Informal "Seed" Systems and the Management of Gene Flow in Traditional Agroecosystems: The Case of Cassava in Cauca, Colombia.

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Introduction

Managing gene flow within traditional agroecosystems and their repercussions requires understanding farming practices' role in crop ecology.

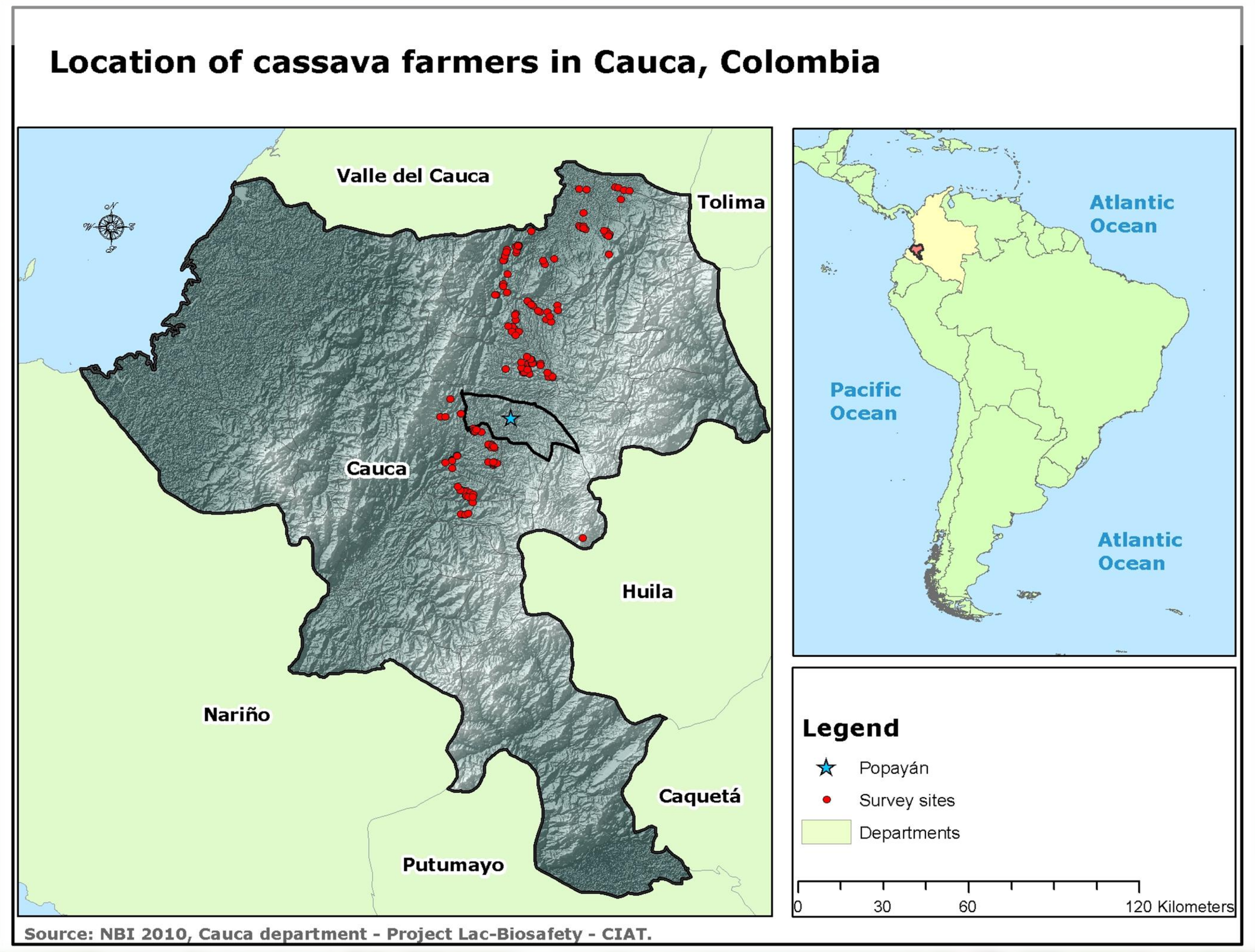
Seed management influences crop's demography and thus has quantifiable effects on gene flow and frequencies [1,2]. Quantifying management's effects requires an appropriate analytical framework.

