infrastructure available to farmers in addition to traditional farming inputs. The basic theoretical model is given by

$$Q_i = A_i L_i^{\alpha_L} K_i^{\alpha_K} \prod_{j=1}^{J} e^{\delta_j N_j} \quad (1)$$

where Qi represents output quantity, A_i represents acres of land, L_i represents labor input, K_i represents capital (or other nonlabor) input, and N_j represents infrastructure of type j. The coefficients, α_L, α_K and δ_j, $j=1,2,\ldots J$ are productivity parameters. We categorize rural radio in the set of infrastructure items. Exponentiation of the infrastructure terms is meant to distinguish the direct physical inputs from indirect nonmaterial inputs. The specification of the production function also implies that production can occur without infrastructure but that such production will yield minimal output. For example, a farmer may not have access to motorable roads but may still produce crops. In this case, the production system will be inefficient and output will be lower than otherwise. The presence of a motorable road has the effect of expanding this output through the market effect. In logarithm form, the production function is translated into

$$\ln Y_i = \alpha_0 + \alpha_L \ln L_i + \alpha_K \ln K_i + \sum_{j=1}^{J} \delta_j N_j \quad (2)$$

where $Yi = \frac{Q_i}{A_i}$ represents crop yield measured in terms of output per acre, and α_0 is a constant term. In estimating the equation, we use data from the Ghana Living Standard Surveys (GLSS)—GLSS 3 (1991–92) and GLSS 5 (2005–6)—and include only sampled households that produce positive quantities of the selected crops. Our crop yield and traditional inputs (labor and capital) are measured at the household level, while the infrastructure items are measured at the cluster and regional levels as far as the data allow. We restrict our analysis to six crops: one tree crop (cocoa), and five nontree crops (beans and peas, groundnut, guinea corn, rice and maize). Together, these crops account for 97 percent and 91 percent of crop market values in the 1991–92 and 2005–6 surveys, respectively. We converted crop outputs from different units of measurement reported by households into kilograms. As a caveat, it is not feasible to convert all the reported measures into kilograms. However, our sample accounts for 99 percent of the production of the selected crops in both periods and covers 1,469 households from the 1991–92 survey and 2,386 households from the 2005–6 survey. The GLSS instruments do not cover access to media either at household or community levels. To fill this gap, we use data from the Demographic and Health Surveys (DHS) conducted in 1993 and 2003. The DHS contains geographical markers that include region, district and clusters within each district. But the district and cluster markers cannot be matched with similar markers in the GLSS data. In merging the two data sets, we computed region-level averages of media participation in the DHS and used the region markers to merge the data sets.

There is a possibility that estimated coefficient of infrastructure items inclusive of radio are biased because they may pick up the effect of other important variables that are excluded from the model. It is indeed plausible that the correlation between radio intensity and crop yield captures unmeasured supply-side effects in addition to the knowledge effect. For example, the establishment of a rural radio station in a particular place is unlikely to be a random exercise; it is likely to be correlated with excluded determinants of crop productivity. Radio stations may be selectively established in areas with a high population density, and these areas are likely to have more fertile soil than areas with a low population density in the same region. In this case, the correlation between radio intensity and crop yield will also capture the simple fact that areas with more productive soil and consequently a higher crop yield have more radio coverage. There is also a potential demand-side challenge: the possibility that agricultural knowledge remains unchanged yet an increase in income in areas with a high crop yield enables greater access to radio. In effect, the change in radio intensity is not distinguishable from unmeasured income or wealth effects. To deal with this potential challenge, we include controls for income and population density in the estimation procedures. The complete list of variables in the analysis and their derivations are provided in the appendix.

DESCRIPTIVE STATISTICS

We provide the trend of crop production and yield in the GLSS data in table 1. Average household cocoa output grew by 122 percent during the 15-year period, from 723 kilograms to 1,607 kilograms. During the same period, average household production of the selected noncocoa crops rose by 72 percent, from 837 kilograms to 1,439 kilograms. However, in terms of acres of land devoted to production, the mean acres of farmland devoted to cocoa production were reduced by 3 percent whereas farmland acres devoted to the other crops were reduced by 42 percent, which perhaps reflects diversification in the mix of crops that households grew over the period. Apart from diversification, these statistics point to farm intensification during the intervening years. We were unable to separate the labor and nonlabor inputs for each crop; therefore, the monetary values of those inputs provided in table 1 are for all crops produced by households. The statistics show that crop production outlays were dominantly labor costs in 1991–92, where labor costs were about 57 percent of those costs combined. The picture in 2005–6 shows that farmers spent more on nonlabor inputs, such as fertilizer and insecticide, so that labor costs were reduced to 44 percent of the combined costs. We attribute this change to the transformation of farm technology, whereby crop production has drastically shifted away from a labor-intensive system to a more technologically driven system that increasingly relies on nonlabor inputs. We attribute this shift in production technology to new knowledge that farmers have acquired over the period as well as to various agricultural policies related to farm inputs.

The lower panel in table 1 shows variation in crop yields defined as output per acreage of land. On average, crop yields grew by 87 percent between the surveys, but this growth is more significantly accounted for by noncocoa crops, which achieved a 111 percent increase in yield, compared with only 20 percent for cocoa. Further, noncocoa crop yield grew at a rate of 130 percent in cocoa regions compared with 87 percent in noncocoa regions, which suggests that noncocoa crop yields in cocoa areas were catching up with yields in noncocoa regions.

Next, we examine shifts in farmers' sources of knowledge regarding various aspects of farming inputs and outputs. These data are derived from two sources. The first source is the community component of the GLSS. The second source is the DHS, which has been conducted in Ghana every five years since 1988. To observe shifts in noncocoa relative to cocoa production, we provide the statistics for cocoa-producing regions and noncocoa regions. Cocoa production takes place in six of the ten regions: Western, Central, Eastern, Volta, Ashanti and Brong-Ahafo.

