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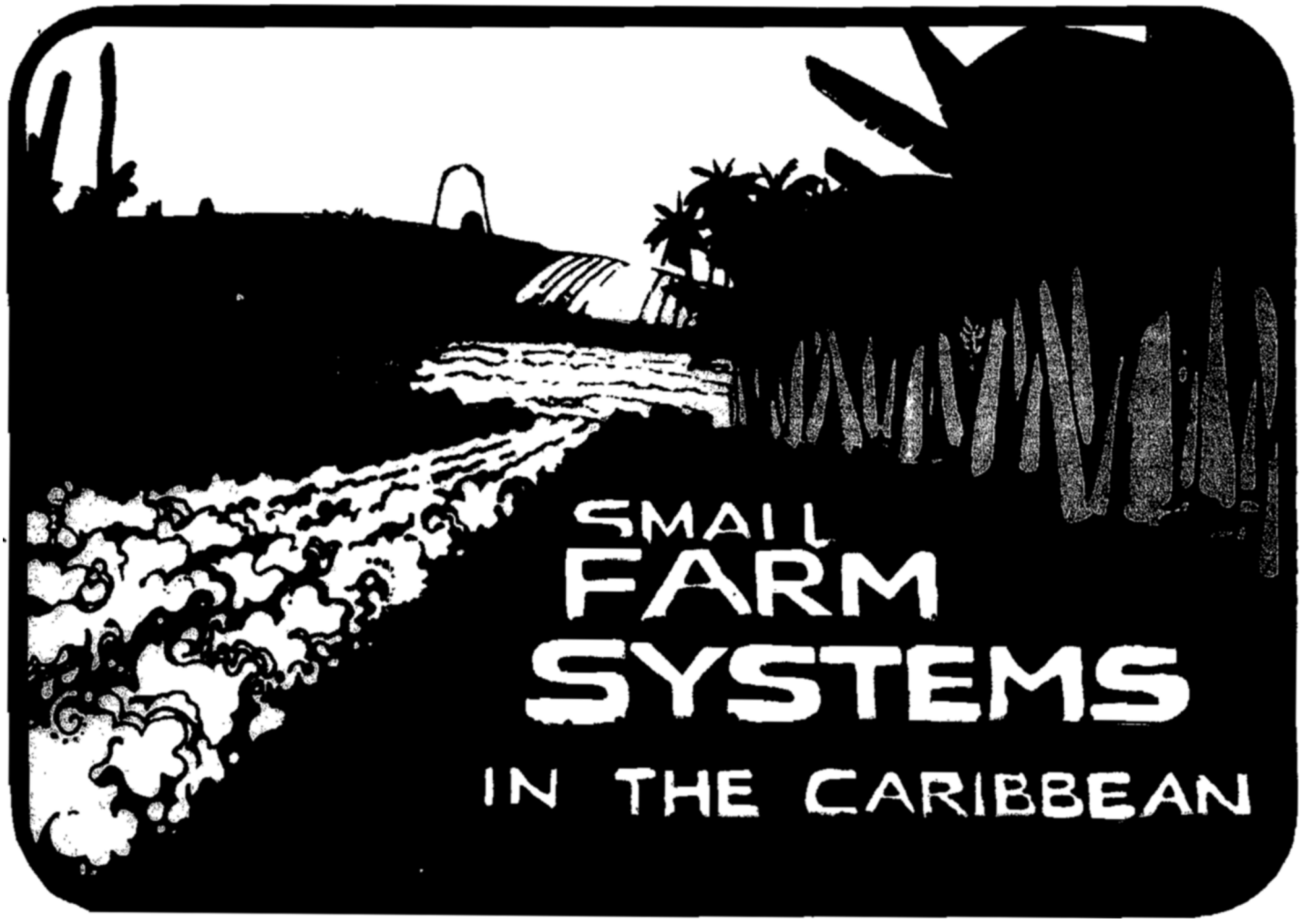

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Small Farming Systems in Las Cuevas Watershed, Dominican Republic

