

Supplementary Material: Analyses on the Consistency of Crop Selection across Years and Farming Plots

To verify the hypothesis that the selection of crop/species is climate change dependent or due to other reasons, the concordance (Cohen’s kappa) and homogeneity (McNemar) tests were applied.

Table 1. Species considered.

- 1 Rice
- 2 Cotton
- 3 Soy beans
- 4 Okra
- 5 Sweet potato
- 6 Millet
- 7 Maize
- 8 Fra Fra potato
- 9 Onion
- 10 Cabbage
- 11 Tomato
- 12 Sorghum
- 13 Beans
- 14 Groundnut
- 15 Carrot
- 16 Watermelon
- 17 Kenaf
- 18 Cowpea
- 19 Pepper
- 20 Piment
- 21 Voandzou
- 22 Banana
- 23 Papaya
- 98 Question does not apply
- 99 No response

Table 2. Frequencies of occurrence of species successions in Plot 1 (out of five plots considered).

group(d1 d3 d5)	Freq.	Percent	Cum.
Rice Rice Rice	1	0.83	0.83
Rice Millet Millet	1	0.83	1.65
Rice Maize Cotton	1	0.83	2.48
Cotton Cotton Cotton	22	18.18	20.66
Cotton Cotton Maize	3	2.48	23.14
Cotton Cotton Sorghum	2	1.65	24.79
Cotton Millet Millet	4	3.31	28.10
Cotton Millet Sorghum	1	0.83	28.93
Cotton Millet Beans	1	0.83	29.75
Cotton Maize Millet	2	1.65	31.40
Cotton Maize Maize	1	0.83	32.23
Cotton Maize Sorghum	1	0.83	33.06
Cotton Sorghum Cotton	1	0.83	33.88
Cotton Sorghum Millet	2	1.65	35.54
Cotton Sorghum Maize	1	0.83	36.36
Cotton Sorghum Sorghum	1	0.83	37.19
Cotton Beans Millet	1	0.83	38.02
Okra Okra Okra	1	0.83	38.84
Millet Rice Cotton	1	0.83	39.67
Millet Cotton Cotton	1	0.83	40.50
Millet Cotton Millet	2	1.65	42.15

Millet	Millet	Millet		11	9.09	51.24
Maize	Cotton	Cotton		1	0.83	52.07
Maize	Cotton	Millet		1	0.83	52.89
Maize	Millet	Millet		1	0.83	53.72
Maize	Maize	Maize		11	9.09	62.81
Maize	Maize	Sorghum		1	0.83	63.64
Maize	Sorghum	Maize		1	0.83	64.46
Sorghum	Cotton	Sorghum		2	1.65	66.12
Sorghum	Maize	Millet		1	0.83	66.94
Sorghum	Sorghum	Cotton		1	0.83	67.77
Sorghum	Sorghum	Maize		1	0.83	68.60
Sorghum	Sorghum	Sorghum		18	14.88	83.47
Groundnut	Millet	Millet		1	0.83	84.30
Groundnut	Groundnut	Groundnut		2	1.65	85.95
	(missing)			17	14.05	100.00

Total					121	100.00

The species occurring seldom (n < 10) were taken out to have a stable basis for analysis

Cohen's Kappa teste stimates the concordance between two decisions, which classify certain items into mutually exclusive categories (Armitage and Colton 2005, Wikipedia 2017).

$$\kappa = \frac{p_o - p_e}{1 - p_e} = 1 - \frac{1 - p_o}{1 - p_e},$$

For categories k, number of items N, where:

p_o = the relative observed agreement among cases

p_e = the hypothetical probability of chance agreement

Table 3. Kappa's test on farmer crop decision for Year 1 versus Year 3.

Major_crop_1year_1		Major_crop_3year_1						
		Rice	Cotton	Millet	Maize	Sorghum		

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	Rice		2	0	1	1	0	
4	Cotton		0	27	6	4	5	
42	Millet		1	3	11	0	0	
15	Maize		0	3	1	12	1	
17	Sorghum		0	3	1	1	21	
26								

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	Total		3	36	20	18	27	
104								

Agreement	Expected Agreement		Kappa	Std. Err.	Z	Prob > Z		

70.19% 26.18% 0.5962 0.0553 10.77 0.0000

The proposition that the crop species decision is randomly made is rejected ($p = 0.000$). The Kappa value (59.6%) indicates a chance to agree superior to 0.5.

Table 4. Kappa cumulated values on farmer crop decision for Years 1, 3 and 5.

Outcome	Kappa	Z	Prob > Z
Rice	0.4896	8.39	0.0000
Cotton	0.5666	9.72	0.0000
Millet	0.6349	10.89	0.0000
Maize	0.6262	10.74	0.0000
Sorghum	0.7136	12.24	0.0000
Combined	0.6285	18.86	0.0000

For all and each of five crop species, there is a significance tendency to stay in the plots originally assigned.

The McNemar test, in paired datasets of 2×2 tables with dichotomous decisions, determines whether the marginal frequencies are equal (Armitage and Colton 2005, Wikipedia 2017).

Table 5. Contrast of farmer crop decisions for Year 1 versus Year 3.

Major_cro p_year_1	Major_crop_3year_1					Total
	Rice	Cotton	Millet	Maize	Sorghum	
Rice	2	0	1	1	0	4
Cotton	0	27	6	4	5	42
Millet	1	3	11	0	0	15
Maize	0	3	1	12	1	17
Sorghum	0	3	1	1	21	26
Total	3	36	20	18	27	104

Table 6. McNemar test contrast of farmer crop decisions for Year 1 versus Year 3.

Cells	Contribution to symmetry Chi-squared			
n1_2 and n2_1	0.0000	these 2 cells do not differ	0	0
n1_3 and n3_1	0.0000	these 2 cells do not differ	1	1
n1_4 and n4_1	1.0000	these 2 cells differ	1	0
n1_5 and n5_1	0.0000	...		
n2_3 and n3_2	1.0000			
n2_4 and n4_2	0.1429	these 2 cells differ	4	3
n2_5 and n5_2	0.5000	...		
n3_4 and n4_3	1.0000			
n3_5 and n5_3	1.0000			
n4_5 and n5_4	0.0000			

Chi² df Prob > Chi²

Symmetry (asymptotic)		4.64	8	0.7950
Marginal homogeneity (Stuart-Maxwell)		2.36	4	0.6705
Marginal homogeneity (Bickenboller)		1.37	4	0.8501
Marginal homogeneity (no diagonals)		3.15	4	0.5329
Symmetry (exact significance probability)				0.9289

There is no significant difference between the farmer's first decision distribution (last column) and the farmer's second decision distribution (last row).