Table 2 summarizes changes in infrastructure in rural communities during the period, disaggregated by region. From the table, the fraction of communities that have access to motorable roads in cocoa regions rose from 83 percent in 1991–92 to 91 percent in 2005–6 but did not change in the noncocoa regions. Land markets have not expanded in Ghana because the fraction of communities where land market exists remained virtually consistent with the 1991–92 figures. These statistics suggest that land titling or ownership rights changes may not be part of potential explanations for observed changes in Ghanaian agriculture. The fraction of communities where local markets exist decreased significantly between 1991–92 and 2005–6 in cocoa regions, from 38 percent to 30 percent, but more significantly in noncocoa regions, from 45 percent to 26 percent. There are no dramatic changes in farmers' cooperatives; however, there was a slight increase of 5 percent in cocoa regions and a slight decrease of 4 percent in noncocoa regions. The proportion of communities with cooperatives increased in cocoa areas and decreased in noncocoa areas; however, these changes are not statistically significant. Nonetheless, a higher proportion of communities reported using insecticide in 2005–6 than in 1991–92 in all regions: from 64 percent to 81 percent in cocoa regions, and from 32 percent to 44 percent in noncocoa regions.

Table 1: Summary Statistics					
	1991/92	Number of Households	2005/06	Number of Households	Change
Crop Input and Output					
Cocoa Output (Kg)	723.00	244	1,606.83	607	122%
	(1,021.50)		(7,982.91)		
Cocoa acres	344.58	244	335.46	607	-3%
	(807.92)		(817.09)		
Non-cocoa Output (kg)	837.33	1,225	1,439.20	1,779	72%
	(1,006.69)		(5,453.70)		
Non-cocoa acres	107.77	1,225	62.32	1,779	-42%
	(383.42)		(305.27)		
Total Crop Output (kg)	886.15	1,469	1,568.63	2,386	77%
	(1,066.83)		(6,298.87)		
Total Crop acres	148.12	1,469	134.47	2,386	-9%
	(490.36)		(507.03)		
Crop labor input (GHC)	9,899.98	1,469	529,506.70	2,386	
	(23,756.75)		(5,022,236.00)		
Crop non-labor input (GHC)	4,772.59	1,469	531,818.30	2,386	
	(9,998.37)		(4,011,944.00)		
Non-labor Costs/Variable Costs	0.43	1,196	0.56	1,881	31%
	(0.42)		(0.40)		
Crop Yield					
Total Crop Yield (kg/Ha)	131.22	1,469	244.73	2,386	87%
	(195.54)		(1,605.86)		
Cocoa Yield (Kg/Ha)	88.29	244	105.78	607	20%
	(197.52)		(215.57)		
Non-cocoa Yield (Kg/Ha)	129.59	1,225	273.67	1,779	111%
	(183.56)		(1,824.10)		
Cocoa Regions	119.61	754	275.67	883	130%
	(215.96)		(2,527.16)		
Non-cocoa Regions	145.58	471	271.70	896	87%
	(112.30)		(562.38)		

NOTE: Non-cocoa crops included are beans/pea, groundnut, guinea corn, maize and rice
Standard deviations in parenthesis

Table 2: Mean Characteristics of Surveyed Areas										
GLSS Sources	**Cocoa Regions**				**Non Cocoa Regions**				**Difference**	
Community Dummies	1991/ 92	2005/ 06	Diff	sig	1991/ 92	2005/ 06	Diff	sig	Diff-in-Diff	sig
motorable road	0.83	0.91	0.08	**	0.72	0.69	-0.03		0.11	
land market	0.12	0.15	0.03		0.04	0.05	0.01		0.02	
local market	0.38	0.30	-0.08	*	0.45	0.26	-0.19	**	0.11	
agric cooperative	0.30	0.35	0.05		0.26	0.22	-0.04		0.09	
farmers use insecticide	0.64	0.81	0.17	***	0.32	0.44	0.12		0.05	
extension services	0.23	0.26	0.03		0.34	0.18	-0.16	**	0.19	**
farmers use fertilizer	0.49	0.72	0.23	***	0.81	0.60	-0.21	**	0.44	***
Number	195	226			47	102				
DHS Sources	**Cocoa Regions**				**Non Cocoa Regions**				**Difference**	
Percent of Households:	1993	2003	Diff	sig	1993	2003	Diff	sig	Diff-in-Diff	sig
Read Newspapers Weekly	0.17	0.20	0.03	*	0.08	0.09	0.01		0.02	
Watch Television Weekly	0.32	0.45	0.13	***	0.19	0.21	0.02		0.11	**
Listen to Radio Weekly	0.59	0.93	0.34	***	0.48	0.80	0.32	***	0.02	
Listen to Radio Only Weekly	0.34	0.50	0.16	***	0.33	0.60	0.27	***	-0.11	**
Number of Clusters	204	164			46	74				

*NOTE: * difference is significant at 10%; ** difference is significant at 5%; *** difference is significant at 1%*

Whereas extension services appear to rise slightly in cocoa regions, from 23 percent to 26 percent, the proportion of communities receiving extension services was reduced significantly, from 34 percent to 18 percent in noncocoa regions. The proportion of communities where farmers use fertilizer follows the same pattern; communities reporting fertilizer use increased from 49 to 72 percent in cocoa regions and decreased from 81 to 60 percent in noncocoa regions. Provision of extension services and fertilizer usage are two items that have increased in cocoa areas but declined in noncocoa areas. Coincidentally, a simple test of the difference of means also shows that differences between cocoa and noncocoa regions are striking only in terms of changes in extension services and fertilizer usage.[7]

We now incorporate the DHS-documented changes in electronic and print media sources of knowledge between the 1993 and 2003 surveys. Although the timing of the DHS does not coincide with the GLSS, the 10-year interval between the two surveys is entirely contained within the 15-year interval between the GLSSs and allows us to observe changes in access to media within the interval. At the individual level, the surveys collect information regarding how frequent respondents read newspapers, watch television and listen to the radio. From this information, we restrict the sample to rural households and construct a household-level dummy that equals 1 if anyone in the household reports a frequency of doing any of these at least once a week and otherwise equals 0. For each item, we compute the average of the dummy across households in each cluster to obtain the fraction of households. Figures reported in the lower panel of table 2 are cluster averages.

