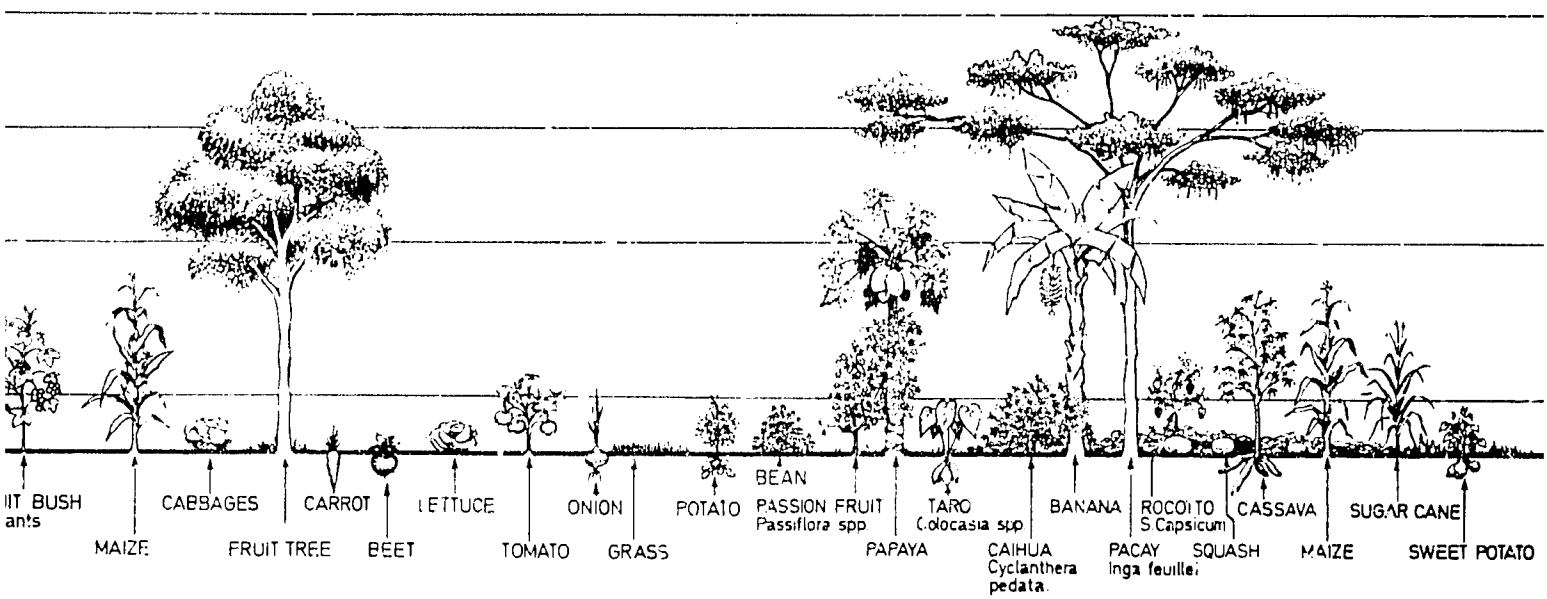
HOUSEHOLD FOOD PRODUCTION: COMPARATIVE PERSPECTIVES

Edited by:

Vera K. Niñez



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Cover designed and printed at CIP. The cover design contrasts tropical, layered with temperate garden plant ecology.

INTRODUCTION: HOUSEHOLD GARDENS AND SMALL-SCALE FOOD PRODUCTION

Vera Niñez
Guest Editor
International Potato Centre, Lima, Peru

The articles in this issue discuss a household-level food production strategy which is as old as human civilization and plant domestication itself: the household garden. Shown to have been of crucial importance to a large proportion of the population in recent world history [3], the home garden still has a promising future in the struggle against world hunger and malnutrition as one of the "last frontiers" for increasing world food production.

* * *

This collection of original essays on small-scale food production for home consumption is the first of its kind. Food production in and around the household is the most ancient form of cultivation. Despite mounting evidence that backyard gardens yield surprisingly significant nutritional and economic benefits to gardening households and societies, they have been ignored as a legitimate area of research. Understanding the present state-of-the-art of garden research may be a key to elevating the household gardening food strategy to its rightful place in the study and improvement of agricultural systems.

