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Generation and Gender Differences in Groundnut Productivity in the Senegalese Groundnut Basin

Peanut Innovation Lab Research Brief

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Groundnuts are an important crop in the livelihoods of low-income rural households in central and western Senegal north of The Gambia, so much so that the region is known as "The Groundnut Basin." Despite the region's strong historic emphasis on groundnut, production has been stagnant in recent years due to a risky environment arising from inconsistent rainfall and degraded soils. For young adults (ages 16 to 29) and females, groundnuts are the major source of their own income within the household. Thus, there is concern that the increasingly unfavorable production environment will deter young adults and females from investing in groundnut production, thereby decreasing their income-generating opportunities and threatening the viability of the sector for next generation farmers.

This research note examines generational and gender differences in the production of groundnut by smallholder farmers in the Senegal Groundnut Basin. First, we look at how fields that are managed to meet household needs differ in terms of land allocation and distribution of harvest from fields managed by individual household members for their own needs.[1] These different management objectives can lead to complex and sometimes conflicting incentives for young or female groundnut farmers. Second, we examine differences in soil fertility management strategies across generations and between genders, and how different strategies may contribute to long-term differences in field productivity. Third, we identify gaps in agricultural input use by generation and gender and, fourth, we examine revenues and profits from groundnut fields managed by individuals. Fifth, we document productivity increases associated with agricultural inputs, as well as remaining productivity gaps for young-adult and female groundnut producers after accounting for input differences and household-specific determinants of productivity. The note concludes by distilling implications for enhancing long-term groundnut productivity of young adults and female farmers in the Groundnut Basin. An accompanying policy brief describes the survey and study data and examines the aspirations, resources, and constraints of young adults involved in groundnut production.

Groundnut Field Management and Production Incentives

Groundnuts are grown both for household consumption and income needs and by individual household members for their own income. We refer to these two types of fields as household managed and individual managed fields, respectively. But this distinction between household and individually managed fields is sometimes not discrete, and some fields are managed to meet a combination of household and individual needs under shared management. We refer to these fields as "shared" fields. As Table 1 shows, whether a field is managed by an individual or the household influences producer resources and incentives. On individually managed fields, the groundnut harvest is sold and the revenue is kept by the individual field manager 83 percent of the time, while 7 percent of the time the revenue is kept by the household or shared among members, and 11 percent of the time the harvest is not sold (Table 1). By contrast, on household managed fields, 61 percent of the time the groundnuts are kept and consumed by

[1] Households are defined as individuals who eat together.

the household, and 25 percent of the time the groundnuts are sold, and the revenue kept for household needs. As Table 1 also confirms, shared management covers a variety of management arrangements, but the groundnuts are usually sold, and the revenues are either shared by the household and the individual field manager or go mainly to the individual involved in the field management.

Table 1: Groundnut field management and revenue sharing (# of fields)

	Revenue distribution			
Type of *management*	Individual	Household	Shared	Not sold
Individual	1,234	45	54	162
Household	40	157	50	381
Shared	139	37	188	28

Land for groundnut production is allocated by the household head. Fields allocated for household production are larger and are located closer to the household then are fields allocated to individual household members (Table 2). However, yields are lower on household managed fields than on individually managed fields. Shared fields (fields that are managed both by the household and an individual) are also significantly larger than individually managed fields, but are not significantly different in terms of distance from the household or yields.

Table 2. Field distance, size, and yield results: By management type

	Distance (meters)	**Size (hectares)**	**Yield (tons/ha.)**
Individual	1,272	1.22	0.84
Household	1,119***	1.90***	0.73**
Shared	1,228	1.80***	0.86
No. Observations	2,487	2,515	2,211

Notes: * p=0.1, ** p=0.05, *** p=0.01. Comparison group is individually managed fields

The household head is usually in charge of household-managed fields. In Senegal, the household head is most often an older adult male; a young adult is the household head for only 14 percent of the fields in our sample. As a result, 76 percent of fields that young adults manage are for their own needs. By the same token, females manage 85 percent of their fields for individual needs. Further, young women are particularly likely to manage fields for individual needs (91 percent). How land is allocated for groundnuts is also influenced by household member age and gender. In Table 3 we highlight differences in distance to field, field size, and yields by generation and gender of the field manager. Fields managed by young adults

lie significantly farther from the household than those managed by older adults, but this difference is driven by the relatively distant fields of young men.