From table 2, the proportion of households that read newspapers at least once a week increased only slightly from 17 percent to 20 percent in cocoa areas compared with noncocoa areas where the proportion moved from 8 percent to 9 percent. The proportion of households that watch television at least once a week increased significantly, by 13 percent in cocoa regions compared with 2 percent in noncocoa regions. The proportion of households that listen to the radio at least once a week increased dramatically in all regions, from 59 to 93 percent in cocoa areas and from 48 to 80 percent in noncocoa regions. These changes are significant at the 1 percent level and are in part the result of the nationwide expansion of radio transmission during the period between the two surveys.

We next examine the possibility of a differential increase in radio listenership over television viewership.[8] To do this, we compute the fraction of households where residents only listen to the radio.[9] The figures show that cocoa and noncocoa regions were not different in the baseline year 1993; one-third (33 percent) of households in both areas had radio-only listeners. However, by 2003, the radio-only proportion had increased by 16 percent in cocoa regions, compared with an increase of 27 percent in noncocoa areas. Simple tests of the difference of means show that these differences are statistically significant. Whereas the change in the proportion listening to the radio might be ubiquitous, the differential change in only listening to the radio is most likely not.

It is straightforward to reconcile the statistics from community surveys and those from the DHS data. Whereas the extension services and cooperatives that constitute the orthodox knowledge diffusion mechanisms grew slightly in cocoa areas but declined in noncocoa areas, farmers in noncocoa areas are differentially more engaged in social learning through the radio. Because extension services are closely related to fertilizer usage, a decrease in extension services is accompanied by a decrease in fertilizer usage in noncocoa areas.[10] It is plausible to assume that knowledge shared on rural radio is not tied to fertilizer usage but perhaps is more generally related to efficient cropping practices. However, the comparisons presented in table 2 are subject to a caveat: We are only able to match changes in knowledge infrastructure to cocoa versus noncocoa *regions* rather than cocoa versus noncocoa crop *cultivation*. Farmers cultivating noncocoa crops in the cocoa regions may participate in rural radio differentially than farmers cultivating cocoa, but this possibility is obscured by these statistics. Indeed, the growth of the noncocoa crop yield in cocoa areas by a wide margin over its growth in noncocoa areas may reflect a more intensive participation among noncocoa farmers in cocoa regions than in noncocoa regions. Another possibility is that access to best practices through knowledge sharing is not matched by access to inputs to implement them; the results are obtainable if access to vital inputs such as fertilizer is constrained in the noncocoa regions relative to the cocoa regions. Decreases in extension services and fertilizer usage in noncocoa regions are consistent with this supply constraint.

RESULTS

We present the results of estimating the cocoa yield function with additional controls separately for each set of survey data. In Model I, we include farm direct inputs, farmer's sale outlet (market traders or other buyers, such as farm gate and institutional buyers) and community infrastructure dummies. In Model II, we expand the regressors to include the orthodox knowledge infrastructure—extension services and cooperatives. In Model III, we add newspaper readership and television viewership; and in Model IV, we add the radio-only listenership variable. We include additional controls in Model V in order to isolate the potential bias due to wealth and population density. In all the models, we include controls for ecological zone and rainfall deviations.

The results for cocoa cultivation are summarized in table 3. The results from both surveys suggest that variation in expenditures on labor inputs do not explain cocoa yield. Expenditures on nonlabor inputs had no effect on crop yield in 1991–92, but crop yield increased with nonlabor input in the 2005–6 survey. Crop yield turned out to be higher in communities where farmers used fertilizer in the 1991–92 survey, but this effect disappears in Model III when we include regional-level, media-related knowledge sources. This suggests that perhaps fertilizer use is part of the knowledge shared via the media so that the inclusion of media variables reduces the fertilizer coefficient. Crop yield was not different between communities where farmers used insecticides in the 1991–92 survey, but farmers in those communities seemed to obtain a significantly lower yield in the 2005–6 data. Rather than insecticide reducing crop yield, the plausible interpretation is that communities applying insecticides are those that have difficulties with pest control, and pests reduce crop yield. The results also show that crop yield was higher in communities where individuals are allowed to buy and sell land, but this effect only applied to cocoa farming in the 1991–92 survey. This perhaps reflects the potential effect of private land rights on investments. Crop yields did not differ by crop sales outlets in the 1991–92 survey but did differ in the 2005–6 survey. Communities where farmers sold their major crops to market traders—rather than other buyers, such as institutional, contract and farm gate buyers—tended to be communities associated with low cocoa crop yields in the 2005–6 survey. Indeed, it is plausible that institutional and contract buyers would source their supply from high-yield cocoa-farming communities. The availability of agricultural extension service seemed to help raise cocoa yields in the 1991–92 survey, but this effect disappeared in the 2005–6 survey. The other institution through which farmers learn from one another—farmers' cooperatives—did not have any effect on crop yields in either survey. One potential explanation for this finding that we verified anecdotally in Ghana is that the cooperatives are more focused on issues of farm credit and political representation than the traditional purpose of knowledge dissemination.

