

Access to technical information and gendered NRM practices: Men and women in rural Senegal^{*}

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Abstract. Gender differences in knowledge of NRM practices have long been noted in Senegal and throughout Sub-Saharan Africa. An exploration of these differences among a sample of rural Senegalese men and women shows that these differences are, in part, a function of extension agent interventions. The level of knowledge of a set of NRM technologies is associated with contact with three key types of extension agent in rural Senegal: extension team leaders, forestry agents, and women's agents. Analysis of intra-household variation in levels of knowledge shows a degree of interdependence between the knowledge levels of husbands and wives for some practices. However, multi-variate analysis, controlling for personal and contextual factors, clearly demonstrates the independent impact of extension agents on gender differences in rural Senegalese NRM knowledge. It can be concluded that contact with extension agents increases knowledge of NRM practices. In particular, contact with the women's agent is a strong predictor of the level of women's NRM knowledge and, surprisingly, also contributes to the level of men's knowledge. Despite the small number of women's agents in the field, they appear to have significant positive impact on the dissemination of NRM knowledge among rural Senegalese women and men.

Key words: Extension agents, Gender, Information networks, Natural resource management, Senegal, Technology transfer, Women extension agents

Abbreviations: CBNRM – Community-Based Natural Resource Management; CERP – Centre d'Expansion Rurale Polyvalent; ISRA – Institut Sénégalaise de la Recherche Agronomique; NGO – non-governmental organization; NRM – natural resource management; USAID – United States Agency for International Development

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Introduction

This study investigates the extent to which contact with extension agents is related to knowledge about and adoption of a set of natural resource management practices (NRM) by rural Senegalese men and women. Gender differences in knowledge of NRM practices and in contact with extension agents have long been noted in Senegal and throughout Sub-Saharan Africa. Two research questions explored in this study are the following: (1) to what degree are gender differences in knowledge and application of NRM practices a function of extension agent interventions? and (2) how does the gender of the agent affect the NRM knowledge and practices of women and men? Husband and wife data gathered in 1996 from a national sample of rural Senegalese households provide the basis for this investigation.

Several recent studies of the relationships between extension agents, men and women, and natural resource management practices in the Sahel, and more generally in sub-Saharan African populations, have found that women farmers prefer working with female extension agents (Ajayi and Laogun, 1998); women's interactions with extension agents are valued (Alawy and McCaslin, 1998); and women are effective conservationists (Aboud et al., 1996) and organizers of community-based natural resource management programs (Mehra, 1993). After controlling for relevant structural and cultural factors, some studies have found that contact with extension agents is not associated with increased adoption of conservation practices by women (although there may be a positive association among men farmers; see Aboud et al., 1996). However, few studies specify the gender of the extension agent, let alone control for it in the analysis. It is possible that the gap between access to extension services and conservation practices among women may reflect the fact that extension program content or delivery is more appropriate for the needs of male farmers.

Although many countries are attempting to address the needs of women farmers by increasing the numbers of female extension agents, it has been amply demon-

strated that women tend to have less access than men to extension services despite their critical involvement in both agriculture and natural resource use and management in the Sahel (see Henderson et al., 1991). Given women farmer's preference for women extension agents and the potential need for parallel extension services in some Islamic areas, it is possible that the impact of extension might be significantly increased if national services perceived a demonstrable benefit for all farmers – regardless of gender – to be derived from an increase in the number of women extension agents.

One study analyzing this demonstrable benefit found that, within an Islamic region in Tanzania where men might be expected to prefer working with male extension agents, men did not object to working with female agents (Due et al., 1996). Farmers of both genders stated that the quality of the extension agent's information, responsiveness, and ability to explain things were more important than gender in determining their preferences. Nonetheless, women in this region expressed a preference for female agents. Despite the fact that women and men extension agents had received the same training, farmers of both genders reported greater confidence in the quality and usefulness of female agents' information regarding crops and livestock. This finding does not suggest that women generally make better agents, but that if a female agent was better prepared or offered more useful information than a male agent, male farmers in this region would acknowledge and take advantage of the difference.