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Farming systems in the watershed are described. Data were gathered by a multi-disciplinary team during the summer of 1982. Sample size was 182. Farming systems identified were (1) irrigated with a rice base, (2) rainfed with an annual crop base and minor permanent crops, and (3) predominantly coffee farms which were not studied in detail. Irrigated farming systems consisted of sole crops of beans, peanuts and maize in addition to rice. Rainfed systems consisted of both sole crops and crop mixtures of beans, maize and pigeon peas. Predominant crop mixtures are beans-maize, beans-pigeon peas, and beans-pigeon peas-maize. Peanuts are predominantly sole cropped. Unique to these systems are: (1) the "convite" system—a social form of labor sharing for harvest; (2) bean trading between rainfed and irrigated systems to maintain fresh seed; (3) peanuts to provide cash; available as a loan from the processing plant. Rainfed systems and increasing population pressures subject the watershed to high rates of soil erosion and resulting siltation downstream.
Keywords: farming systems; crop systems; crop associations; "convite.".

Most islands in the Caribbean are experiencing ecological problems of uncommon magnitude. Small territories and population pressures are pushing farmers to marginally productive steeplands. The Dominican Republic is no exception. Antonini et al. (1981) have summarized the problem in the following manner:

> *The Dominican Republic today is faced with serious problems of erosion due to the widespread practice of slash-and-burn agriculture and the prevalence of shallow soils on steep slopes. Substantial amounts of top soil are lost due to poor management practices and there results greatly reduced soil fertility and crop productivity . . . As a consequence of increasing population pressure and a depleting resource base, the farm-pasture-fallow cycle is rapidly being shortened, the land's capability for sustained productivity is diminishing, and increasingly more marginal lands are being brought under cultivation and extensive use. The results of this deterioration of the Dominican steeplands is affecting not only farmers within the high watersheds, but it is also influencing the government's ability to develop and maintain water resources for meeting energy, agricultural and human needs* (p.4).

Solving these problems is no easy task. But it seems obvious that knowing the resources and farming practices prevalent in these areas provides a good starting point for developing conservation policies. For that reason, this paper describes the farming systems in Las Cuevas watershed of the Dominican Republic.

The results reported are part of a multi-disciplinary research effort sponsored by the State Secretariat of Agriculture of the Dominican Republic, the Association of Caribbean Universities and Research Institutes, and the University of Florida. The final objective of this inter-institutional agreement was to develop an integrated management and protection plan for Las Cuevas watershed.

The Study Region

Las Cuevas watershed is located on the southwestern flank of the Cordillera Central and covers approximately 600 km². Antonini et al. (1981, pp. 16-19) have described some of the region's most important characteristics.

More than 80% of the watershed is mountainous with elevations ranging between 2,200 and 2,800 m. Plateaus and interior lowlands account for about 13%, while the rest of the area consists of flood plains and river terraces.

Dry subtropical conditions prevail in the westernmost portion where the average temperature is 24.5°C and the mean annual rainfall is about 750 mm. These conditions exist in 12% of the total area. A wet subtropical life zone covers 15% of the basin, with more humid conditions but still irregular rainfall distribution. Some 52% of the area is characterized by low montane wet forest, with irregular rainfall and periodic frosts. The very wet low forest accounts for 18% of the area, where mean annual precipitation is 55% higher than evapotranspiration. Finally, 3% of the watershed is very wet montane forest in the eastern portion, with average temperatures of 17.7°C and mean annual precipitation of 1,750 mm. Frosts are more frequent and average rainfall exceeds evapotranspiration by 60%.

The population of the watershed is 85% rural and 15% urban. Population estimates for 1981 were 39,411 inhabitants, with an average density of 65 persons per km². The population is expected to double by the year 2,000.

About 7,000 families live in the study region. More than half live in small rural settlements (100 to 2,500 persons) in the hills or along the terraces and flood plains adjoining the Las Cuevas river and its tributaries. The greatest number of families live in isolated hamlets and small agricultural villages. One road connects these villages with Padre Las Casas, the only urban center in the area, and most interconnecting dirt trails become impassable during the rainy season.