The reader may find it of interest that, in putting together this issue, I sent requests to researchers in many development-related professions. It soon became apparent that serious field study of home gardens is in its infancy. Most individuals who expressed interest in submitting papers reporting empirical field data on existing household production systems were anthropologists or geographers, who came to realize the importance of the traditional garden production system through prolonged observation of village life.

Generally, the first phase in the scientific study of a newly discovered phenomenon is description. All the papers in this issue are case-studies based on first-hand, in-depth research by the authors. They deal with gardening systems and people from four major continents: Latin America, North America, Asia, and Africa. Despite great diversity in the details of each case, there are certain similarities. Isolating these common elements can take us one step further towards a clearer understanding of the nature, functions, and possibilities of household gardens.

FUNCTIONS

The adaptive functions of household gardens, as illustrated in all the articles in this issue, are:

- producing relatively large amounts of food with marginal labour on areas of land too small for field agriculture;
- supplying nutrition lacking in field agricultural production,
- providing food, including staples, directly in non-farm settings, especially urban centres, thereby cutting costs and obviating distribution problems;
- making food available during periods of crop failure or disruption of food supplies;
- providing fodder for household animals and meeting other household-related needs (handicrafts, firewood, petty cash from sale of surplus);
- lending convenience and security through proximity to dwellings;
- enabling experimentation with new plant genetic materials and cultivation techniques before implementation in field agriculture;
- allowing diffusion of plant genetic materials and maintaining genetic diversity; and
- guaranteeing households a regular and secure supply of food, petty cash, or goods to trade.

DEFINITION

What is a household garden and how does it differ from field production or market gardening? Ruthenberg [6], one of the few agricultural systems analysts to discuss home gardens, distinguishes:

> garden cropping from . . . arable cropping by the following features which are usually, but by no means in all cases, found simultaneously: (1) cropping those plants for personal consumption that cannot be collected nor supplied by arable farming, (2) small plots, (3) proximity to the house, (4) fencing, (5) mixed or dense planting of a great number of annual, semi-permanent, and perennial crops, (6) a high intensity of land use, (7) land cultivation several times a year, (8) permanence of cultivation, and (9) cultivation with hand implements.

TABLE 1.

Characteristics	Household Garden	Market Garden	Field Agriculture
Planting and harvesting			
Species density	High	Medium to low	Low
Species type	Staple, vegetable, fruit (cultural)	Vegetable, fruit (market-oriented)	Staple (subsistence, agro-industrial)
Harvest frequency	Daily, seasonal	Seasonal (short)	Seasonal (long)
Cropping patterns	Irregular, row	Row	Row
Production and economic			
Production objective	Home consumption	Market sale	Subsistence, market sale
Economic role	Supplementary	Major economic activity	Major economic activity
Technology needed	Simple hand tool	Hand tool or mechanized	Mechanized if possible, hand tool
Inputs-cost	Low	Medium to high	Medium to high
Economic assistance needed	None or minor	Credit	Credit, extension
Labour			
Labour source	Family (female, elderly, children)	Family or hired (male, female)	Family, hired (male female)
Labour requirements	Part-time	Full-time	Full-time
Skills required	Garden-horticultural	Market-horticultural	Agricultural, commercial
Spatial			
Space utilization	Horizontal, vertical	Horizontal, vertical	Horizontal
Location	Close do dwelling	Close to urban market	Rural setting, near or distant from homestead
Distribution	Rural and urban	Sub-urban	Rural

Table 1 distinguishes three main types of primary food production systems: (i) household gardens, (ii) market gardens, and (iii) field agriculture.

What is needed is a global definition of household gardens that stresses universal basic denominators differentiating household garden production for home consumption from market gardening or field production. Apart from social, clinical, recreational, ideological, and aesthetic considerations, the following definition for household gardens has been formulated [4]:

> The household garden is a subsystem within larger food procurement systems which aims at production of household consumption items either not obtainable, readily available, or affordable through permanent or shifting field agriculture, hunting, gathering, fishing, livestock husbandry, or wage earning. Household gardens supply and supplement subsistence requirements and generate secondary direct or indirect income. They tend to be located close to permanent or semi-permanent dwellings for convenience and security.

