A NOTE ON THE DISTRIBUTION OF CASSAVA AMONGST DIFFERENT CLIMATE AND SOIL TYPES IN SOUTH AMERICA

SIMON E. CARTER

AGROECOLOGICAL STUDIES UNIT - CIAT

NOVEMBER 1986

A NOTE ON THE DISTRIBUTION OF CASSAVA AMONGST DIFFERENT CLIMATE AND SOIL TYPES IN SOUTH AMERICA

A hierarchical classification of climate and soil conditions has been described for cassava (Carter 1986a). The classification is based on the identification of some very simple crop-environment relationships based on the experience of, and in collaboration with, members of CIAT's Cassava Program. Both soil and climate components of the classification have been used to produce a map of environmental homologues for cassava.

It is stressed here and elsewhere (Carter 1986b) that the map and indeed classifications are interim measures. Our goal in the Agroecological Studies Unit is to attach raw or summarised environmental data to smaller homogeneous micro-regions, so that all-embracing classifications such as this can be discarded. Instead a researcher can assess the distribution of whatever particular environmental condition he is interested in, such as mean annual temperature range or soil clay content.

Two questions were put to the author on completion of the maps.

Firstly, can we obtain a overview of the relative importance of the different climate-soil homologues, and thus some quantitative assessment of priorites for research in cassava?

Secondly, how can we adequately reconcile the former cassava classification of ecosystems (CIAT 1981, 1982) with the present study?

To answer the first question properly requires that the micro-regions be defined. The relative importance of 'homologues' in terms of the amount (in hectares) of cassava grown will depend on how you define those homologues. For example, suppose that a decision is required about whether or not to work specifically for areas where soil pH is lower than 5.0, or where climatic conditions favour superelongation. These quite specific sets of conditions can be mapped, and the amount of cassava, either absolute or as a proportion of the total which is affected, can be calculated by overlaying the crop distribution map. Of course, deciding research priorities on the basis of the proportion of the crop which occurs under certain conditions may not always be the best course, but it is important that such information be available to researchers.

Secondly, the need for a classification will disappear once the micro-regions are defined, because we will be able to map the distribution of any level of any variable in which a researcher is interested. For example; Which areas have the same rainfall totals and distribution as Colombia's North Coast? (Which part of Colombia's North Coast?). What parts of Latin America have soils with phosphorous levels equal to or lower than those in Carimagua? The only requirement on the part of the researcher is that he define carefully enough just what he wants to know, and on what basis he wishes to compare or classify areas which produce the crop.

Given that the micro-region definition work has a long way to go before we can employ the optimal solutions, I'll attempt to answer both questions below from the maps which have been produced.

Cassava distribution amongst the climatic and soil homologues

Table 1 gives the number of hectares (000's) of cassava grown in each of the climate and soil homologues defined in Carter (1986a). The homologues are identified by a letter (climate) and number (soil) system. Their location can be found on Map 4 in Carter (1986a). The percentage of cassava area in each climate and soil class is given in Tables 2 and 3.

Note that the percentages of cassava given in Table 2 are for the lowest members of each branch of the classification dendrogram (see Figure 1, Carter 1986a). These data can be aggregated for each of the different levels of the classification, depending on the requirements of the reader. For example, the data indicate that about 77 percent of the cassava, is grown in 'lowland' conditions (mean growing season temperatures above 22°C) and 23 percent in highland conditions (m.g.s.t. below 22°C). This calculation could similarly be made for length of dry season, daily temperature ranges and seasonality.

If we examine the individual climatic classes, there are only 7 which have more than 5 percent of the cassava each. Between them they account for 87.3 percent.

The class in which most cassava is grown is 'Lowland Humid Subtropical' with 21.7 percent. This includes areas like Eastern Paraguay, and much of the Paraná basin in Brazil. The second most important is 'Lowland Semihot Isothermic' with 19.7 percent. This includes most of Colombia's North Coast, parts of coastal Ecuador and Venezuela, and the 'Litoral' of North-East Brazil. Following this in importance is 'Lowland Humid Tropical' (15.3 percent), which represents much of the Amazon Basin, Colombian Chocó and middle Magdalena, and part of the Ecuadorian coastal lowlands. Fourthly is 'Lowland Hot Isothermic' (10.7 percent). This includes the Colombian and Venezuelan Llanos, the Bolivian savannas, and much of Maranhao and Piauí in Brazil. Fifth is 'Lowland semi-arid Isothermic' (7.9 percent), which includes Western Manabí

(Ecuador), parts of coastal Venezuela and much of North-East Brazil. Sixth is 'Highland Semi-arid Isothermic', mainly in North-East Brazil, and one or two areas in coastal Venezuela (6.4 percent). Seventh is 'Highland Humid Tropical' (5.6 percent) which is mainly restricted to Andean Colombia and the Piedmont to the East of the Peruvian Andes. The remaining classes have no more than 3 percent of the cassava each. One class, 'Highland Semi-arid Non-Isothermic' appears to have no cassava from the dot-map (it is only represented by two small areas in Brazil).