MATERIALS AND METHODS

The study area was visited by a multi-disciplinary group in March, 1982. All members were placed on small teams and a type of "sondeo" following Hildebrand (1981) was conducted. The results of this visit provided valuable input for developing a questionnaire which was pre-tested near the end of June. Once the questionnaire was redesigned, the final interviews were conducted during the month of July.

The relevant population used was 5,609 households existing in Las Cuevas watershed according to the 1980 population census. Systematic sampling methods as outlined by Mendenhall et al. (1971) were used to draw the sample size. The key variable in the design was the level of household income, and accuracy of the systematic sample was based on the assumption of random household income and the advantages of systematic sampling in the field work (Mendenhall et al., 1971). From the total population of 5,609 households, a sample of 286 was selected. Because the survey was multipurpose, 104 sampled households did not operate any agricultural enterprise. Thus, the final sample for this study included 182 agricultural households.

For the purpose of this analysis, relevant classification criteria were needed. Ruthenberg (1980) has outlined this need as follows:

> *In the process of adopting cropping patterns and farming techniques to the natural, economic and socio-political conditions of each location and the aims of the farmers, more or less distinct farm systems have developed. In fact, no farm is organized exactly like any other, but farms producing under similar natural, economic and socio-institutional conditions tend to be similarly structured. For the purpose of agricultural development, and to devise meaningful measures in agricultural policy, it is advisable to group farms with similar structural properties into classes. It is important in this context that relevant classification criteria are used and no single criterion allows the formation of meaningful classes* (p. 14).

The cropping patterns and farming systems found in the watershed were analyzed by clustering the most important crops of the watershed with homogeneous technology and characteristics. The classification was based on relevant factors such as irrigated and rainfed land, type of land preparation, type of planting, level of input usage, yields and crop cycles.

The final classification of the farming systems included:

1. short-cycle sole crop systems on irrigated land (beans, rice, peanuts and maize) or on rainfed land (beans, maize, pigeon peas and peanuts);
2. short-cycle crop mixtures on rainfed land (beans-maize, beans-pigeon peas and beans-pigeon peas-maize);
3. permanent sole crop system (coffee); and
4. permanent crop mixture system (coffee-bananas).

RESULTS AND DISCUSSION

Both large and small farms are found throughout the watershed although half of them contain 3 ha or less land. Excluding the nine largest farms with 64% of the area, average farm size is about 5 ha. Slightly over half the farms had only one parcel; the others were divided into two or three parcels (Table 1). Half the land area is in pasture, forest or bush and only 10% is in annual (short season) crops (Table 2).

Coffee is the most important crop and is sole cropped on 675 ha (Table 3). It is associated with bananas on another 71 ha and with a mixture of other crops on 5 ha. Rice and peanuts are only sole cropped, 78% of the beans are sole cropped, but only 18% of the maize and 10% of the pigeon peas are grown alone (Table 4). The most important annual crop associations are bean-pigeon pea, bean-pigeon pea-maize and bean-maize (Table 5).

TABLE 1. Land distribution by numbers of parcels on each farm and percentage of total area in Las Cuevas watershed, Dominican Republic, 1982.

Number of parcels	Farms		Total area	
	Number	Percentage	Ha.	Percentage
1	100	55.0	941	36.1
2	67	36.8	967	37.1
3	15	8.2	697	26.8
Total	182	100.0	2605	100.0

TABLE 2. Land uses found in the 182 surveyed farms in Las Cuevas watershed, Dominican Republic, 1982.

Classification	Area (ha)	Percentage of total
Short-cycle crops	255	9.8
Permanent crops (excluding coffee and coffee-banana)	49	1.9
Coffee and coffee-banana	746	28.6
Fallow land	203	7.8
Pasture, forest or bush	1352	51.9
Total	2605	100.0

TABLE 3. Land use by sole crop systems in the 182 surveyed farms in Las Cuevas watershed, Dominican Republic, 1982.