The objective of this paper is to explore the effects of contact with extension agents on natural resource management knowledge and practices by gender of both agents and farmers. We begin by presenting the frequencies of husbands' and wives' acquaintance with three key extension agents across six eco-geographic zones in rural Senegal. We then examine the extent to which knowledge of a set of NRM technologies is associated with extension agent contact for each type of agent. Intrahousehold variation in levels of knowledge is then analyzed to determine the degree

of independence between husbands and wives. Finally, a multivariate analysis, controlling for personal and contextual factors, will demonstrate the independent impact of extension agents on rural Senegalese NRM knowledge among women and men.

Data and method

Survey data

Data collected in the USAID/Senegal-funded Community-Based Natural Resource Management (CBNRM) Project provide the basis for this investigation. The CBNRM 1996 Knowledge, Attitudes, and Practices Survey provides a broadly based point of reference on national perspectives concerning the mechanisms to improve NRM at the local level. The design of the sample framework involved a two-stage procedure. In the first stage, the rural population of Senegal (five million) was stratified according to six eco-geographical zones (*Cellule Aménagement des Terroirs Villageois et Cartographie*, 1993). Within these zones, villages were arranged by population and administrative unit, assuring a broadly based homogeneity of the stratified sampling base. Villages were then drawn systematically. In the second stage, households, clustered at the village level were selected systematically from lists prepared by the village heads. These data were subsequently weighted to provide estimates of national population parameters (Moore and Thiongane, 1996).

Survey instruments were based on previous surveys, but subjected to rigorous review and revision. An informal survey was conducted to test, develop, and target survey items before the final instruments were pre-tested. The field work for the survey took place during June and July 1996 (Senagrosol-Consult, 1996). Interviews were conducted with household heads and their "leading" wives¹ from five randomly selected households in each village. Completed individual questionnaires are available for 725 male household heads and 765 leading wives. The analysis presented in this paper uses 694 paired responses.

Eco-geographical variation

In order to control for ecological variation in NRM practices and perspectives, zoning of Senegal's rural space was introduced into the sampling framework. Zonage systems have been developed for a variety of purposes and lines of demarcation refined. In 1981, Senegal was divided into six zones according to vegetative cover, and agricultural, forestry, and pastoral practices by the *Direction des Eaux et Forêts* (Ministère du Développement Rural, 1981). Another

of the early zoning systems was documented by the *Direction de l'Aménagement du Territoire*, which elaborated 17 different zones characterized by differences in agriculture, industry, and tourism (Ministère de l'Intérieur, 1986). The zonage system applied by *Institut Sénégalaise de la Recherche Agronomique* (ISRA) emphasizing agricultural production considerations, both human and biophysical, specified eight zones (Diallo and Thiongane, 1994). The *Plan d'Action Forestier* (1993) detailed the original specification of six zones developed by the *Direction des Eaux et Forêts*. In the context of the Rural Forestry Development Project, these six zones were clearly demarcated down to the village level by the *Division d'Aménagement et Cartographie, Eaux et Forêts* (*Cellule Aménagement des Terroirs Villageois et Cartographie*, 1993: map 1). This zonage system provides the only segregation of census units, thus facilitating sampling procedures.

The six major zones (the Fleuve, the Ferlo, the Niayes, the Peanut Basin, the southeast Agro-Silvo-Pastoral zone, and the Southern Forest zone) documented by the *Eaux et Forêts* are easily recognized and distinguishable. The main ethnic groups of Wolof, Peul, Serere, Toucouleur, Diolo, and Manding are distributed within these zones, with the pastoral Peul found in each zone and the predominant Wolof population inhabiting the northern zones. A description of the six zones follows.