Let's now consider the soil classes, based on the restrictions posed for cassava. 42.6 percent of cassava is grown on soils with high acidity (Carter 1986a) which were used to group soil classes of the FAO/UNESCO classification (FAO/UNESCO 1974). Of this cassava, about 2.4 percent is grown on soils which also have permanent depth restrictions, and about 1.7 percent on soils with potential depth restrictions (plinthite). After this, 23.6 percent of cassava is grown on soils with none of the restrictions listed in Table 3. 17.1 percent is grown on soils with permanent depth restrictions, 8.8 percent on soils with permanent drainage problems, and 6.8 percent on soils with seasonal drainage problems. The other restrictions, potential depth and fine texture, account for negligible percentages, 2.8 and 0.6 respectively.

These data bring to light an important problem with the soil classification system used. It is unlikely that nearly

9 percent of cassava should grow on permanently wet soils; rather, this cassava is probably found on associated soils included within the majority 'mapping-unit' soil used on the FAO soil map (FAO/UNESCO 1971). The same may be true for the soils with depth restrictions; however, many of these are located in North-East Brazil, and the soil map is quite clear about the widespread existence of stony phases. How much this will affect cassava producers' choice of where to plant is difficult to tell. In the case of permanent drainage problems, it is likely that much of the cassava grown in areas with these characteristics experiences seasonal soil drainage problems. Given the nature of the available data, we can only accept the relative importance of these soil restrictions in cassava producing areas in South America as a whole.

Table 4 gives the 12 principal soil-climate homologues in order of the proportion of cassava grown within them. Together they account for 68 percent of the cassava on the dot map. Their locations can be identified from Map 4 (Carter 1986a). Not surprisingly, the acid soils of the humid lowland subtropics and tropics, and soils without restrictions in the subtropics are the three most important homologues (25 percent of cassava).

Reconciliation with the Cassava Programme's Traditional Ecosystems

The Cassava Programme's ecosystems (CIAT 1981, 1982) are defined according to a mixture of soil and climate criteria. Some (Ecosystems 1, 4 and 5) have no particular soil conditions specified. It is possible to compare these with the climate-soil homologues which have been defined, to see how well they fit into this system, and how much of the area in cassava they may represent. Those which coincide with any of the 12 major climate-soil homologues are included in Table 4.

Ecosystems 2, 3 and 6 fit logically into the classification (Homologues B6, A6 and E6 respectively - 23.7 percent of the cassava in total). The climatic classification makes no distinction between Ecosystem 1 and 4; neither seasonal rainfall pattern nor differences in mean growing season temperatures (apart from the 22° cut-off point), which distinguish these two ecosystems from each other, are included in the classification. That isn't to say that it couldn't be done, however it would raise the question of what other homologues would require similar such divisions. In other words, the classification would have to be extended further.

Where an ecosystem appears in Table 4 followed by a question mark, it means that climatically the comparison is valid, but that soil conditions may not be represented by that ecosystem, or the current testing sites. The major omission in the Ecosystem classification is that soil conditions are specified for some ecosystems and not for others, and this ought to be resolved.

Ecosystem 5, represented by Popayán, corresponds climatically with 'Highland Humid Tropical'. Whilst 5.6 percent of cassava is grown in this type of climate, no soil specifications are given for the Ecosystem. Table 1 shows that cassava is grown on soils with permanent depth restrictions (1 percent), high acidity (2 percent) and with no restrictions (2.6 percent) within this climatic type.

Finally, allowing for the climatic similarities which the various Ecosystems cover, there are some important climatic types which are not included in that system (Table 5). Particularly important are the semi-arid areas of North-East Brazil, highland and lowland. These differ from Ecosystem 1 because the dry season is longer, 6-9 months, and in the case of the highlands because mean growing season temperatures are lower (it may be of interest to point out that, using the classification of climates, lowland semi-arid areas in N.E. Brazil have the same characteristics as Western Manabí in Ecuador - climate type a.3.1.1). The other areas which the Ecosystem classification neglects are highland areas with varying lengths of dry season, and the humid subtropical highlands of southern Brazil. With the exception of the Andean areas (4-6 dry months) these have large daily temperature ranges during the growing season. Between them they account for about 10 percent of cassava.