The results in Models III and IV show a positive correlation between crop yield and television intensity in both years, but the positive coefficients of newspaper readership and radio listenership in the 1991–92 data disappeared in the 2005–6 data. Moving from Model III to Model IV by including radio-only listenership intensity resulted in an increase in the coefficient of television intensity. We anticipated this change because the two variables are negatively correlated by construction. We include income and regional population density in Model V, but the coefficient of radio-only listenership does not change by much. Changes in the coefficient of determination—or, alternatively, the goodness of fit of the model—are also instructive as we look across the surveys. Inclusion of the media variables in the 1991–92 data increased the coefficient of determination from 17 percent in Model II to 29 percent in Model IV, but only from 10 percent to 12 percent in the 2005–6 data. Overall, the lower coefficient of determination in the 2005–6 data suggests that the

Table 3: Determinants of Cocoa Yield (Output Per Acre)

Dependent variable = Log yield	1991/92 Survey					2005/06 Survey				
	I	II	III	IV	V	I	II	III	IV	V
Log value of labor Input	0.021	0.005	0.006	0.017	0.007	0.027	0.025	0.025	0.024	0.016
	[0.0389]	[0.0389]	[0.0367]	[0.0364]	[0.0368]	[0.0175]	[0.0175]	[0.0173]	[0.0174]	[0.0176]
Log value of non-labor Input	-0.053	-0.050	-0.009	-0.006	-0.009	0.0357**	0.0356**	0.0290*	0.0299*	0.027
	[0.0356]	[0.0352]	[0.0349]	[0.0344]	[0.0353]	[0.0166]	[0.0166]	[0.0169]	[0.0169]	[0.0171]
Fertlizer use	1.2488***	1.0973***	0.460	0.569	0.6427*	0.182	0.127	0.123	0.157	0.240
	[0.3587]	[0.3610]	[0.3595]	[0.3560]	[0.3584]	[0.3042]	[0.3061]	[0.3127]	[0.3141]	[0.3134]
Insecticide use	-0.547	-0.310	-0.028	-0.143	-0.190	-1.0095**	-1.0764**	-0.9804**	-0.9530**	-0.9643**
	[0.3908]	[0.3962]	[0.3777]	[0.3740]	[0.3754]	[0.4407]	[0.4428]	[0.4408]	[0.4413]	[0.4435]
Land market	1.5431***	1.7007***	1.4844***	1.1568***	1.0133**	0.481	0.438	0.309	0.333	0.188
	[0.4211]	[0.4199]	[0.3999]	[0.4100]	[0.4248]	[0.3432]	[0.3465]	[0.3473]	[0.3478]	[0.3494]
Crops sold to market traders	0.301	0.223	0.076	0.146	0.114	-1.5334*	-1.5237*	-1.4337*	-1.4457*	-1.4894*
	[0.7859]	[0.7775]	[0.7338]	[0.7229]	[0.7229]	[0.8451]	[0.8444]	[0.8380]	[0.8379]	[0.8299]
Agric extension service		0.8866**	0.9775***	0.8211**	0.8397**		0.336	0.261	0.246	0.216
		[0.3645]	[0.3450]	[0.3441]	[0.3454]		[0.2372]	[0.2373]	[0.2377]	[0.2435]
Agric cooperative		-0.459	-0.156	-0.067	-0.059		0.173	0.226	0.200	0.301
		[0.3263]	[0.3230]	[0.3195]	[0.3209]		[0.2304]	[0.2338]	[0.2349]	[0.2375]
Newspapers intensity			0.1067***	0.0707**	0.0782**			0.008	0.036	0.035
			[0.0252]	[0.0278]	[0.0312]			[0.0358]	[0.0433]	[0.0434]
Television intensity			0.1009***	0.1432***	0.1327***			0.0585***	0.0878**	0.071
			[0.0231]	[0.0271]	[0.0277]			[0.0226]	[0.0344]	[0.0449]
Radio-only intensity				0.0885***	0.0783**				0.058	0.047
				[0.0308]	[0.0311]				[0.0516]	[0.0640]
Population Density					0.022					0.025
					[0.0418]					[0.0419]
Log Income					0.3134*					0.4605***
					[0.1679]					[0.1068]
Constant	0.348	0.116	-3.6619***	-6.4897***	-11.0796***	0.043	0.068	-2.3040**	-6.9735*	-14.4302***
	[0.6789]	[0.6956]	[0.9466]	[1.3559]	[2.9509]	[0.5632]	[0.5630]	[0.8924]	[4.2275]	[4.6591]
Observations	244	244	244	244	243	607	607	607	607	590
R-squared	0.14	0.17	0.27	0.29	0.31	0.10	0.10	0.12	0.12	0.15

Standard errors in brackets; Regresion models include ecological zones and rainfall deviation
** significant at 10%; ** significant at 5%; *** significant at 1%*

models we estimate do poorly in explaining variations in cocoa yield relative to the 1991–92 data.

The results for noncocoa crops presented in table 4 differ in many respects from the pattern shown in table 3. The negative coefficient of labor cost in 1991–92 is surprising; otherwise, the labor cost coefficients are similar to those found in table 3. Expenditures on nonlabor inputs are positively correlated with crop yield in both surveys. Communities where farmers use fertilizer do not seem to achieve greater crop yield than nonuser communities in both surveys. Similar to cocoa, the use of insecticides is associated with lower noncocoa crop yield and the negative effect holds in both data sets. Communities where individual property rights exists in land were associated with higher crop yields in the 1991–92 survey but were associated with lower crop yield in the 2005–6 survey. In contrast to the case of cocoa, communities where farmers sold their major crops to market traders rather than institutional buyers, such as contract and farm gate buyers, tend to be associated with higher crop yields, in both the 1991–92 and 2005–6 surveys. While the existence of farmers' cooperatives did not exert any influence on crop yield in both surveys, communities where extension services were available in the 2005–6 data were associated with lower crop yields. In Models IV and V, higher newspaper intensity is associated with reduced crop yield, while increases in television viewership and radio listenership are both associated with higher crop yield in both surveys. Relative to the 1991–92 data, both coefficients increased in the 2005–6 data; but the increase in the radio intensity coefficient is more dramatic (from 0.06 to 0.21) compared with the television viewership coefficient (from 0.07 to 0.11). The differential increase in the coefficient of radio intensity over television may capture the possibility that farmers are able to share more information on the radio than on television, implying that a 1 percent increase in radio intensity provides more productive knowledge than television.