Fleuve (Senegal River). The *Vallée du Fleuve Senegal* zone covers a band of 10–15 km width containing some natural forest remains. Originally inhabited by the agropastoral Toucouleur and Peul, the Wolof people have recently migrated to the zone to conduct irrigated agriculture along the river. Soils are relatively fertile and their texture differs more or less across the upper and lower reaches of the river differentiating three subzones: *Walo*, *Dieri*, and *Delta*. The zone's water resources increase the productive value of lands that can be easily flooded. Irrigated agriculture is a major activity in the zone.

Ferlo. The *sylvo-pastorale* zone of the Ferlo covers a major portion of the Senegal River basin characterized by low rainfall and very degraded pasture lands. Two parts can be distinguished. On the sandy Ferlo, rainwater generally gathers in the depressions to form the temporary ponds around which the pastoral life of the Peul is organized. The laterite Ferlo is characterized by a woody cover. The Wolof also inhabit this zone and are primarily involved in peanut production.

Peanut Basin. The agricultural zone of the Peanut

Basin covers the greatest number of administrative regions. Half of Senegal's population lives in this region, which accounts for one third of the country's total land area. Soil productivity has been declining due to climatic factors and to the overuse of agricultural land and forest resources. This is the zone of intensive peanut production dominated by the Wolof population. The sedentary, agro pastoralist Serere also inhabit this zone.

Niayes. The Niayes zone is a band of five kilometers width with sand dunes and inter-dune depressions running north from Dakar along the Atlantic Coast. It is characterized by very rich soils in which vegetables are cultivated. This narrow band, near major urban centers, is largely inhabited by the Wolof and Peul ethnic groups.

Southeast (Senegal Oriental). The *Agro-Sylvo-Pastorale* zone of the southeast is very large and contains many natural forests (including the National Park of Niokolo Koba in the south). This zone is sparsely populated by primarily Peul and Manding ethnic groups. Soils are not very deep, but they are dominated by laterite. While the zone is both agricultural and pastoral, forest exploitation is also a major activity.

Southern Forest (Casamance). The *Zone Forestière* of the south has a particular ecology that distinguishes it from the rest of the country with higher rainfall and a denser vegetative cover. It has recently become the destination for internal migration from the declining Peanut Basin, although it is still predominantly populated by the Diolo, with large Peul and Manding populations. Rice cultivation is practiced along the Casamance River and its tributaries.

For this paper, a rainfall indicator (using approximately 600 millimeters/year as the cutoff level) has been used to control for the major sources of ecological variation within the multiple regression analyses. The lower rainfall Northern Zone includes the Fleuve, Ferlo, Peanut Basin, and the Niayes. The higher rainfall Southern Zone includes the Southeast Agro-Sylvo-Pastoral and Southern Forest Zones. This rainfall indicator, in combination with the control for ethnic groups, provides considerable precision in the identification of various types of production systems.

Rural Extension Service Centers (CERP)

Rural Extension Service Centers (*Centre d'Expansion Rurale Polyvant* or CERP) are locally based service providers coordinating technical experts from several

different national-level ministries. These teams, having potentially up to five or six members, are based at the *arrondissement* level serving some 5,000–10,000 rural households. The CERP is run by a team leader from the Ministry of the Interior with expertise in planning or agriculture. The usual staff of a CERP consists of a forestry service agent and an additional agent or two with a specialty in home economics (women's agent), livestock, horticulture, agriculture, hydrology, or fisheries. All CERP teams are staffed by men with the exception of those with a women's agent whose responsibilities are largely targeted to serving all of the women in the *arrondissement*.

CERP team leaders have considerable administrative responsibilities, including provision of technical advice to the local authorities. The forestry agents have the greatest contact with the population. Forestry agents are responsible for preventing forest fires and protecting the natural resource base of *flora*, including the administration of tree cutting. Recently, forestry agents have moved into more positive development roles with the promotion of agroforestry technologies and income-generating activities such as woodlots. The women's agents are responsible for home economics, often promoting improved stoves for firewood conservation and for the reduction of labor time. However, the women's agent is involved in all women's productive activities, from horticultural production to penned livestock raising.