Methods

We quantify management practices of cassava *(Manihot esculenta Crantz)* in Cauca, Colombia, to model the crop's demographic dynamics—the first model for a clonal crop.

The model reveals the implications of management for gene flow, the conservation of cassava diversity, and the biosafety of clonal crops in centers of diversity.

Differences in management across crop populations were estimated based on rates of seed replacement, exchange within and across localities (i.e., diffusion and introduction) and mixing. Differences were determined using three-way tables based upon log-linear models [3].



Results

Replacement: Improved varieties are replaced at higher rates than landraces, but landrace replacement varies significantly across altitudes (Table 1A).

Diffusion: Landraces are diffused at higher rates than improved varieties (Table 2A).

Farmers own seed (i.e., seed saved across cycles) is diffused more than newly acquired seed (Table 2B). Seed introduced into a locality is diffused more than local seed (Table 2C).

Table 1. Various seed-management rates for cassava in Cauca, Colombia[1]

	Type of seed		
	Landraces	Improved	Total
A. Replacement by elevation (N = 655)			
High	0.33	0.34	0.33
Intermediate	0.15	0.33	0.19
Low	0.21	0.38	0.28
Total	0.25	0.35	0.28
G elevation effect	17.4* (4 df)		
G type effect	12.0 *(3 df)		
B. Diffusion by origin[2] (N = 165)			
Local	0.78	0.65	0.75
Introduced	0.72	0.88	0.79
Total	0.77	0.72	0.76
G origin effect	1.7 (2 df)		
G type effect	1.8 (2 df)		
G complete independence	1.9 (4 df)		
C. Introduction by elevation (N = 170)			
High	0.12	0.27	0.15
Intermediate	0.26	0.79	0.46
Low	0.14	0.13	0.13
Total	0.15	0.35	0.21
G elevation effect	19.4* (4 df)		
G type effect	11.9* (3 df)		
D. Mixing by origin (N = 165)			
Local	0.44	0.32	0.41
Introduced	0.61	0.39	0.50
Total	0.47	0.35	0.43
G origin effect	1.0 (2 df)		
G type effect	1.6 (2 df)		
G complete independence	2.1 (4 df)		

Significance at the 0.05 level is indicated by *:
[1]. Expressed as a ratio (varying between 0 and 1), replacement rates imply that seed is not saved across cycles; diffusion rates entail the exchange of saved seed; introduction rates mean that seed is brought into a locality. **[2].** Seed is "local" if acquired from neighbors and "introduced" if acquired in another locality.

Introduction: Improved varieties are exchanged across localities at higher rates than landraces, except at low elevations (Table 1C). Most improved varieties at intermediate elevations have been acquired outside the localities where they are grown.

Mixing: 43% of cassava seed stocks in Cauca are a mix of multiple varieties (Table 1D), and no differences were found across seed type or origin.

Dynamics: Improved cassava populations grow at higher rates than landraces, except at low elevations, where the opposite is true.

Table 2. Seed diffusion rates for cassava in Cauca, Colombia

	A. Diffusion by type (N = 633)			B. Diffusion by source[1] (N = 691)			C. Diffusion by origin (N = 189)		
Elevation	landrace	improved	total	own	new	total	local	introduced	total
High	0.90	0.90	0.90	0.97	0.75	0.90	0.76	0.64	0.74
Intermediate	0.94	0.81	0.90	0.94	0.81	0.91	0.70	0.95	0.82
Low	0.95	0.83	0.92	0.93	0.72	0.87	0.66	0.80	0.68
Total	0.92	0.84	0.90	0.95	0.76	0.89	0.71	0.83	0.74
G elevation effect		6.1 (4 df)			5.4 (4 df)		6.7 (4 df)		
G origin effect							6.8 (3 df)		
G complete indep							26.4* (4 df)		
G source effect					50.6* (3 df)				
G type effect		14.8* (3 df)							

Significance at the 0.05 level is indicated by *.
1. Seed acquired during the current cycle is "new;" seed saved by the farmer from a previous cycle is his/her "own."

Conclusions

- Cassava populations are remarkably dynamic and open (e.g., compared to maize) [8].
- A large portion of populations consists of non-local germplasm, often grown in mixed stands with local varieties.
- Improved GM cassava varieties might not displace landraces or compromise their diversity; but rapid diffusion and subsequent incorporation into landraces, seed banks or wild populations could obstruct the tracking and eradication of deleterious transgenes.

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