SOCIO-ECONOMIC CHARACTERISTICS

In reviewing the cases presented here it should be obvious that societies have different degrees of dependence on the gardening strategy. For example, shifting cultivators with a dietary base of cassava and plantain depend to a much greater degree on their gardens than either peasants of the High Andes, who traditionally grow a wide variety of grain and tuber staples high in micro-nutrients and protein, or groups that have greater access to outside markets or wage labour opportunities. None the less, as the lack of land for growing populations of shifting cultivators becomes more of a problem for development action, and as agriculturalists from different ecosystems move into previously used tropical forests, the search is on for viable strategies.

Food production for direct home consumption is part of rural and urban household economies. Given a choice, families provide themselves with enough space around their dwellings to plant crops and keep animals. The degree and type of use this space is put to depend on the nature and

success of other family economic strategies. Again, two basic types (with a variety of subtypes) can be identified: subsistence gardens and budget gardens.

Subsistence Gardens

The subsistence garden forms an essential part of subsistence field agricultural economies producing mainly for home consumption. The role of the garden is: (i) to supply, during the productive season, three main categories of daily meal ingredients (condiments, ready-to-hand staples, leaf vegetables, and fruit); (ii) to supply vegetable staples earlier and more conveniently than field agriculture (roots and tubers, maize); (iii) to produce consumption luxuries under close surveillance (e.g. certain fruits and vegetables); (iv) to provide space and fodder for farmyard animals; and (v) to produce small surpluses for sale in the market. The proportion of garden space allocated to various categories of produce depends on the accompanying field production and ecological conditions. The bulk of energy needed by the household comes from field agriculture, with the garden providing nutritional essentials not otherwise obtainable.

Budget Gardens

Budget gardens exist in rural and urban variants. The rural budget garden is located in a rural setting, serving a family whose main income comes from wage labour (rural or urban). The urban budget garden is generally located in the yard of an urban home, a vacant lot, or an allotment on the periurban fringe. Budget gardens aim to supplement purchased food supplies or, if possible, to replace them with garden staples, vegetables and condiments, and fruit.

These gardens also provide space and/or fodder for the raising of small animals (usually poultry, rodents and small ruminants). In extreme cases, the budget garden may be the only source of livelihood and income for the rural and urban poor. If enough space is available, small cash crops may be produced and exchanged or sold for purchased food.*

ECONOMICS AND NUTRITION

The lack of economic and nutritional data on the benefits of household gardens has been a major obstacle to official recognition of the universal phenomenon of family food production. Data collection is difficult for a number of reasons, the main one being that by its very nature production for immediate consumption does not lend itself to measurement by the producer/consumer and therefore rarely appears in government statistics.

To say that gardens produce between 10 and 20 per cent of a family's income, or up to 40 per cent of family consumption needs, may or may not be meaningful depending on the audience, anyone, however, would surely be impressed by the fact that Indonesian home garden production has a monetary value of about 60 per cent of that of the total rice production in the country (see Soemarwoto, p. 45). The very persistence of this form of production, from time immemorial down to the present, can be taken as proof of its intrinsic economic and nutritional merit. The importance of gardens is further attested to by the fact that in times of need societies have had recourse to the garden strategy – for example, the Irish potato gardens during the Great Depression and the Second World War.

The only consolation to development economists in regard to the scarcity of statistics on an apparently important food production strategy is the fact that development nutritionists have even less empirical data to work with. The only serious nutritional analyses extant on garden production are based on model gardens.

GARDEN ECOLOGY

Household gardens are found, historically and ethnographically, in all arable regions. Although there are an infinite number of variations, tropical and temperate gardens can be conveniently designated as the major ecological types, to be used as springboards for further research.

Tropical Gardens

As John Brierley points out in his article in this issue of *Food and Nutrition Bulletin*, those unfamiliar with tropical gardens often perceive them as lacking order in cropping patterns, a characteristic that they imagine reduces productivity while increasing labour input. Spatial arrangements in tropical gardens, however, often depend on the utilization of plant-symbiotic relationships, which both increase soil fertility and reduce labour input.