Table 1 presents the proportion of household heads and leading wives who are at least familiar with the three primary CERP agents investigated in this study. For leading wives, the forestry agent is the most commonly known (44 percent) agent. Few leading wives know their CERP team leader (14 percent versus 40 percent for male household heads), but leading wives are more likely than their husbands to know the women's agent (21 percent versus 16 percent). Nevertheless, when one spouse knows a particular agent, the other is likely to know the agent as well. Spearman's correlation coefficients are all positive ranging from a low correlation coefficient ($r = 0.202$) for CERP Team leader to a high correlation coefficient ($r = 0.319$) for women's agent (all correlation coefficients significant at the 0.001 level).

Further examination of Table 1 demonstrates a high degree of variability between the various eco-geographic zones. For example, leading wives are very unfamiliar with their CERP team leader in the northern zones (Fleuve, Ferlo, Niayes, Peanut Basin), whereas in the south over a quarter of the leading wives know their team leader. In the Peanut Basin, leading wives are more likely than their husbands to know the forestry agent (47 percent versus 38 percent). The women's agent is best known in the Niayes, and house-

Table 1. Percent of male household head's and leading wife's acquainted with extension agents by eco-geographic zone.

	CERP team leader		Forestry agent		Women's agent	
	Wives	HHs	Wives	HHs	Wives	HHs
Northern zones	10.2	36.5	46.1	47.1	20.0	24.2
Fleuve	11.0	52.7	44.0	63.7	20.0	24.2
Ferlo	7.3	52.3	46.8	78.0	13.2	13.8
Niayes	9.0	49.3	38.8	50.7	62.7	58.2
Peanut Basin	10.5	29.5	47.1	38.4	23.7	15.3
Southern zones	26.3	52.1	36.9	54.3	13.2	5.9
Southern Forest	26.0	53.4	35.6	52.7	12.3	5.5
Southeast	27.4	47.4	37.6	60.0	16.7	7.4
Senegal	14.1	40.3	43.7	48.9	21.4	15.6

hold heads are nearly as likely as their wives to know her across the northern zones.

Knowing about NRM technologies: The dependent variable

Three NRM technology knowledge measures have been used in this study: two single measures (nursery techniques and composting) and a composite measure developed through factor analysis (agroforestry practices). Each technology is measured on a self-reported three-point scale: do not know about it; know about it but do not use it; and know and use the technology. This scale measures broad levels of knowledge about each technology in question. Here, we are concerned with the extent to which contact or acquaintance with extension agents is related to increased levels of that knowledge. Of course, the highest levels of knowledge are derived from direct experience with a technology after adoption. In some zones, a technology may be less appropriate than in others, thus the highest knowledge level would be "knows about but does not use it."

The first NRM technology involves nursery techniques used by both men and women to prepare seedlings for trees, horticultural crops, or rice (depending on the irrigation potentials of the zone). In Table 2, those areas with irrigation potential (Fleuve, Niayes, and Southern Forest Zones) have the highest levels of knowledge of nursery techniques. This knowledge is particularly high among women in the Southern Forest Zone (Casamance) where women are the traditional rice producers. Although not a new technology *per se*, nursery techniques require care and effort to be successful. The second NRM technology is composting (the transformation of organic wastes into fertilizer to improve soil quality), which with the exception of the Southern Forest Zone

Table 2. Average level of male household head's and leading wife's knowledge of NRM technologies by eco-geographic zone.

	Nursery techniques		Composting		Forestry practices	
	Wives	HHs	Wives	HHs	Wives	HHs
Northern zones	1.02	1.10	0.18	0.78	2.60	3.18
Fleuve	1.20	1.29	0.01	0.76	2.59	3.07
Ferlo	0.95	1.12	0.19	0.83	2.95	3.14
Niayes	1.27	1.45	0.22	1.04	3.06	3.97
Peanut Basin	0.97	1.03	0.20	0.75	2.52	3.16
Southern zones	1.55	1.19	0.46	0.52	1.28	1.91
Southern Forest	1.75	1.27	0.51	0.52	1.31	1.92
Southeast	0.87	0.89	0.31	0.53	1.19	1.85
Senegal	1.15	1.12	0.25	0.71	2.28	2.87

(Casamance), has only recently been introduced in Senegal. For the most part, development projects and non-governmental organizations (NGOs) have been responsible for the promotion of composting. The formal extension system has only recently begun to promote this technology. The highest levels of knowledge concerning composting are found in the commercialized agriculture of the Niayes.