CONCLUSIONS

By subdividing cassava-growing areas on the basis of a simple climatic and edaphic classification, it is apparent that the cassava programme's ecosystems between them cover some important climate-soil homologues. A more systematic approach towards soils is required if that system is to continue to be used, and there are some important semi-arid and highland areas which are not currently covered by these, and which might warrant expansion of the number of ecosystems. It is recognised that CIAT's Cassava Programme cannot work specifically for all the different classes identified. However, knowledge of their existence and relative importance can help the programme in the process of deciding where to work and how many different ecosystems to work for.

Given the restrictions of the climate and soil classifications, the individual classes of each are easily assessed in terms of importance, by overlaying a dot distribution map on the homologue map and totalling the area of cassava falling within each homologue. Care should be taken in interpreting the results of this sort of exercise, particularly when considering soils.

Rather than be restricted by this type of classification, and the problems of mapping and interpretation that go with it, organisation of raw-data in a micro-regions framework is seen as a longer-term solution to specific climatic and edaphic classification problems which arise in the Cassava Programme's research and planning.

REFERENCES

CARTER, S.E. 1986a. Climatic and Edaphic Classification at a Continental Scale (1:5,000,000) for Cassava in South America. Internal Document, Agroecological Studies Unit. CIAT.

CARTER, S.E. 1986b. Crop Specific Micro-Regions: A method for defining them. Internal Document, Agroecological Studies Unit. CIAT.

CIAT 1981. CIAT Report 1981. Cali, Colombia.

CIAT 1982. CIAT Report 1982. Cali, Colombia.

FAO/UNESCO 1971. Soil Map of the World. Volume IV. South America, UNESCO, Paris.

FAO/UNESCO 1974. Soil Map of the World. Volume I. Legend. UNESCO, Paris.

TABLE 1: Hectares of Cassava according to climate and soil conditions.

CLIMATE	SOIL RESTRICTIONS							
	1. Fine Texture	2. Permanent Depth Restrict.	3. Potential Depth Restrict.	4. Seasonal Drainage Problems	5. Permanent Drainage Problems	6. Acidity	7. No Restrictions	TOTAL
A LOWLAND HUMID TROPICAL	500	8,500	40,000	18,000	71,000	154,000	19,000	278,000
B LOWLAND HUMID SUBTROPICAL	-	-	-	74,000	14,000	155,000	151,000	394,000
C LOWLAND SEMIHOT ISOTHERMIC	10,000	59,000	-	24,000	19,000	145,000	100,000	357,000
D LOWLAND SEMIHOT NON-ISOTHERMIC	-	2,000	-	-	-	11,000	2,000	15,000
E LOWLAND HOT ISOTHERMIC	-	23,000	10,000	4,000	55,000	121,000	8,000	195,000
F LOWLAND HOT NON-ISOTHERMIC	-	-	-	2,000	-	3,000	2,000	7,000
G LOWLAND SEMI-ARID ISOTHERMIC	-	82,000	-	-	-	52,000	24,000	144,000
H LOWLAND SEMI-ARID NON-ISOTHERMIC	-	2,000	-	-	-	2,000	1,000	5,000
I LOWLAND ARID ISOTHERMIC	-	5,000	-	-	-	4,000	-	9,000
J HIGHLAND HUMID TROPICAL	-	17,834	-	-	-	36,432	47,834	102,000
K HIGHLAND HUMID SUBTROPICAL	-	-	-	-	-	26,000	25,000	51,000
L 'ANDEAN' SEMIHOT ISOTHERMIC	-	3,000	1,500	-	-	15,500	13,000	33,000
M 'BRAZILIAN' HOT ISOTHERMIC	-	20,333	-	-	-	12,333	8,333	41,000
N 'BRAZILIAN' HOT NON-ISOTHERMIC	-	6,333	-	-	1,000	32,333	14,333	54,000
O HIGHLAND SEMI-ARID ISOTHERMIC	-	70,333	-	1,000	-	35,333	11,333	117,000
P HIGHLAND SEMI-ARID NON-ISOTHERMIC	-	-	-	-	-	-	-	-
Q HIGHLAND ARID ISOTHERMIC	-	12,000	-	-	-	-	2,000	14,000
TOTAL	10,500	311,333	51,500	123,000	160,000	804,831	428,833	1,816,000

NOTE: Some Cassava is grown on soils with more than one kind of restriction. In these cases the totals have been included in all of the relevant columns; column totals do not, therefore, add up to the correct total of hectares, 1,816,000. These are detailed below.

Hectares of cassava grown with more than one soil restriction.

CLIMATE	SOIL RESTRICTIONS	
	2 and 6	3 and 6
A	8,000	25,000
E	21,000	5,000
G	14,000	-
O	1,000	-

TABLE 2. Percentage of Cassava (area) by climate.