Vegecultural reproduction predominates over seed cultures in tropical cropping systems [1], largely eliminating seed production and storage problems. Tropical gardens also have several vegetation "storeys," imitating the tropical forest structure (fig. 1). The top storey consists of tall trees, such as *Inga feuillei, Mangifera indica, Persea gratissima,* and *Artocarpus incisa,* which form a protective canopy against the tropical sun and torrential rains. Such trees

* For a more detailed discussion of household garden typology, see Niñez [3, 4].

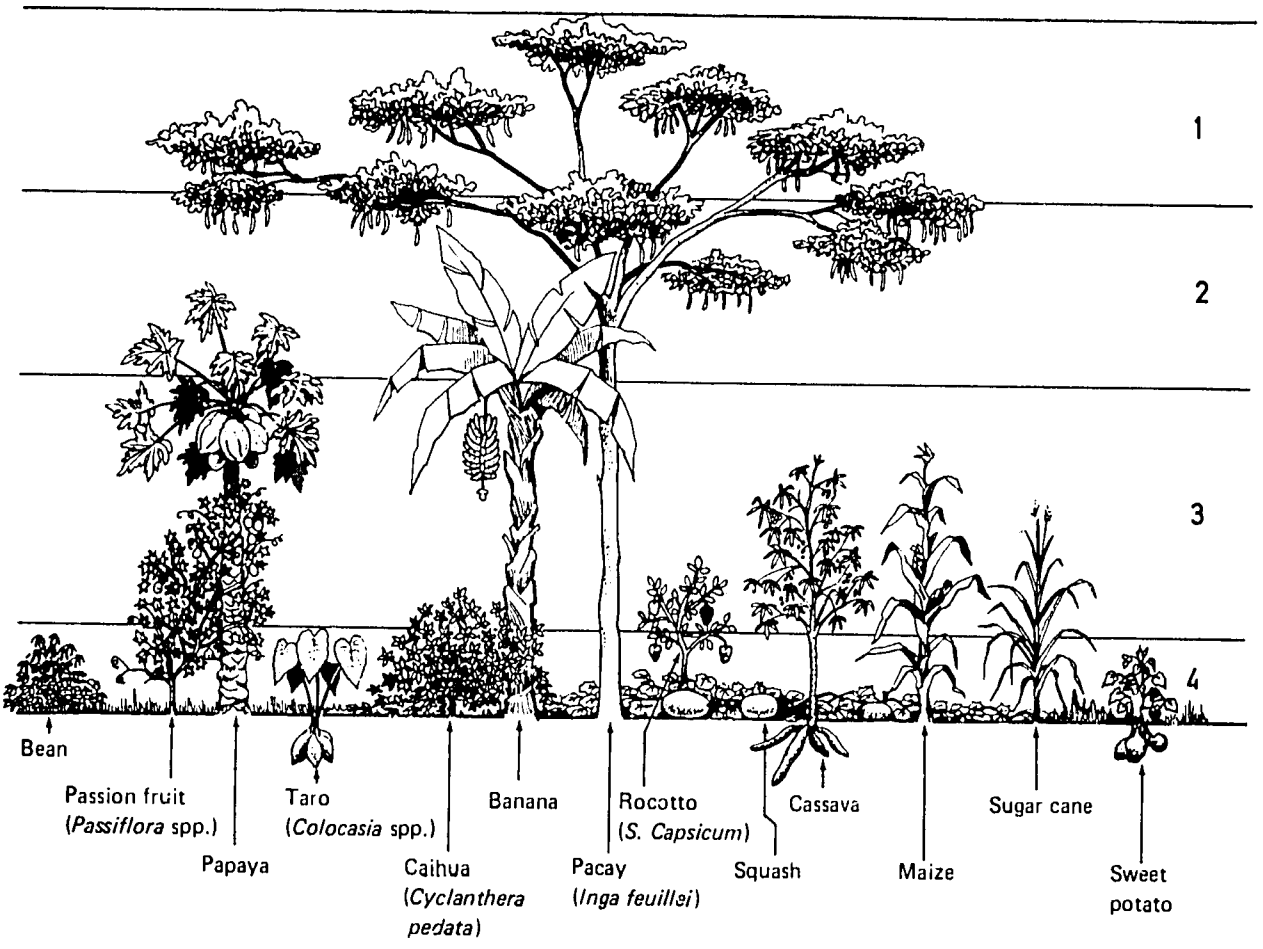

FIG. 1. A Typical Tropical Layered Household Garden

supply nourishment, their fallen leaves contributing to spontaneous soil regeneration and helping to maintain relatively constant moisture and temperature levels.