The third NRM technology is composed of agroforestry practices including windbreaks, live fences, and village woodlots. Windbreaks and live fences are designed to reduce erosion from fields and protect those fields from ranging livestock. Village woodlots have been promoted as community income-generating investments and have contributed to the reforestation of many areas. These practices have been introduced by the Forestry Service and have been promoted by CERP agents for many years. They have also been promoted by development projects and NGOs since the droughts of the 1970s and early 1980s. It has long been recognized that the lower rainfall zones of the north have been subject to serious deforestation over the past decades. Consequently, substantial efforts have been made to disseminate reforestation practices in these zones.

We will first focus on the direct relationship between knowledge of NRM technologies and contact with extension agents (Table 3). Nursery techniques are positively related to contact with all three extension agents, for both husband and wife. For each of these positive relationships, the eta is also significant, signaling an important increase in average levels of knowledge of nursery techniques associated with knowing extension agents. Knowledge of composting technology, on the other hand, is largely unrelated to contact with extension agents. Only male household heads appear to have their knowledge of composting

Table 3. Spearman correlation and eta difference in means for the relationship between male household head's and leading wife's level of acquaintance with extension agents and their knowledge of NRM technologies.

		Familiarity with: CERP team leader		Forestry agent		Women's agent	
		Wives	HHs	Wives	HHs	Wives	HHs
Nursery techniques	r	0.188**	0.191**	0.184**	0.217**	0.170**	0.131**
	eta	0.186**	0.218**	0.196**	0.194**	0.189**	0.136**
Composting	r	0.022	0.090**	0.024	0.045	-0.015	0.225**
	eta	0.024	0.089	0.040	0.066	0.030	0.204**
Forestry practices	r	0.114*	0.074*	0.198**	0.102**	0.213**	0.179**
	eta	0.101*	0.078	0.229**	0.100*	0.241**	0.186**

Coefficients significant at 0.05 level(*); significant at 0.01 level (**).

influenced by extension agents, and this is through their acquaintance with the women's agent. Knowledge of forestry practices is influenced by contact with the forestry agent and the women's agent. The relationship appears strongest for leading wives.

Tables 4A and 4B clarify the similarities and differences between a husband's and a wife's knowledge levels concerning the three NRM practices. On a 0-to-2 scale, knowledge about nursery techniques is relatively common and equal for both husbands (1.12) and wives (1.15), with no statistically significant difference in levels (Table 4A). However, there is a significant difference between the relatively low levels of knowledge of composting (husbands, 0.71, and wives, 0.25). There is also a significant difference between knowledge levels for forestry practices (husbands, 2.87, and wives, 2.28 on a scale from zero to six). With the exception of nursery techniques, husbands appear to be more knowledgeable than wives. Table 4B allows us to gauge the extent to which knowledge is shared in a household, as opposed to being individual knowledge. Knowledge of nursery techniques and forestry practices is positively correlated for husbands and wives, suggesting that acquaintance with these technologies is shared. There appears to be no relationship between a husband's and a wife's knowledge of composting techniques.

Knowledge of NRM technologies is related to a number of factors. The agro ecological zone is assumed to affect men and women equally, in that both men and women independently conduct a wide range of agricultural activities. Ethnicity may also be a factor in that tenure systems, NRM practices and perceptions, and household and intra household access to factors and means of production differ from one ethnic group to the other. In the regression models that follow, ethnicity is measured by dummy variables for each major

Table 4A. Gender differences in levels of knowledge concerning NRM technologies (N = 694).