A different story arises for field size. Young adults tend fields that are significantly smaller than those of older adults. But gender, rather than generation, appears to be a significant factor in groundnut field size. Groundnut fields managed by females are 47 percent smaller than the average, and the fields of young women are 55 percent smaller. Fields managed by young men are, by contrast, only 9 percent smaller than average. Gender also shows a larger influence on yield. Fields managed by females have 15 percent lower yield than the overall average and fields managed by young women have 18 percent lower yield.

Table 3: Field distance, size, and yield results: By manager type

	Distance (meters)	Size (hectares)	Yield (tons/ha.)
All	1,227	1.49	0.817
Young Adults	1,326***	1.13***	0.763*
Females	1,234	0.79***	0.697***
Young Adult Females	1,180	0.67***	0.669**
Young Adult Males	1,395***	1.35*	0.810
No. fields	2,553	2,590	2,217

Notes: * p=0.1, ** p=0.05, *** p=0.01. Comparison group is all others not in designated group

Total groundnut harvests (in tons) are also smaller on fields managed by young adults and women than on fields managed by older adults and men, respectively (Table 4). This is not surprising, given that fields are significantly smaller and yields per hectare are lower on fields managed by young adults and females. But again, gender, not generation, is most strongly associated with lower total output. Total harvest is 61 percent lower than average on fields managed by women and 68 percent lower on fields managed by young women. By contrast, total harvest on fields managed by young men is only 15 percent lower than the average on all fields.

From the point of view of incentives for individual managers to generate their own income, these production disparities are reduced after accounting for production that is shared with the households or given as a community tithe (Zakat). Young adult and female field managers keep 65 percent and 80 percent of the production, respectively, from the fields they manage, compared to 54 percent for the sample as a whole (that includes household-managed fields). Further, young women keep 83 percent of harvest on average.

Table 4: Harvest distribution

	Total harvest (t)	Individual harvest (t)	Household harvest (t)	Zakat (t)
All	0.99	0.54	0.36	0.08
Young Adult	0.68***	0.44**	0.18***	0.06
Female	0.39***	0.31***	0.06***	0.03
Female Young Adult	0.32***	0.27***	0.04***	0.02
Male Young Adult	0.85*	0.52	0.25***	0.08

Notes: * p=0.1, ** p=0.05, *** p=0.01. Comparison group is all others not in designated group.

Soil Fertility Management Strategies

Most fields in the Groundnut Basin have degraded soils, characterized by low levels of organic matter due to continuous cultivation and few external fertility amendments. In our sample, 69 percent of fields were under a constant groundnut-millet-groundnut-millet rotation over the past four cropping seasons. The most common deviation from this continuous groundnut-millet rotation is a fallow season, where no crop was grown on the field. However, only 14 percent of all fields had a fallow spell in the three cropping seasons prior to growing groundnuts in the 2019 cropping season (Table 5). Fields with a fallow spell are significantly farther (by half kilometer) from the household and much larger (by 0.6 hectares) on average. Further, groundnut fields with a fallow spell in the last four years are disproportionately managed by young men. Fallowed fields often lie in areas with some remaining available land for clearing and cultivation and may be left fallow mainly due to labor constraints rather than as a soil fertility management strategy.

Household managed fields and fields with shared management show higher use of inorganic fertilizer (49 percent and 53 percent use rates, respectively) than do fields managed by an individual (44 percent). Further, fields managed by young adults receive significantly less fertilizer than do fields managed by older adults. Again, these generational differences stem from young women using less fertilizer, not young men. Less than one-third of the groundnut fields managed by females use inorganic fertilizer. Further, rates of inorganic fertilizer application are statistically similar in the narrow range of 138 kilograms per hectare to 155 kilograms per hectare on all fields. So, differences in inorganic fertilizer stem from use rather than rate of fertilizer use. It is also worth noting that for all field types about one-third of fertilizer purchases are made with government subsidies, implying that access to government subsidized fertilizer is not driving lower rates of use among young adults and women.