The next layer features staple and fruit production (e.g. *Musa* spp., *Carica papaya*), followed by bush-level growth (cassava, maize, peppers). Ground-covering and climbing species (Cucurbitaceae, beans) form a fourth layer, with in-ground roots and tubers completing the structure. Space utilization is optimal in tropical food production arrangements, and, although it appears "chaotic" to the temperate-climate scientist's eye, this kind of vertical layering must become a model for future food production under conditions of limited space.

Temperate Gardens

Layering is not as definite a feature of temperate gardens in the cooler, sun-poor regions of the world. In temperate gardens, trees and bushes are well-spaced, leaving ground-covering plants without shade. Annual seed culture is prominent where distinct seasons control plant growth. Thus, defined cropping areas are the rule in temperate gardens, with reduced inter-cropping and mixed cropping resulting in a more open vegetation canopy that takes full advantage of solar radiation.

HOME GARDEN DEVELOPMENT PROJECTS

Home garden projects are like small windows through which one can see the biases and misguided assumptions of larger agricultural development projects in the Third World. Being small with visible limits, garden projects mirror the development agency mentality in that they favour Western agronomic techniques and crop selection, linear planting and high inputs, and they place stress on mono-cropping and row cropping.

Unfortunately, those people who have studied traditional gardening systems intensively are rarely the ones who participate in the design and implementation of garden projects. The massive literature on "how-to-do-it" has not been linked with "how-it-is-already-done." There is

clearly a need for interdisciplinary research involving nutrition and garden — as opposed to field — horticulture and for project implementers of household garden programmes.

Continued neglect and misunderstanding of home food production can no longer be afforded at a time when "alternatives for increasing food consumption levels of . . . poor households are [urgently] sought" [7] in order to ensure that, in the words of FAO Director-General Edouard Saoma, "all people at all times have both physical and economic access to the basic food they need" [2].

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WORKING AT HALF-POTENTIAL: Constructive Analysis of Home Garden Programmes in the Lima Slums with Suggestions for an Alternative Approach

Vera Niñez
International Potato Centre, Lima, Peru

INTRODUCTION

While "urban agriculture" is a relatively recent concept in development circles, city and town dwellers from ancient times until the present have produced at least some of their own food in and around urban settlements. As new projects are formulated to develop urban small-scale food production systems, an understanding of traditional approaches will help pave the way for successful implementation.

Based on this philosophy, this article deals with traditional gardening and garden development projects in Lima, Peru. First, I will briefly describe the socio-economic and nutritional background of low-income target populations served by small-scale food production development projects. Second, on-going "native" food production at the urban household level, emphasizing household gardens, will be discussed. Third, a series of past and contemporary programmes will be analysed and, fourth, concrete suggestions will be offered to guide future programme design.

THE FOOD SITUATION IN THE LIMA SLUMS

Once an agriculturally self-sufficient nation, Peru today has reached a point where the need for annual imports of basic foodstuffs (mainly US white polished rice, wheat, and powdered milk) amount to over US$1 billion [16, p. 69]. These imports virtually cancel out Peruvian exports in minerals, one of the greatest riches of the nation. Even the persuasive argument that Peru should acquire imports through the sale of those export commodities in which it has a comparative international advantage cannot at present be sustained when food imports literally eat up such a gigantic share of the country's foreign exchange earnings.

Peruvian governments past and present have attempted to feed the nation's 19 million people by both increasing agricultural output and expanding the land area under cultivation. Neither land reform nor large-scale colonization, however, have produced the expected results. Despite a growing population, agricultural output has remained static over the past years, with a decline in some subsistence crops [2, B3]. Agricultural production is generally marked by an increasing coastal output in urban food items (chickens, eggs, milk, horticultural field produce) and agro-industrial crops and a decline in smallholder subsistence-oriented production [2, B10].