		Level of knowledge concerning					
		Nursery techniques		Composting		Forestry practices	
		Wives	HHs	Wives	HHs	Wives	HHs
Mean score		1.15	1.12	0.25	0.71	2.28	2.87
Paired samples t		0.762		-13.699		-8.205	
differences test sig.		0.446		0.000		0.000	

Table 4B. Correlations between leading wives and male household heads in levels of knowledge concerning NRM technologies (N = 694).

		Level of knowledge concerning:			
		Nursery techniques		Forestry practices	
		Wives	HHs	Wives	HHs
Paired samples r		0.242	0.036	0.306	
correlations sig.		0.000	0.340	0.000	

ethnic group. Age, access to land, and other indicators of relative wealth may also facilitate adoption. Age was measured as an interval variable (less than 25, 26 to 35, 36 to 45, 46 to 55, and over 55). Access to land was measured in terms of hectares controlled. Hectare categories for household heads included the following: less than three hectares, 3.0 to 7.99, 8.0 to 19.99, and 20 or more. Leading wives' hectare categories were considerably smaller: none, 0.01 to 0.8, 0.81 to 2.99, and 3 or more. The following multivariate analysis controls for these factors.

Table 5. Regression analysis on factors contributing to knowledge concerning nursery techniques for leading wives and male household heads.

Independent variables	Regression models							
	Know agent		Control variables		Direct effects of agent contact		Complete model	
	Wives	HHs	Wives	HHs	Wives	HHs	Wives	HHs
Respondent knows CERP leader	0.114**	0.123**				0.131**		0.100*
Respondent knows forestry agent	0.124**	0.115**			0.191**	0.112**	0.172**	0.072
Respondent knows women's agent	0.112**	0.058			0.187**		0.175**	
Spouse knows CERP leader							0.099**	
Spouse knows forestry agent								0.161**
Spouse knows women's agent								0.102**
Respondent's age								
Respondent's land controlled			0.087*		0.090*		0.088*	
Respondent's hired labor								
Northern rainfall zone			-0.255**		-0.263**		-0.239**	
Ethnicity								
Wolof			0.100*		0.075		0.075	
Serere				0.106**		0.087*		0.053
Peul								
Toucouleur			0.151**		0.141**		0.128**	
Manding								
Diolo			0.175**	0.104**	0.216**	0.098*	0.215**	0.128**
ANOVA F	14.984	12.689	20.251	6.665	25.010	10.280	22.995	11.811
Adjusted R-squared	0.059**	0.048**	0.125**	0.016**	0.202**	0.053**	0.209**	0.089**

Coefficients significant at 0.05 level (*); significant at 0.01 level (**).

Impact of extension agents

Tables 5 through 7 present a set of regression models designed to determine the extent of influence of extension agents over the levels of rural Senegalese farmers' knowledge concerning NRM technologies. Four models are presented in each table for both household heads and leading wives. The first simply establishes the direct influence of extension agents. The second column demonstrates the effect of control variables, including respondent's age, amount of land controlled, amount of labor hired, rainfall zone, and ethnicity. In the third column, the independent influence of extension agents is examined while controlling for significant other factors. The complete model considers the influence of the spouse's contact with the extension agents as well. The empty cells in these tables signify variables that were tested, but did not achieve levels of significance sufficient for inclusion in the models.

Knowledge of nursery techniques is positively affected by acquaintance with extension agents for both husbands and wives (Table 5, column 1). When the control variables are considered on their own (column 2), leading wives' level of knowledge is

highly dependent on being from Diolo or Toucouleur ethnic groups and on being from the higher precipitation southern zones (where the Diolo reside). Household heads' level of knowledge is predicted poorly by the control variables. Adding the respondents' acquaintance with the extension agents (column 3) significantly increases the explained variance for both household heads and leading wives (r^2 change = 0.037 for household heads and 0.077 for leading wives, both significant at the 0.001 level). Knowing the forestry agent and the women's agent increases the explanation of the level of knowledge of nursery techniques for leading wives. The combination of knowing the CERP team leader and the forestry agent increases the explanation of the husband's knowledge. When the complete model is considered, including whether the respondent's spouse is acquainted with extension agents, minimally increases the explanation of the wife's knowledge levels, but significantly increases the husband's (r^2 change = 0.036, significant at the 0.001 level). This finding combined with the positive correlation between spouses' knowledge levels suggests some transfer of knowledge between spouses. Interestingly, contact of the wife with the women's agent may have

