

***Synopsis:* Effects of agricultural mechanization on economies of scope in crop production in Nigeria**

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RESEARCH OVERVIEW

Agricultural mechanization has often been characterized by scale-effects and increased crop specialization. Such characterizations, however, fail to explain how mechanization may grow in Africa where production environments are more heterogeneous and where diversification of crop production may help in mitigating risks from increasingly uncertain climatic conditions.

Economies of scope (EOS) refer to the economic benefits of producing multiple types of outputs rather than specializing in producing a specific output. EOS closely relates to the potential for crop diversification. Using panel data from farm households and crop-specific production costs in Nigeria, we estimate how the adoption of animal traction or tractors affects EOS between rice, non-rice grains, legumes/seeds, and other crops, which are the crop groups that are most widely grown with animal traction or tractors in Nigeria.

We find that the adoption of mechanization technologies is associated with lower EOS between non-rice grains, legumes/seeds, and other crops, but greater EOS between rice and other crops. The results inform how mechanization can support crop diversification or increased specialization.¹

BACKGROUND

Table 1 summarizes the mechanization shares of plots on which different crop groups are grown in Nigeria. These estimates were drawn from data collected by the Living Standard Measurement Study - Integrated Survey on Agriculture (LSMS-ISA) over three waves in 2010/11, 2012/13, and 2015/16. Tractor adoption rates are highest on rice plots. Animal traction is used on 30 to 40 percent of plots where rice, non-rice grains, or legumes/seeds are grown.

Table 1. Distributions of crops and mechanization use at plot level

Crop groups	% of all plots on which grown ^a	% of crop plots on which animal traction or tractors were used		
		Either animal traction or tractors	Animal traction	Tractor
Rice	4	44	30	14
Non-rice grains	52	37	34	3
Legumes/seeds	29	46	43	3
Other crops	51	6	4	2

Source: Authors' calculations from combined LSMS-ISA datasets.

^a Sum of column exceeds 100 because multiple crop groups may be grown on the same plots.

Non-rice grains = sorghum, maize, millet, acha, wheat.

Legumes/seeds = cowpea, groundnut, Bambara nut, sesame, pigeonpea, pumpkin seed, shea nut, soybeans, zobo seed, agbono.

Among farmers in our analytical sample, mechanization is used across more than one crop group, if it is used at all (Table 2). These results confirm that mechanization can be combined with crop diversification.

Table 2. Use of mechanization among farmers growing both crop groups

Categories		Mechanize other crops	
		No	Yes
Mechanize rice	No	49.2	7.8
	Yes	2.1	41.0***
Mechanize non-rice grains	No	64.6	0.9
	Yes	0.9	33.7***
Mechanize legumes/seeds	No	55.2	1.0
	Yes	0.6	43.2***

Source: Authors' calculations based on LSMS-ISA data. Asterisks indicate the statistical significance based on chi-square test; *** 1%.

In Nigeria, rice tends to be grown on plots with a distinct set of characteristics in terms of soil type or slopes. In contrast, non-rice grains and legumes/seeds tend to be grown on the more typical, average plots of the households (Table 3). As rice-growing households often also have plots that are unsuitable for rice, they tend to grow non-rice crops in addition to rice, rather than

¹ A detailed discussion of this research can be found in NSSP Working Paper 53, *Effects of agricultural mechanization on economies of scope in crop production in Nigeria*. <http://ebrary.ifpri.org/cdm/ref/collection/p15738coll2/id/132813>

specializing in rice only. For rice growers, 33 percent report growing other crops on plots with different soil types than are found on their rice plots.

Table 3. Plot heterogeneity for production of rice, non-rice grains, and legume/seed crops

Crop groups	% with other crop groups grown on the same plot	% with other crops grown on plots with different reported characteristics within the household		
		soil type	soil quality	slope
Rice	30	33	7	22
Non-rice grains	73	12	5	12
Legumes/seeds	84	10	6	12

Source: Authors' calculations based on LSMS-ISA data.

RESEARCH APPROACH AND RESULTS

Our analyses combine methods for assessing the impact of technology adoption with both primal and dual methods for estimating EOS. The results indicate that adoption of mechanization significantly increases the EOS between rice and non-rice crop production (Table 4). These results are consistent in both the primal and dual analyses. The dual analyses shows that, if mechanized, production costs for producing both rice and non-rice crops would be 26 percent lower than costs from specializing in one of these crop groups, while they would not be statistically significantly different from zero if non-mechanized. Mechanization thus seems to raise EOS. In contrast, for non-rice grains or legumes/seeds, mechanization adoption is associated with a decrease in EOS – that is, diseconomies of scope.

Table 4. Parameters of economies of scope for different crop groups, and changes in EOS caused by mechanization (positive value = economies of scope, negative value = diseconomies of scope)

Crop groups	Method	Mechanized	Non-mechanized
Non-rice grains vs. other crops	Primal	-0.020*	-0.001
Legumes/seeds vs. other crops	Primal	-0.010 [†]	0.005
Rice vs. other crops	Primal	0.109***	0.010
Rice vs. other crops	Dual	0.261**	0.050

Source: Authors' estimations.

Adoption of mechanization leads to the increased adoption of rice and to the increased joint production of rice and other crops (Table 5). For legumes/seeds or non-rice grains, mechanization adoption leads to no or reduced probability of growing each crop group. However, it results in increased scale of production for those who decide to grow crops in the crop group.

Table 5. Effects of mechanization adoption on the probability and scale of production (by different crops groups combinations)

Crop groups	Rice versus other crops		Legumes or seeds versus other crops		Non-rice grains versus other crops	
	A	B	A	B	A	B
Crop group of interest	4.0**	-4.9	-3.5 [†]	-4.2	0.3	9.2 [†]
Other crops	-0.9*	4.8	-1.3**	9.3 [†]	-1.5	6.8
Both groups	2.7 [†]	-22.1	-3.9*	6.8	-1.6	5.2

Source: Authors' estimations.

A = percentage point increase in the probability of production;
B = percent increase in production value

CONCLUSIONS

In Nigeria, mechanical technologies appear to raise EOS between crops that are grown in more heterogeneous environments, even though it may lower EOS between crops that are grown in relatively similar environments. Agricultural extension strategies can be designed based on these findings.

- Even with mechanization, rice production may remain atomistic, characterized by many small producers. A continued focus on modalities that can exploit the existing informal rice production sector, rather than targeting support to selected large rice producers, is merited.
- In contrast, for legumes/seeds or non-rice grains, in-depth extension advice focused on the specialized crop-group farmer is required, with monitoring of their production plans, and training them on managing market risks, because specialized production of these crop groups will be more risk-prone compared to mixed-cropping.

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