Since the 1950s, massive rural-urban migration resulting from the desire of the rural population to escape the yoke of agricultural stoop labour and find employment in the capital has brought millions of hinterlanders to Lima and the coast [14]. Newcomers settle in *invasiones* (literally "invasions") of straw huts erected practically overnight on rocky hillsides and sand dunes around the metropolitan core. These subsequently mature into *pueblos jovenes* (young towns) with the right to community status, infrastructural facilities, and community administration. Today, over six million people, or one-third of Peru's total population, are concentrated in and around Lima. The 1981 census by the Ministry of Housing counted at least 1,171,840 persons living in blighted urban sectors with the 1984 estimate close to two million. Newcomers to Lima's *pueblos jovenes* are faced with high levels of unemployment and resulting low and often irregular incomes. Monthly income for the average family of seven among Lima's poor oscillates around US$80 [14]. Monthly allowable expenditure per capita is thus below US$12.

Although the coast supplies 43 per cent of agricultural output [1, B1], costly commercial production puts prices out of reach of many urban poor households. The poorest families especially are forced to subsist mainly on government-subsidized basic imported foods, to the widespread exclusion of vegetables, fruit, and animal proteins. At the same time, production of nutritionally high-quality traditional crops has declined in favour of market production, lowering rural nutritional standards while increasing the dependence of the primary sector on government-subsidized basic foods [16, pp. 36, 62]. Consequently, balanced nutrition, critical at the wider national level, becomes a factor affecting family well-being at the individual, family, and community levels. Signs of malnutrition and cases of severe clinical malnutrition are found particularly in the age-group under five [7].

Lower-income families spend over 60 per cent of their monthly incomes on basic food and drink [9], despite government expenditures on subsidies and basic food imports that averaged 26.8 per cent of the national deficit between 1973 and 1983 [3].

Comparing prices of individual food items to monthly income, the food selections of low-income housewives make sense economically (table 1). Food intake for the lower social strata consists of a diet heavy in vitamin-and-mineral-deficient yet low-cost carbohydrate sources.

Sugar is used in large quantities. Vegetables are consumed regularly but in small quantities in soups rather than as the main feature of meals. Consumption of plant protein, such as beans, is higher than that of animal protein, including eggs, but low in comparison to total calorie intake (cf. table 1) [6].

The major source of calories, white polished rice, also supplies a high percentage of protein to low-income diets. In a 1980 unpublished survey [6], rice supplied 16.38 per cent of the daily family protein intake at 9.25 per cent of the total daily consumption cost, followed by fish (17.11 per cent at 6.35 per cent of the total cost), chicken (8.07 at 16.24 per cent of the total cost), and eggs (1.22 at 1.54 per cent of the total cost). Wheat flour products, especially in the form of *panes* (rolls), are consumed with and in between meals, and add to the high carbohydrate intake.

TABLE 1. Prices of Foods in the Lima Market

Commodity	Price (soles)[a]	Food Category and Primary Nutrients
1 kg rice	1,500	Staples (carbohydrates)
1 kg noodles	2,200	
1 kg sweet potato	250	
1 kg beans	4,500	Legumes (plant protein)
1 kg peas	6,000	
1 kg broad beans	4,000	
1 kg chicken	5,000	Meat, fish, eggs, milk products (animal protein)
1 kg beef, muscle	10,000	
1 kg fish, low-priced	4,000	
1 kg offal	5,500	
1 kg eggs	3,700	
1 kg milk	1,200	
1 kg cheese, low-priced	12,000	
1 unit cabbage	800	Vegetables (vitamins, minerals)
1 unit lettuce	500	
1 unit cucumber	300	
1 unit eggplant	300	
1 kg tomato	1,400	
1 kg carrot	1,200	
1 kg squash	1,600	
1 kg onions (white)	2,200	
1 medium papaya	2.300	Fruit (vitamins A and C)
1 unit banana	140	
1 unit apple	200	
1 unit mango	800	
1 kg oranges	1.600	
1 kg passion fruit	1,200	

a. Prices date from early 1984 with an exchange rate of 2,700 soles to US$1.