The results thus far support the hypothesis of a positive conditional correlation between social learning through radio listening and the growth of noncocoa yield between 1991–92 and 2005–6, which is consistent with the statistics reported in the bottom panel of table 1. The next challenge is to demonstrate the extent to which social learning contributes to noncocoa yield growth differentially in cocoa areas compared with noncocoa areas, because crop yield statistics show that the growth rates are different by area. To proceed, we pool data for noncocoa crops from both the 1991–92 and 2005–6 surveys and separate them into cocoa and noncocoa regions. In addition to Model V shown in table 4, a dummy for the 2005–6 survey and an interaction term of this dummy with the radio intensity variable will capture the change in correlation between radio intensity and crop yield between 1991–92 and 2005–6 and enable us to examine how the change differs between cocoa and noncocoa regions. We present these results in table 5. In Model V, the coefficient of the interaction term *radio-only intensity x year 2006* in cocoa regions, 0.13, is more than double the coefficient in noncocoa regions, 0.06, implying that a similar increase in radio intensity is associated with an increase in crop yield in cocoa areas that is twice the rate at which it occurs in noncocoa areas. This difference is consistent with the bottom panel of table 1, where noncocoa crop yield grew by 130 percent in cocoa regions compared with 87 percent in noncocoa regions.

Our finding that noncocoa crops have done better in cocoa regions than in noncocoa regions may have several potential explanations. First, differences in ecological conditions may induce cultivation of different types of noncocoa crops in both cocoa and noncocoa regions. If noncocoa technologies in cocoa regions are more amenable to learning by doing than noncocoa technologies in noncocoa regions, then non-

Table 4: Determinants of Non-Cocoa Crop Yield (Output Per Acre)

Dependent variable = Log yield	1991/92 Survey					2005/06 Survey				
	I	II	III	IV	V	I	II	III	IV	V
Log value of labor Input	-0.018	-0.019	-0.0369***	-0.0393***	-0.0240**	-0.005	-0.004	0.007	0.009	0.003
	[0.0118]	[0.0118]	[0.0119]	[0.0120]	[0.0119]	[0.0067]	[0.0067]	[0.0067]	[0.0064]	[0.0067]
Log value of non-labor Input	0.0314**	0.0307**	0.0365***	0.0389***	0.0332***	0.0407***	0.0404***	0.0396***	0.0399***	0.0368***
	[0.0125]	[0.0126]	[0.0126]	[0.0126]	[0.0124]	[0.0073]	[0.0073]	[0.0071]	[0.0068]	[0.0069]
Fertlizer use	0.117	0.092	0.141	0.152	0.161	-0.098	-0.093	-0.1860**	0.020	-0.011
	[0.1158]	[0.1187]	[0.1168]	[0.1168]	[0.1158]	[0.0931]	[0.0937]	[0.0928]	[0.0894]	[0.0903]
Insecticide use	-0.1901*	-0.2327**	-0.2949**	-0.3111***	-0.169	-0.6172***	-0.5885***	-0.3191***	-0.3481***	-0.3130***
	[0.1123]	[0.1181]	[0.1171]	[0.1174]	[0.1164]	[0.0980]	[0.1009]	[0.1020]	[0.0969]	[0.0985]
Land market	0.5008**	0.4855**	0.325	0.295	0.5082**	-1.3180***	-1.2883***	-1.1294***	-0.9572***	-0.8940***
	[0.2042]	[0.2046]	[0.2013]	[0.2018]	[0.1992]	[0.1556]	[0.1573]	[0.1542]	[0.1469]	[0.1497]
Crops sold to market traders	0.3119***	0.3200***	0.2839***	0.2851***	0.2859***	0.5137***	0.5062***	0.5086***	0.5100***	0.4852***
	[0.1001]	[0.1003]	[0.0982]	[0.0981]	[0.0963]	[0.0844]	[0.0846]	[0.0829]	[0.0787]	[0.0805]
Agric extension service		0.120	0.182	0.179	0.105		-0.162	-0.092	-0.2231**	-0.2381**
		[0.1282]	[0.1254]	[0.1253]	[0.1236]		[0.1156]	[0.1126]	[0.1073]	[0.1092]
Agric cooperative		0.073	0.013	0.005	-0.072		0.031	0.124	0.149	0.157
		[0.1193]	[0.1177]	[0.1177]	[0.1150]		[0.1029]	[0.1006]	[0.0955]	[0.0974]
Newspapers intensity			-0.0453***	-0.0511***	-0.0392***			-0.0388***	-0.1829***	-0.1611***
			[0.0095]	[0.0101]	[0.0100]			[0.0125]	[0.0158]	[0.0222]
Television intensity			0.0530***	0.0574***	0.0720***			-0.0227***	0.1178***	0.1109***
			[0.0068]	[0.0073]	[0.0073]			[0.0052]	[0.0112]	[0.0125]
Radio-only intensity				0.0153*	0.0624***				0.2149***	0.2104***
				[0.0088]	[0.0102]				[0.0154]	[0.0170]
Population Density					0.0752***					0.009
					[0.0092]					[0.0072]
Log Income					0.1667***					0.0951***
					[0.0461]					[0.0328]
Constant	0.8688***	0.8771***	0.271	-0.265	-8.1526***	2.1743***	2.1579***	3.6739***	-10.7241***	-12.6487***
	[0.1885]	[0.1890]	[0.2463]	[0.3946]	[0.9872]	[0.1375]	[0.1387]	[0.2116]	[1.0524]	[1.2045]
Observations	1225	1225	1225	1225	1203	1779	1779	1779	1779	1739
R-squared	0.38	0.38	0.41	0.41	0.45	0.28	0.28	0.32	0.39	0.39