Crop	Area (ha)	Percentage of total	
		Including coffee	Excluding coffee
Rice	23	2.4	7.8
Beans	181	18.7	61.6
Peanut	18	1.8	6.1
Maize	7	0.7	2.4
Pigeon pea	5	0.5	1.7
Coffee	675	69.7	-
Other	60	6.2	20.4
Total	969	100.0	100.0

TABLE 4. Land use by crops grown alone and associated in the 182 surveyed farms in Las Cuevas watershed, Dominican Republic, 1982.

Crop	Area (ha)		Percentage of crop	
	Sole cropped	Associated	Sole cropped	Associated
Beans	181	51	78.0	22.0
Maize	7	31	18.4	81.6
Pigeon pea	5	43	10.4	89.6
Coffee	675	71	90.5	9.5

sloping land. Soil loss is minimal fot permanent crop systems which are prepared and planted only once over many years. The following sections describe these farming systems.

Short-cycle Sole Crop Systems on Irrigated Land

These systems are located on lowlands. The four crops rotated include rice, beans, peanut and maize (Table 6).

Rice is planted once a year, maize and peanuts are planted twice and beans three times. Land preparation is the same for the four crops: with oxen and a plow. For 0.6 ha of rice, a nursery bed of 10 m, where 45 kg of seed are broadcast, is prepared.

Although four major types of farming systems emerged from the classification, this paper is concerned mainly with short-cycle sole and associated crop systems on irrigated and on tainfed land. The emphasis placed on these systems is related to soil conservation concerns. Short-cycle crop systems require land preparation one to three times a year. This permits soil erosion when farming

TABLE 5. Associations of beans, maize and pigeon pea in the 182 surveyed farms in Las Cuevas watershed, Dominican Republic, 1982.

Association	Area (ha)
Bean-pigeon pea	17
Bean-pigeon pea-maize	16
Bean-maize	10
Other bean associations	8
Other pigeon pea associations	10
Other maize associations	5
Total bean associations	51
Total pigeon pea associations	43
Total maize associations	31

Rice transplanting by hand occurs one month after land preparation. A seed drill with a mule is used to plant the other three crops. Seed rates are about 73 kg ha $^{-1}$ for rice, between 73 and 87 kg ha $^{-1}$ for beans and for peanuts and maize 73 and 22 kg ha $^{-1}$, respectively.

Fertilization practices are absent in peanuts and maize. However, from 145 to 363 kg ha $^{-1}$ urea are applied twice to rice, and urea or the formula 15-15-15 are used on beans at a rate of between 73 and 254 kg ha $^{-1}$.

Weeding is done with machetes in all four crops. No insecticides are applied to either rice or maize. Beans receive an application of insecticide mixed with liquid N, while powdered insecticide is applied once to peanuts.

Harvesting dates vary among the four crops and wide yield fluctuations are ptesent. In the case of beans, most of the farmers harvest by "convite." Under this system, the owner of the farm prepares a large meal for the men, women and children working in the harvest and no cash payment is involved. The people are willing to provide their labor because they receive the same help when they harvest their own crops. This is a system of mutual exchange of labor for mutual help among the farmers and is carried out in a festive mood. The "convite" is also practiced in other systems where beans are involved; *i.e.*, beans as sole crop and crop mixtures on rainfed land. Perhaps one contributing factor is the more complex harvesting and packaging process involved in bean harvesting. After being pulled by hand, the dry plants are collected over a canvas and mules are passed ovet them ro thresh out the grains. Then the grains are cleaned and sacked.

Marketing for beans and maize is through middlemen at the farm gate on these lowland fatms where access to roads is more general. Rice is sold to local millers. All peanut production is bought by "La Manicera," which is the only peanut processing plant in the country. This company finances all peanut production and deducts that money at harvest time. Farmers feel that peanut production is not profitable but they plant this crop as a means of obtaining cash from the loan to subsist during the period when they do not have another feasible choice.

TABLE 6. Characteristics of short-cycle sole crops systems on irrigated land in Las Cuevas watershed, Dominican Republic, 1982.