Table 6. Regression analysis on factors contributing to knowledge concerning composting for leading wives and male household heads.

Independent variables	Regression models							
	Know agent		Control variables		Direct effects of agent contact		Complete model	
	Wives	HHs	Wives	HHs	Wives	HHs	Wives	HHs
Respondent knows CERP leader	0.022	0.061			0.086*		0.086*	
Respondent knows forestry agent	0.017	−0.015						
Respondent knows women's agent	−0.019	0.197**			0.166**		0.166**	
Spouse knows CERP leader								
Spouse knows forestry agent							0.114**	
Spouse knows women's agent								
Respondent's age				0.110**		0.099**		0.099**
Respondent's land controlled								
Respondent's hired labor								
Northern rainfall zone				0.145**		0.136**		0.136**
Ethnicity								
Wolof								
Serere								
Peul								
Toucouleur								
Manding								
Diolo				0.302**		0.302**	0.303**	
ANOVA F	0.894	10.811	66.698	12.894	66.698	13.442	38.632	13.442
Adjusted R-squared	−0.004	0.041**	0.090**	0.033**	0.090**	0.069**	0.101**	0.069**

Coefficients significant at 0.05 level (*); significant at 0.01 level (**).

a positive effect on the husband's level of knowledge concerning nursery techniques.

Unlike nursery techniques, knowledge of composting is only weakly related to acquaintance with extension agents for household heads, and not at all for leading wives (Table 6). For leading wives, knowledge of composting only appears to derive from being Diolo. In contrast, household heads appear most likely to learn about composting when they are acquainted with women's agents. This significantly increases the explanation of the level of the household head's knowledge even when controlling for the positive effects of respondent's age and residence in the lower rainfall zones (r^2 change = 0.036, significant at the 0.001 level).

Leading wives' knowledge of agro forestry practices (Table 7) is affected by acquaintance with forestry and women's agents. Male household heads' knowledge levels are only positively associated with acquaintance with the women's agent. The control variables (column 2) of not being Diolo and of being from the lower rainfall northern zones explain the majority of the variance in knowledge levels for both husbands and wives. However, the agro forestry prac-

tice knowledge levels of both increases minimally with the acquaintance with extension agents (r^2 change = 0.025 for household heads and 0.043 for leading wives, both significant at the 0.001 level). There was no significant increase in explained variance when the influence of the spouse's acquaintance with extension agents was examined (column 4). Men appear to depend on the CERP team leader and the women's agent, and women appear to depend on the forestry agent and the women's agent. What stands out here for both husbands and wives is the difference acquaintance with the women's agent can make for both spouses.

Discussion

Extension agents are not the sole source of information concerning NRM practices. However, they provide an important institutionalized conduit for such information. These findings are supportive of the hypothesis that contact with extension agents does increase knowledge of NRM practices for rural Senegalese household heads and their leading wives. Contact with the CERP team leader seems most important

Table 7. Regression analysis on factors contributing to knowledge concerning agro-forestry practices for leading wives and male household heads.