Standard errors in brackets; Regresion models include ecological zones and rainfall deviation
** significant at 10%; ** significant at 5%; *** significant at 1%*

Table 5: Determinants Of Non-Cocoa Crop Yield (Output Per Acre)—Pooled Sample										
Dependent variable = Log yield	**Cocoa Regions**					**Non-Cocoa Regions**				
	I	II	III	IV	V	I	II	III	IV	V
ln_croplab	0.0237*	0.0282**	0.015	0.015	0.020	-0.0161**	-0.0161**	-0.0168**	-0.0177**	-0.0229***
	[0.0131]	[0.0130]	[0.0131]	[0.0130]	[0.0133]	[0.0074]	[0.0074]	[0.0078]	[0.0078]	[0.0079]
ln_cropnlab	0.0226*	0.018	0.005	-0.002	-0.005	0.0150**	0.0150**	0.0146*	0.013	0.012
	[0.0134]	[0.0132]	[0.0135]	[0.0136]	[0.0139]	[0.0074]	[0.0074]	[0.0084]	[0.0085]	[0.0084]
agric fertilizer use	0.150	0.18	0.187	0.2321**	0.2126*	-0.4686***	-0.4637***	-0.4914***	-0.5080***	-0.5560***
	[0.1198]	[0.1190]	[0.1172]	[0.1173]	[0.1190]	[0.0741]	[0.0742]	[0.0742]	[0.0745]	[0.0738]
agric insecticide use	-0.6856***	-0.6751***	-0.5576***	-0.5173***	-0.4982***	0.3383***	0.3349***	0.3096***	0.3100***	0.3412***
	[0.1280]	[0.1271]	[0.1257]	[0.1256]	[0.1278]	[0.0781]	[0.0783]	[0.0782]	[0.0781]	[0.0779]
agric land sale	-0.5347***	-0.5299***	-0.5156***	-0.4760***	-0.4633***	0.439	0.438	0.371	0.339	0.382
	[0.1571]	[0.1559]	[0.1531]	[0.1528]	[0.1553]	[0.3820]	[0.3818]	[0.3805]	[0.3802]	[0.3804]
crops sold to market traders	0.4135***	0.4549***	0.4336***	0.3723***	0.3759***	0.4122***	0.4122***	0.4125***	0.4158***	0.4123***
	[0.1071]	[0.1064]	[0.1044]	[0.1052]	[0.1071]	[0.0612]	[0.0612]	[0.0610]	[0.0609]	[0.0612]
agric extension worker	-0.136	-0.147	-0.184	-0.175	-0.211	-0.036	-0.036	-0.020	-0.027	-0.044
	[0.1415]	[0.1404]	[0.1378]	[0.1372]	[0.1400]	[0.0811]	[0.0811]	[0.0812]	[0.0811]	[0.0811]
agric cooperative	0.085	0.074	0.012	-0.004	-0.016	-0.121	-0.119	-0.119	-0.107	-0.103
	[0.1210]	[0.1201]	[0.1180]	[0.1175]	[0.1195]	[0.0775]	[0.0775]	[0.0786]	[0.0786]	[0.0782]
newspapers intensity	0.005	-0.007	-0.004	0.022	0.021	-0.0372***	-0.0366***	-0.0523***	-0.0724***	-0.0707***
	[0.0153]	[0.0148]	[0.0147]	[0.0162]	[0.0165]	[0.0104]	[0.0104]	[0.0111]	[0.0143]	[0.0142]
television intensity	-0.002	0.0195***	0.0439***	0.0238***	0.0227**	0.0170***	0.0194***	0.0375***	-0.016	-0.005
	[0.0079]	[0.0064]	[0.0070]	[0.0087]	[0.0093]	[0.0058]	[0.0064]	[0.0079]	[0.0253]	[0.0257]
Radio-only intensity		0.0377***	0.0287***	0.011	0.009		0.003	0.002	-0.0261**	-0.0274**
		[0.0057]	[0.0064]	[0.0080]	[0.0088]		[0.0029]	[0.0032]	[0.0127]	[0.0127]
Year 2006			-7.4807***	-7.4205***	-7.6141***			-3.2115***	-3.2948***	-4.0296***
			[0.9284]	[0.9248]	[0.9455]			[0.8455]	[0.8451]	[0.8746]
Radio-only intensity x Year 2006			0.1244***	0.1220***	0.1257***			0.0510***	0.0521***	0.0645***
			[0.0168]	[0.0168]	[0.0171]			[0.0131]	[0.0131]	[0.0136]
Population density				0.0492***	0.0472***				0.0445**	0.033
				[0.0130]	[0.0134]				[0.0199]	[0.0203]
Log Income					0.022					0.0774***
					[0.0450]					[0.0236]
Constant	-0.310	-0.8781**	-1.1523***	-2.8101***	-2.9067***	1.7661***	1.6848***	1.4503***	3.5994***	2.6599**
	[0.3286]	[0.3458]	[0.3432]	[0.5562]	[0.6351]	[0.4734]	[0.4979]	[0.4995]	[1.0823]	[1.1376]
Observations	1637	1637	1637	1637	1599	1367	1367	1367	1367	1343
R-squared	0.25	0.26	0.29	0.30	0.30	0.18	0.18	0.19	0.20	0.21