Table 5: Soil fertility management strategies by field type and manager

	Fallowed prior 3 years (%)	Use inorganic fertilizer (%)	Fertilizer (kg/ha)	Use manure (%)	Apply nothing (%)
Household	14	49**	138	30***	26***
Shared	17	53***	151	26***	29***
Individual fields	14	44	155	16	40
Young Adult	23***	38***	151	10***	43*
Woman	14	31***	145	10***	53***
Young Woman	16	27***	152	11*	55***
Young Man	26***	45	151	10***	36***

Notes: Comparison group for household and shared fields is individual fields. Comparison for individual fields managers is all others not in designated group.

Whether a field is fertilized with manure also depends on who manages the field. Around 30 percent of household fields and 26 percent of shared fields receive organic manure, compared to 16 percent of fields managed by individuals. About 10 percent of individually managed fields of young adults, women, young women, and young men use manure. On the other hand, a significant share of fields, including over half of all fields managed by women are under continuous cultivation use no soil fertility amendments.

Opportunities exist for farmers to enhance long-term soil organic matter over time. For example, 82 percent of households indicate that they integrate shrubs into the cropping system on at least some of their fields. However, 91 percent of households that integrate shrubs cut them back during the dry season and burn the cuttings, which greatly reduces potential contributions of shrub biomass to field soil organic matter. Enhanced strategies to reverse long-term declines in soil organic matter and associated soil organic carbon are needed, particularly on the fields of young adult and females who currently employ few soil fertility amendments.

Generation and Gender Input Gaps

We now focus on the 1,475 individually managed fields in the sample where we can consistently measure field agricultural input expenditures (table 6). Young adults and females have lower input expenditures, but again this is more driven by gender than generation. About 47 percent of all fields managed by individuals purchase seeds (but only 2 percent of purchases are from seed dealers) and 53 percent use their own seed. Females are more likely to use their own groundnut seed for planting than are males, but the propensity to purchase seed in the market does not differ by generation. The value of seed inputs, calculated as the value of seed

based on kilograms applied and a price of CFA 250 per kg., corresponds closely to area planted, as all groups show average seed application rates of around 135 kg. per hectare.[2]

Inorganic fertilizer is the other major input expenditure. But, as noted, young adults and women are less likely use fertilizer on their fields than are older males and correspondingly show significantly lower expenditures on fertilizer. Overall, only 48 percent of fields apply inorganic fertilizer and the average amount spent on these fields is CFA 16,600. Phytosanitary expenditures to protect against pests and diseases are also significantly lower on fields managed by young adults, women, and young women. As noted, 16 percent of individually managed fields and about 10 percent of fields managed by young adults, women, young women, and young men have organic manure applied. Farmers rarely pay for manure that is applied to their fields (only three cases in the survey), so no input expenditures are calculated for manure.

Table 6: Input expenses on individually managed groundnut fields

	Purchased seed (%)	Value of seed (CFA)	Fertilizer (CFA)	Pesticides & insecticides (CFA)
All	47	31,168	16,606	2,484
Young adults	46	23,668***	9,055***	1,896***
Women	34***	15,882***	4,836***	1,383***
Young women	34***	14,309***	3,090***	1,188***
Young men	53**	29,562	12,772	2,338
Notes: * p=0.1, ** p=0.05, *** p=0.01. Comparison group is all others not in designated group				

Total Expenses, Total Revenues, and Profits

We now focus on field-level total expenses, total revenues, and profits for the slightly smaller sample of 1,218 individually managed groundnut fields that report revenues received as individual earnings from the sale of field groundnut (Table 7). Young adult, female, and young female field managers have significantly lower input expenses. Fields with young adult male managers also show slightly lower expenses.