CLASS		CLIMATE	Percentage of Cassava
a.1.1	A.	Lowland Humid Tropical	15.3
a.1.2	B.	Lowland Humid Subtropical	21.7
a.2.1.1	C.	Lowland Semihot Isothermic	19.7
a.2.1.2	D.	Lowland Semihot Non-Isothermic	0.8
a.2.2.1	E.	Lowland Hot Isothermic	10.7
a.2.2.2	F.	Lowland Hot Non-Isothermic	0.4
a.3.1.1	G.	Lowland Semi-Arid Isothermic	7.9
a.3.1.2	H.	Lowland Semi-Arid Non-Isothermic	0.3
a.4	I.	Lowland Arid Isothermic	0.5
b.1.1	J.	Highland Humid Tropical	5.6
b.1.2	K.	Highland Humid Subtropical	2.8
b.2.1.	L.	'Andean' Semihot Isothermic	1.8
b.2.2.1	M.	'Brazilian' Hot Isothermic	2.2
b.2.2.2	N.	'Brazilian' Hot Non-Isothermic	3.0
b.3.1.1	O.	Highland Semi-Arid Isothermic	6.4
b.3.1.2	P.	Highland Semi-Arid Non-Isothermic	0.0
b.4	Q.	Highland Arid Isothermic	0.8

TABLE 3: Percentage of Cassava (area) by soil restriction.

TYPE OF SOIL RESTRICTION	Percentage of Cassava
1. Fine textured	0.6
2. Permanent depth restrictions	17.1
3. Potential depth restrictions	2.8
4. Seasonal drainage problems	6.8
5. Permanent drainage problems	8.8
6. High acidity	42.6
7. No restrictions	23.6

Note than the percentages add up to more than 100, as some cassava is grown in soils with more than one kind of restriction (depth and acidity restrictions combined).

TABLE 4: 12 Most important climate-soil homologues in terms of Cassava area.

Mapping Unit Code	CLIMATE-SOIL HOMOLOGUE	Hectares of Cassava	% of total	CASSAVA PROGRAM ECOSYSTEMS
B6	LOWLAND HUMID SUBTROPICAL-ACID	155,000	8.5	EASTERN PARAGUAY (ECOSYSTEM 6)
A6	LOWLAND HUMID TROPICAL-ACID	153,000	8.5	FLORENCIA (ECOSYSTEM 3)
B7	LOWLAND HUMID SUBTROPICAL-NO RESTRICTIONS	151,000	8.3	ECOSYSTEM 6?
C6	LOWLAND SEMIHOT ISOTHERMIC-ACID	145,000	8.0	ECOSYSTEM 1? 4?
E6	LOWLAND HOT ISOTHERMIC-ACID	121,000	6.7	CARIMAGUA (ECOSYSTEM 2)
C7	LOWLAND SEMIHOT ISOTHERMIC-NO RESTRICTIONS	100,000	5.5	PALMIRA, BETULIA (ECOSYSTEM 1,4)
G2	LOWLAND SEMI-ARID ISOTHERMIC-PERMANENT DEPTH	82,000	4.5	-
B4	LOWLAND HUMID SUBTROPICAL-SEASONAL DRAINAGE	74,000	4.1	ECOSYSTEM 6?
A5	LOWLAND HUMID TROPICAL-PERMANENT DRAINAGE	71,000	3.9	ECOSYSTEM 3?
Q2	HIGHLAND SEMI-ARID ISOTHERMIC-PERMANENT DEPTH	70,333	3.9	-
C2	LOWLAND SEMIHOT ISOTHERMIC-PERMANENT DEPTH	59,000	3.0	ECOSYSTEM 1? 4?
E5	LOWLAND HOT ISOTHERMIC-PERMANENT DRAINAGE	55,000	3.0	ECOSYSTEM 2?
	T O T A L	1,237,333	68.1	

TABLE 5. Climatic types not covered by current ecosystems.

CLIMATE		Hectares Cassava	% of Total
a.3.1.1	Lowland Semi-Arid Isothermic	144,000	7.9
b.3.1.1	Highland Semi-Arid Isothermic	117,000	6.4
b.2.2.2	Brazilian Hot Non-Isothermic (Highland)	54,000	3.0
b.1.2	Highland Humid Subtropical	51,000	2.8
b.2.2.1	Brazilian Hot Isothermic (Highland)	41,000	2.3
b.2.1	Andean Semihot Isothermic	33,000	1.8
a.2.1.2	Lowland Semihot Non-Isothermic	15,000	0.8
b.4	Highland Arid Isothermic	14,000	0.8
a.4	Lowland Arid Isothermic	9,000	0.5
a.2.2.2	Lowland Hot Non-Isothermic	7,000	0.4
a.3.1.2	Lowland Semi-Arid Non-Isothermic	5,000	0.3
b.3.1.2	Highland Semi-Arid Non-Isothermic	0	0.0