		Land Preparation		Planting			Fertilization			Weeding			Harvesting		
Crop	Rotation	Time	Means	Time	Means	Rate (kg ha^{-1})	Time	Type	Rate (kg ha^{-1})	Time	Means	Pesticides	Time	Yield (kg ha^{-1})	Marketing
Rice (R)	B P	Feb.-March	Oxen with plow	Apr.-May	Hand	73	May(1) June(1)	Urea	145-363	May-Jun.	Hand (machete)	None	Aug-Sep.	1450-3630	Local millers
Bran (B)	R B	March Aug. Dec.	Oxen with plow	Apr. Sep. Jan.	Seed drill with mule	73-87	May Oct. Feb.	Urea or 15-15-15	73-254	May Oct. Feb.	Hand (machete)	1 applic. of insect. mixed with liquid N	July Dec. March	726-1452	Middlemen at farm gate
Peanut(P)	R B M	March Aug.	Oxen with plow	Apr. Sep.	Seed drill with mule	73	None			May Oct.	Hand (machete)	1 applic. of powdered insect.	July Nov	544-1452	Processing plant
Maize (M)	B P	March Aug.	Oxen with plow	Apr. Sep.	Seed drill with mule	22	None			May Oct.	Hand (machete)	None	July-Aug. Dec-Jan.	363-2250	Middlemen at farm gate

Short-cycle Sole Crop Systems on Rainfed Land

Table 7 shows that bean, maize, pigeon pea and peanut are the main short-cycle sole crop systems grown on rainfed land. With the exception of pigeon peas, which is grown only once a year, crops can be planted twice each year. Land preparation starts in March for all crops; the second time for bean, maize and peanut is in August. It is performed by hand with a machete in the case of pigeon pea, while an oxen with plow or a machete are used for the other crops.

Planting occurs within a month afrer rhe land has been prepared. All crops are planted by hand with a machere although in some cases peanut planting is done with a seed drill and a mule. Seed rates for bean, maize, pigeon pea and peanut are 73, 43, 14, and 80 kg ha^{-1}, tespectively. Some of the farmers who harvest beans in July-August provide bean seed to those who plant in September with the agreement that when these farmers finish their harvest in December, they will return an exrra 50% of the seed borrowed. Under this system, the farmers harvesting in July and August conserve the germination quality of the seed and obtain a 50% bonus. The farmers planting in September need no cash for seed purchases.

The use of fertilizers and pesticides is not common. Weeding is done during the same time of the year for all crops and is performed with a machete. Yields are lower than those obtained on irrigated land owing in part to the occurrence of periodic droughts.

Marketing under these systems, in which are produced on the more accessible rainfed lands, is very similar to that for irrigated systems. Peanut production is sold to "La Manicera" under the same conrract discussed above. The other three crops are sold to middlemen who come with their trucks to purchase the outpur at the farm gate or nearest road. Sometimes, pigeon peas are transported by mules to be sold in the nearest market.

Short-cycle Crop Mixture Systems on Rainfed Land

Bean-maize, bean-pigeon pea, and bean-pigeon pea-maize (Table 8) are the three most important crop mixtures found on rainfed land. They are grown only once a year with rhe exception of bean-maize which is produced twice each year. The bean-pigeon pea-maize crop mixture is mostly found on more remote farms in the uplands. Farmers argue that under this system, if one crop fails it is still possible to obtain some production from rhe others; that is, this system guarantees them the possibility of a certain amounr of food for their families.

TABLE 7. Characteristics of short-cycle crops systems on rainfed land in Las Cuevas I watershed, Dominican Republic, 1982.