As noted, the revenue measured is only for individual revenues from groundnut sales and is not a full accounting of the value of groundnuts harvested. As discussed (Table 4), some groundnuts are retained for seed, some are consumed at home, and some are given as Zakat. The total revenue measure in Table 7 does not account for these non-market allocations from groundnut production. However, individual revenue is indicative of income incentives for field managers net of these other non-monetary allocations of groundnut harvest. Fields managed by young

[2] In March 2020 the exchange rate was approximately 590 CFA to 1 USD.

adults show significantly lower revenues from individual sales, and female and young adult female managed fields show particularly low total revenues from sales. By contrast, the total revenue generated by young men is not significantly different than that brought in by the sample as a whole – again implying gender may be the important factor in revenue gaps than generation. Profits (total revenues minus total expenses) show a similar pattern and are notably low for women and young women. However, examination of profits per hectare reveals a different story. There is no significant difference on a per-hectare basis across generations and gender, suggesting lower groundnut profits for young adults and women may stem more from small field size allocations than from lower yields.

Table 7: Total expenses, total revenues, and profits on individually managed fields

	Total expenses (CFA)	Total revenues (CFA)	Profits (CFA)	Profits per hectare (CFA)
All	19,379	168,586	149,207	146,945
Young adults	10,958***	121,269***	110,312**	147,400
Women	6,387***	71,368***	64,981***	133,010
Young women	4,555***	63,399***	58,844***	141,515
Young men	14,973*	157,561	142,588	151,090

Notes: * p=0.1, ** p=0.05, *** p=0.01. Comparison group is all others not in designated group.

In Table 8, we explore how inclusion of a valuation for field production not sold by the individual influences revenue estimates on individually managed fields. On average, 81 percent of estimated field production is sold for individual managed fields. However, the estimated share sold from female managed fields is 91 percent, implying they face a lower implicit household and community tax on production. Surprisingly, we also see that the reported price received on sales is slightly higher for fields managed by young adults, women and young women. This suggests that young adults and women do not face price discrimination when marketing their groundnuts, though they continue to show lower total revenues and net revenues even when unsold production is valued at the same price as their sold production. Further, generation and gender differences in profits per hectare remain statistically insignificant after accounting for the value of unsold production. Revenues and profit gaps do widen slightly for females, as the value of unsold groundnut production on female and young adult female managed fields is relatively low. But, overall, the results reinforce the finding that field size allocations play an important role in generation – gender disparities in groundnut profits.

Table 8: Share of harvest sold and projected total value of revenues

	Share of crop sold (%)	Price (CFA/kg)	Value of production (CFA)	Profit (CFA)	Profit per ha. (CFA)
All	81	249	218,243	198,864	205,929
Young adult	82	253***	160,615**	149,657**	189,906
Women	91**	254***	91,035***	84,648***	184,023
Young women	88	256***	84,303***	79,748***	180,986
Young men	79	251	208,471	193,499	195,500

Notes: * p=0.1, ** p=0.05, *** p=0.01. Comparison group is all others not in designated group.

Determinants of Groundnut Field Productivity

We report the results of a multivariate regression that controls for all unobserved household factors (with household fixed-effects), field size, and field agricultural inputs. The results reveal strong positive associations between use of soil fertility amendments and groundnut field productivity (Table 9).[3] Application of manure on a field is associated with a 13% increase in groundnut harvest. The easiest interpretation of the fertilizer coefficient is that at average yields, an additional 100 kg. of fertilizer leads to an additional 151 kg. of groundnuts produced on the field, roughly a 50 percent rate of return on fertilizer investments at current prices. Higher groundnut seeding rates also increase productivity, but there is no difference in field productivity when using own seed or purchasing seed in the market. Groundnut fields also show 27 percent greater productivity when coming out of fallow in the previous season than on an otherwise equivalent field. Note that the estimate may overstate the effect of a year of fallow, as fallowing last year may also be associated with the field being brought into production more recently and a more general long-term ability to incorporate fallow into the field crop rotation. There is some weak evidence of sustained impacts of fallowing on groundnut production, with significant 20 percent increases in production from fallowing three seasons prior (just insignificant at conventional levels).[4]

Groundnut production also remains notably lower on fields managed by young adults (19 percent) and women (42 percent), even after controlling for inputs, soil fertility management, and field size. Further, young women are associated with an additional 14 percent decrease in groundnut productivity. Thus, while field size is strongly significant in determining total production, significant productivity gaps remain based on gender and generation. Some of these gaps may be associated with low soil fertility on fields allocated to women and to young adults. By the same token, the result suggests fields managed by women and young adults are

[3] Groundnut harvest is in logarithmic form, so parameter estimates are interpreted using the transformation (exp(*B*)-1).