Independent variables	Regression models							
	Know agent		Control variables		Direct effects of agent contact		Complete model	
	Wives	HHs	Wives	HHs	Wives	HHs	Wives	HHs
Respondent knows CERP leader	−0.001	0.014				0.122**		0.122**
Respondent knows forestry agent	0.167**	0.032				0.137**	0.121**	
Respondent knows women's agent	0.188**	0.151**				0.154**	0.144**	0.80*
Spouse knows CERP leader							0.081*	
Spouse knows forestry agent								
Spouse knows women's agent								
Respondent's age								
Respondent's land controlled								
Respondent's hired labor								
Northern rainfall zone			0.287**	0.319**	0.261**	0.338**	0.279**	0.338**
Ethnicity								
Wolof								
Serere								
Peul								
Toucouleur								
Manding								
Diolo			−0.101*	−0.088*	−0.074	−0.081	−0.075	−0.081
ANOVA F	18.611	6.548	47.455	55.926	33.764	33.183	28.101	33.183
Adjusted R-squared	0.073**	0.023**	0.121**	0.137**	0.164**	0.162**	0.169**	0.162**

Coefficients significant at 0.05 level (*); significant at 0.01 level (**).

for male household heads' knowledge levels, while contact with the women's agent is most important for leading wives. Acquaintance with the more well-known forestry agent contributes to both husbands' and wives' knowledge.

Considering the low percentages of men and women who have contact with women's agents, these results are particularly interesting. Only one-fifth of the women and one-sixth of the men know a women's agent. Yet these tests of the independent effects of women's agents, controlling for region, ethnicity, and control of productive resources, indicate that women's agents have as broad an influence as the other agents. Women's agents score significant independent positive effects (in the Complete Model) a total of five times of a possible twelve. CERP team leaders and forestry agents each score five as well. While knowledge levels are relatively equivalent between spouses with nursery techniques, the women's agent plays a key role in the level of the wife's knowledge. Furthermore, women's agents – and only women's agents – are talking directly to both spouses in a way that appears to raise the NRM

knowledge of both.

Knowledge levels are lowest for composting and there is a significant difference between the levels of knowledge of men and women. Only some Diola women appear to have an awareness of composting, which accounts for the vast majority of explained variance. The fact that age of household head is a positive predictor suggests that some indigenous knowledge of the technique exists, although the practice seems to have fallen into disuse. However, contact with a women's agent is the strongest predictor of the household head's knowledge. This may be explained by the practice of showcasing women's agents on CERP Teams where donor projects are operating and have been recently promoting composting techniques. Nevertheless, there appears to be some discontinuity in local knowledge.

In the two cases where NRM knowledge appears to be spreading (reforestation and nursery practices), the role of the extension agents can be perceived. In the case of nurseries, women's contact with forestry and women's agents increases knowledge levels for

both themselves and for their husbands, independent of the control variables. A similar pattern is seen for reforestation practices. Here, the direct impact of agents is positive and independent of the control variables for both husbands and wives with an apparently greater impact on women's knowledge. In both cases, the women's agent makes a significant contribution to the explained variance.

Overall, these models are better predictors of women's NRM knowledge than of men's. However, control variables account for the majority of explained variance. Extension agents are not the only source of information about new technologies. Indeed, most farmers learn about these technologies from their families, friends, and neighbors (Moore and Thiongane, 1996). This accounts for the importance of ethnicity and eco geographic zone as predictors. However, there is still a substantial amount of unexplained variance. Extension agents, ethnicity, socioeconomic status, and eco-geographic zone are not all that contributes to rural Senegalese knowledge of new NRM technologies.

This study has measured formal contacts with outside sources of information to gauge knowledge levels. We have seen that extension agent contact with women, particularly that of the women's agent is a strong predictor of women's knowledge. We suggest the following hypothesis: informal networks through which men receive new (externally-derived) knowledge are more effective than those of women. If we consider the relative lack of mobility of women (lack of inter-village contacts) with respect to men, we can see a potential reason for the importance of formal contacts with women to assure that information is being transferred to them. Pursuing this hypothesis may provide important insights into how information is transferred and the differences between men's and women's information sources. Clearly more detailed study is called for, both to provide more refined indicators of socio-cultural situations and to address the issue of knowledge-enhancing networks.

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Note

1. "Leading" wife refers to the dominant wife in households where the male household head has more than one; or as is more frequently the case, it refers to the only wife of the household head.

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