Crop	Rotation	Land preparation Time	Land preparation Means	Planting Time	Planting Means	Planting Rate ($kg\ ha^{-1}$)	Fertilization and Pesticide	Weeding Time	Weeding Means	Harvesting Time	Harvesting Yield ($kg\ ha^{-1}$)	Marketing
Bean		March Aug.	Oxen w/plow or hand (machete)	April Sept.	Hand (machete)	73	Rarely used	May Oct.	Hand (machete)	July Dec.	167-725	Middlemen at farm gate
Maize		March Aug.	Oxen w/plow or hand (machete)	April Sep.	Hand (machete)	43	Rarely used	May-June Oct-Nov.	Hand (machete)	Aug.-Sept. Jan.-Feb.	363-1183	Middlemen at farm gate
Pigeon pea		March	Hand (machete)	April	Hand (machete)	14	None	May-June	Hand (machete)	Jan. (for 2-3 months)	363-1088	Middlemen at farm gate or in mules to nearest market
Peanut		March Aug.	Oxen w/plow or hand (machete)	April Sep.	Seed drill w/mule or hand (machete)	80	None	May Oct	Hand (machete)	July Dec.	239-624	Processing plant

TABLE 8. Characteristics of short-cycle crop mixture systems on rainfed land in Las Cuevas watershed, Dominican Republic, 1982.

Crop mixture	Rotation	Land Preparation Time	Land Preparation Means	Planting Time	Planting Means	Planting Rate ($kg\ ha^{-1}$)	Fertilization and Pesticide	Weeding Time	Weeding Means	Harvesting Time	Harvesting Yield ($kg\ ha^{-1}$)	Marketing
Bean-maize		March	Oxen w/plow or hand (machete)	April	Hand (machete)	Bean: 50-73 P.Pea: 7-15	None	May	Hand (machete)	Bean: July P. Pea: Nov.-Feb.	181-725 14S-617	Middlemen at farm gate
Bean-maize		March Aug.	Oxen w/plow or hand (machete)	March Sep.	Hand (machete)	Bean: 50-73 Maize: 15-22	None	April Oct.	Hand (machete)	Bean: July; Nov-Dec. Maize: Aug;Dec-Jan.	290-653 218-580	Middlemen at farm gate
Bean-pigeon pea-maize		March	Oxen w/plow or hand (machete)	April	Hand (machete)	Bean: 4J-65 P.Pea: 11-15 Maize: 15-22	None	Continu-ously	Hand (machete)	Bean: July P.Pea: Nov-Dec. Maize: Aug.-Sep.	109-377 240-435 196-363	Home consumption

Land preparation takes place in March for all crops. A second crop of bean-maize requires land pteparation in August. For all systems, the land is prepared with oxen and plow or with a machete.

Planting is done with a machete, opening a small hole in the soil and dropping in the seed. Seeding rates are similar in all systems except that less bean seed is used in the bean-pigeon pea-maize association.

Ferrilizers and pesticides are not used in these systems. Weeding is done by hand with a machete and, in the case of bean-pigeon pea-maize, is a continuous activity carried out by all members of the family.

Yields vary among the three ctop mixtures and from those obtained on sole crop systems. Output of bean-maize and bean-pigeon pea is sold to middlemen. The production from the bean-pigeon pea-maize crop mixtute is consumed at home.

CONCLUSIONS

This papet has desctibed the small farming systems in Las Cuevas watershed of the Dominican Republic. Several important characteristics, some of them unique in this area, were found.

The role of crop associations in these farming systems was a relevant finding. Fot example, 82% of the maize and 90% of the pigeon peas are grown in association with other crops. Furthermore, all output from the bean-pigeon pea-maize assocation is devoted to home consumption.

Two systems of mutual help among the farmers were also found. One consists of the exchange of bean seed between those harvesting in July—August and those planting in September. The fotmer conserve the getmination quality of the seed and obtain a 50% bonus, while the latter do not need cash for seed purchases. The "convite" system is the means by which farmers harvest theis bean crops without incurring labor expenses. Farmers are willing to provide their labor because they receive the same help when they harvest their own crops.

Peanut production, although not profitable, is catried out as a means of obtaining cash from a loan to subsist duting the period when they do not have anothet feasible choice.

Although a relatively small amount of all the land in the watershed is devoted to short-cycle crops, these systems ptoduce high rates of soil erosion that are unacceptable. Increasing population pressures are likely to worsen this problem. The importance of these systems to the farmers' diets preclude any policy that would prohibit their future production. Perhaps the problem could be alleviated by the development of improved technology that would bring about increased production in the uplands on a smaller land area.

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