[4] As noted, most fields are in a strict groundnut-millet rotation. Fallowing in the previous cropping season and three seasons prior would be substitutes for millet on the field.

likely to see high returns to fertilizer use if access constraints can be effectively addressed. Estimated high returns to soil fertility amendments are also complemented by a recognized need for soil fertility inputs among farmers. Lack of fertilizer is the most frequently stated constraint to groundnut production by young adults (over 75 percent of respondents). Thus, there exists both a demand for improved soil fertility management strategies and the potential for such strategies to significantly increase agricultural productivity, particularly on young adult and female managed fields.

Table 9: Field production regression estimates: ln(total harvest)

Variable	Coef.	St. Err.
Hectares	0.1098	0.0268***
Distance (km)	-0.0672	0.0340*
Phytosanitary_CFA (000)	0.0164	0.0131
Seed (ton)	0.0046	0.0033
Manure	0.1707	0.0689**
Fertilizer (ton)	1.4853	0.3746***
Fallow 16	0.1870	0.1095*
Fallow 17	-0.0838	0.1166
Fallow 18	0.2783	0.1187**
Managed by an individual	-0.2245	0.0748***
Managed by a young man	-0.2560	0.0806***
Managed by a woman	-0.6285	0.0747***
Managed by a young woman	-0.0735	0.0764
constant	-0.5583	0.1190***

Household fixed effects	**Yes**
# Observations	2,049
# Groups	585
F(13,73)	49.21***

Implications for Groundnut Productivity and Closing Generation and Gender Gaps

This research brief highlights important differences between groundnut fields managed for household consumption and income and groundnut fields managed by individual household members for their own income. Fields managed for the household generally rely on more extensive production strategies, with larger fields but lower yields. Young adults and females usually manage fields for their own income rather than for household needs. But even as individual field managers, they must contribute some of the harvest to the household and to the community. We find that young adults and females face significant gaps in both access to

land, as evidenced by smaller fields, and lower rates of agricultural input use compared to fields managed by older men. These land access and input gaps are particularly acute for women.

We also find differences in soil fertility management strategies by generation and gender. Young adults appear to fallow fields more frequently, but have less access to inorganic and organic fertilizers. However, differences in inorganic fertilizer use among generations arise mainly from very limited use by female groundnut farmers. Women show limited use of soil amendments with over half of their fields not receiving any type of amendments, while a little under half of young adult males apply inorganic fertilizer to their fields and about a quarter have access to previously fallowed fields.

Rates of return on all soil fertility inputs are estimated to be high, suggesting access to fertilizer and other soil fertility inputs continue to constrain groundnut productivity. Further, young adults and, particularly, female producers show pronounced productivity gaps, even after accounting for lower levels of input use. Part of these generation and gender gaps in field productivity may be due to unobserved differences in field management. But the legacy of continuous cultivation under groundnut-millet rotations with few soil fertility amendments on fields, particularly those that stem declines in soil organic matter, also contribute to the productivity gaps seen by women and young adult farmers.

Long-term soil fertility management strategies are needed to restore critical organic matter in degraded soils. However, enhanced fertility management strategies come with upfront costs that few resource-constrained farmers, especially young adults and women, are able or willing to bear. Adoptable interventions will require a combination of short-term assistance to establish enhance soil organic matter management systems on fields (for example planting of shrubs to incorporate biomass), and long-term incentives to maintain established enhanced systems for next generation farmers. Since enhanced organic matter in soil increases carbon sequestration, long-term incentives should be tied to the value of sequestered carbon and supported through North to South carbon-credit transfers. Effective long-term soil fertility management systems will also require strengthening the security of young adult and female tenure rights to future field access so that they can capture to benefits of their investments in field soil fertility.

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