Standard errors in brackets; Regresion models include ecological zones and rainfall deviation
We include interaction of labor and non-labor costs with year dummy to isolate general increase in prices between the surveys.
** significant at 10%; ** significant at 5%; *** significant at 1%*

cocoa farmers in cocoa regions might be able to find the frontier faster and achieve higher yield than farmers in noncocoa regions. A second possibility is that noncocoa technologies may be regionally invariant but differences in access to other farm inputs, such as rainfall and fertilizer, between regions may generate differences in crop yield. Third, there may be knowledge spillovers from formal extension services that are more common in cocoa regions than in noncocoa regions. Because there are more research facilities in cocoa regions, noncocoa technologies may also be subject to scientific analysis to some extent in cocoa regions and noncocoa farmers may benefit from this knowledge. In effect, while farmers in noncocoa regions would only be applying tacit knowledge, farmers in cocoa regions would have access to both tacit and scientific knowledge. We presently do not have the data needed to discriminate between these competing hypotheses.

CONCLUSION

We analyze the trends in crop yield in Ghana over a period when farmers gained cheaper and easier access to frontier tacit farming knowledge. Our results establish a positive correlation between the intensity of participating in rural radio networks and the increase in noncocoa crop yield, and we interpret this association as having emerged through the socialization of farming knowledge through radio listenership.

Our finding of conditional correlations between participation in rural radio and crop yield does little to establish the channels through which information shared on radio programs influences farm technology. Further work in this area will involve developing testable frameworks to explain how farmers interact on radio programs, analyzing the content of agricultural programs on rural radio and developing a model of learning through radio networks.

The correlations that we have found in this paper suggest the existence of an enormous potential for agricultural research to make an impact on farm practices at a faster rate than orthodox extension services if research institutions take advantage of widely broadcast community radio programs. Utilizing this recommendation, agricultural research findings would not simply sit on shelves or in conference papers, but would be communicated directly to the end users, the farmers, via programs on rural radio stations. Chapman and others (2003) demonstrate that this approach has been useful in enabling farmers to adopt soil water conservation practices in northern Ghana.

APPENDIX

Variable	Definition	Source
Crop yield	Output per acre cultivated	GLSS
ln_croplab	Log of labor input for all crops	GLSS
ln_cropnlab	Log of nonlabor input for all crops	GLSS
agric fertilizer use	Whether farmers use fertilizer in the community	GLSS
agric insecticide use	Whether farmers use insecticides in the community	GLSS
agric land sale	Whether individuals can buy or sell land in the community	GLSS
crops sold to market traders	Whether crop output is sold in regular markers	GLSS
agric extension worker	Whether an extension worker is located in the community	GLSS
agric cooperative	Whether farmers' cooperative exists in the community	GLSS
newspapers intensity	Region-level rate of newspaper readership	DHS
television intensity	Region-level rate of television viewership	DHS
Radio-only intensity	Region-level rate of radio-only listenership	DHS
Population density	Population per cluster in a given region	GLSS
Log Income	Log of total household income	GLSS

Note: GLSS = Ghana Living Standard Surveys; DHS = Demographic and Health Surveys.

REFERENCES

Bediako, J. A., P. Nkegbe, and A. Iddrisu. 2005. "Establishing the Future Potential for the Use of Mud Silos by Smallholder Farmers: An Assessment of Mud Silos Promotion in the Northern Region of Ghana." University of Development Studies, Tamale, Northern Region, Ghana.

Benin, S., E. Nkonya, G. Okecho, J. Pender, S. Nahdy, S. Mugarura, E. Kato, and G. Kayobyo. 2007. *Assessing the Impact of the National Agricultural Advisory Services (NAADS) in the Uganda Rural Livelihoods.* Discussion Paper 00724. Washington: International Food Policy Research Institute.

Bill and Melinda Gates Foundation. 2010. *Farm Radio Profiles of Progress.* Global Development Program. http://www.gatesfoundation.org/agriculturaldevelopment/Documents/farm-radio-profile-of-progress.pdf

Boateng, W. 2006. "Knowledge Management Working Tool for Agricultural Extension Practice: The Case of Ghana." *Knowledge Management for Development Journal* 2, no. 3: 19–29.

Borts, G. H., and J. L. Stein. 1964. *Economic Growth in a Free Market.* New York: Columbia University Press.

Chapman, R., R. Blench, G. Kranjac-Berisavljevic, and A. B. T. Zakariah. 2003. *Rural Radio in Agricultural Extension: The Example of Vernacular Radio Programmes on Soil and Water Conservation in N. Ghana.* AgREN Network Paper 127. London: Overseas Development Institute.

Cleaver, K. M. 1993. *A Strategy to develop Agriculture in Sub-Saharan Africa and a Focus for the World Bank.* World Bank Technical Paper Number 203. Africa Technical Department Series: World Bank.

Conley, T. G., and C. R. Udry. 2010. "Learning About a New Technology: Pineapple in Ghana." *American Economic Review* 100, no. 1: 35–69.

Eicher, C. K. and M. Rukuni. 2003. *The CGIAR at 31: An Independent Meta-Evaluation of the Consultative Group on International Agricultural Research.* Thematic Working Paper. Washington: World Bank.

Foster, A., and M. Rosenzweig. 1995. "Learning by Doing and Learning from Others: Human Capital and Technical Change in Agriculture." *Journal of Political Economy* 103, no. 6: 1176–1209.

Girard, B. 2001. "The Challenges of ICTs and Rural Radio." Paper presented at First International Workshop on Farm Radio Broadcasting, sponsored by Food and Agriculture Organization, Rome February 19–22.

Government of the Republic of Uganda. 2000. "Plan for Modernization of Agriculture: Eradicating Poverty in Uganda." Ministry of Agriculture, Animal Industry, and Fisheries. http://api.ning.com/files/ffRLhO7x-pp8FfrnIEFfaTgGP5wzeKG2UAhWQzkkYkM_/PMAMaindocument.pdf.

McKay, B. 2003. "Fishers and Radios: A Case Study of Radio Ada in Ghana." www.kit.nl/-/INS/15587/Royal-Tropical.../KIT.../ILS-Dossiers.pdf.

Mugera, A. and A. Ojede. 2011. "Agricultural Productivity Growth in Africa: Is Efficiency Catching Up or Lagging Behind?" Paper presented at 55th Annual National Conference of the Australia Agricultural and Resources Economics Society, Melbourne, February 8–11.

Munshi, K. 2004. "Social Learning in a Heterogeneous Population: Technology Diffusion in the Indian Green Revolution." *Journal of Development Economics* 73, no. 1: 185–215.

Quarmyne, W. 2001. “Participatory Research for Community Radio Program Series for Social Change. Ghana Community Radio Network and Radio Ada.” http://asiapacific.amarc.org/files/OURMedia6_Sydney/NM6_Community%20Radio%20in%20Ghana_2007.04.pdf.

Ray, H. E. 1978. *The Basic Village Education Project: Guatemala.* Washington: Academy for Educational Development.

Roling, N. 1992. “The Emergence of Knowledge Systems Thinking: A Changing Perception of Relationships among Innovation, Knowledge Process and Configuration.” *International Journal of Knowledge Transfer and Utilization* 5, no. 1: 42–64.

Sangare, O. 2000. “Impact of Radio Broadcasts in the Mali-South Region: Follow-Up and Evaluation. An Evaluation of the GCP/MLI/020/NET Project of the Food and Agriculture Organization (FAO).” http://www.fao.org/docrep/003/x6721e/x6721e14.pdf.

Whaites, N. 2005. “Tuning In: An Inventory of Rural FM Radio in Ghana.” Thesis, Faculty of Graduate Studies, University of Guelph.

World Bank. 2007. *World Development Report 2008: Agriculture for Development.* Washington: World Bank. http://siteresources.worldbank.org/INTWDR2008/Resources/WDR_00_book.pdf.

ENDNOTES

1. Under orthodox agricultural extension, designated officers from agricultural research institutes or equivalent institutions visit farmers on their farms or in group meetings to educate them about new scientific knowledge.

2. Existing studies examining social learning from neighbors in other settings, such as Foster and Rosenzweig (1995) and Munshi (2004), who analyze the Indian green revolution found similar results.

3. Rural radios have also become the medium through which neglected folks voice out their concerns over all issues affecting them. In particular, peasants have used the rural FM radio stations as platforms to reach their political leaders and to organize community development efforts.

4. The reach of radio programs have widened tremendously since 1996. A World Bank estimate shows that the number of radios per capita increased from 231 per 1,000 in 1995 to 710 per 1,000 in 2001 (Eicher and Rukuni 2003). Rural FM stations would have a tremendous impact on this change.

5. Before 1996, the Ghanaian Broadcasting Service maintained monopoly over radio transmission.

6. Nowhere is this shift more nationalized than in Uganda. After several decades of orthodox agricultural extension services that failed to stimulate productivity growth and expansion, in 2000 the Ugandan Ministry of Agriculture created a National Agriculture Advisory Services (NAADS) system, whereby farmers themselves are the lead players in knowledge extension (Government of the Republic of Uganda 2000). Under this new approach, farmer groups instead of extension officers are responsible for the planning, prioritization, resource allocation, monitoring and evaluation of extension services. Of particular importance, farmers are able to socialize their successful private farming practices through this process. An evaluation of the program in 2005 by Benin et al. (2007) shows that compared with areas that remain under orthodox extension services, NAADS has been successful in promoting the adoption of improved crop varieties and the adoption of yield-enhancing technologies and post-harvest systems. There is also evidence that the program helped farmers to avoid the income declines that affected most farmers between 2000 and 2004.

7. The co-movement of extension services and fertilizer usage in community is naturally expected. Community leaders are asked whether extension agents visit the community and whether farmers in the community use fertilizer. Most of the advice given by extension agents might involve fertilizer usage and application.

8. Our focus in this paper is to isolate the effect of knowledge that is socialized among farmers through radio on crop yield. Inevitably, segments of television programs that are broadcast in rural areas would be dedicated to local development issues similar to the ones that are transmitted on local radio. There is therefore the potential that radio and television serve the same purpose at least by devoting some air time to similar issues. However, opportunities for rural indigenes to share their knowledge and learn from others will be captured more intensively on radio than television. The on-air discussions that enable people in rural communities to share their knowledge and experience are unlikely to take place on television sets.

9. The idea of radio-only, or more appropriately radio but not television, is similar to the idea of differencing in set theory. Given two sets, A and B, the difference "A less B," denoted A\B, is the set of elements that are present in A but not in B. It is plausible to consider the content of broadcast on radio and television as elements of two sets. The differencing isolates the content of segments broadcast on radio but not on television.

10. The decrease in fertilizer usage may be due to prices or issues related to availability. Indeed, though farmers in noncocoa regions may be learning best practices, an inability to obtain the needed inputs, especially in the case of fertilizer, may constrain the effect of socialized learning.

The views expressed in this working paper do not necessarily reflect the official position of Brookings, its board or the advisory council members.

© 2012 The Brookings Institution

ISSN: 2166-5184 (online) | 2166-5176 (print)

Cover photos courtesy of (left to right): Trevor Samson / World Bank, Hansjoerg Richter, John Hogg / World Bank, Andrew Martin Green, Lorenzo Codacci, Eric Miller / World Bank, Ami Vitale / World Bank

BROOKINGS

1775 Massachusetts Avenue, NW
Washington, DC 20036
202-797-6000
www.brookings.edu/global