LIMA URBAN FOOD PRODUCTION: GARDEN CITY IN THE SLUMS

National and international programmes working to improve the nutritional standing of Lima's poor households are as old as the slum settlements themselves. The Government has tried measures ranging from "free food" and "food-for-work" programmes to high-protein but culturally unacceptable "mixes" (such as ones based on fish and cotton seed meal) [4]. Recent intervention projects have stressed innovative, self-help strategies to provide more and better balanced food; among these have been the establishment and promotion of household-level food production in the form of family backyard or community gardens.

Urban gardening is a food production strategy that has been employed since Roman times to secure close-at-hand basic and supplementary food supplies [12]. A traditional companion to rural subsistence economies, the food garden in an urban setting has many additional advantages over exclusive dependence on other means of food procurement, both at the family level and at wider societal and national levels, since it:

- utilizes marginal (urban) space;
- utilizes marginal labour (mainly female) not readily employable otherwise;
- draws on present knowledge and practices;
- produces considerable amounts of food where the highest concentration of consumers is found;
- reduces dependence on unstable and high-priced market goods;
- utilizes existing scarce infrastructural and natural resources;
- provides fresh vegetables, staples, and fruit as well as animal protein not available otherwise, thus improving nutritional standing and changing consumption habits;
- provides petty cash through neighbourhood sale of surplus produce;
- offers the possibility of self-help action, thus having positive economic, nutritional, and psychological benefits;

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- reduces dependence on free food, thus helping governments reduce imports and save scarce foreign exchange for other national needs; and
- benefits not only physical health but also psychological well-being by providing a measure of nutritional security and improving the urban environment aesthetically.

Lima is historically known as the "Garden City" [10]. Judging by the lack of greenery today (except in the more affluent suburbs), one cannot help but wonder how this appellation came about. Gardening on the Peruvian desert coast is not an easy task. Except in river deltas, such as the Rimac and Chillon in the case of Lima, the substratum is sand, often considerably saline, and all efforts at cultivation depend on the presence of (non-saline) irrigation water – something that poses a particular problem for the "young towns" or slums. For the slum inhabitants, whose huts are constructed on a substratum of pure sand, poor soil is an additional impediment to the "instant" establishment of productive gardens.

City Gardens: Native Technology and Management

Low-income families in the process of establishing themselves in a Lima *pueblo joven* have to pool all their resources in order to achieve a relatively sound economic and nutritional base. Among these resources are rural skills and the determination to put them to productive use. While male family members, including boys, seek employment outside, women with small children are usually unable to find work away from home. Using no more than a spade and a hoe or mason's trowel, many female heads of household have, therefore, opted to start a small garden adjacent to the family dwelling.

The data on indigenous food gardens presented here are based on a survey of Lima low-income gardens ranging in size from a few square metres to an entire lot of 900 square metres, destined for construction in the future. Following a general observational survey of 76 gardens, 46 of these were selected for detailed study, focusing on socio-economic characteristics, garden management, species choice and variety, seed procurement, complementary small animal production, and nutritional and economic benefits.

Lima gardens often do not appear as such to the Western observer. Garden nuclei, or first beginnings, often consist of nothing more than a few corn stalks, a young banana shoot, and some herbs and flowers. Plant species correspond to vegetables frequently consumed by the household. The family garbage pile often functions as a seedbed, where spontaneous propagation from kitchen waste takes place (e.g. tomato, papaya, and Cucurbitaceae). Also, rural relatives and neighbours may supply seed.

Gardens evolve from an often insignificant patch to an average size of 200 square metres. As planting continues and increases, soil is improved slowly through the incidental and planned incorporation of plant refuse. Examples of excellent suppliers of organic refuse are banana, papaya, and pigeon pea, locally called *vainita de palo* (*Cajanus cajan*). Vegetable remains that can be fed to household animals end up as garden manure. Commercial fertilizers and pesticides are used to a minor extent, generally speaking, once the garden has matured to a size and productivity that guarantees a return on input, a must for low-resource households. Often the establishment of a garden is incidental or secondary to the growing of fodder for

A woman improves a garden in Cochahuasi on the Peruvian coast by removing the topsoil and digging in pig bedding and manure (photo by Vera Niñez)

a few small household animals, usually guinea pigs and/or rabbits and poultry, including ducks, turkeys, and chickens.

In mature gardens with water and space available, the cropping list can be quite diverse. The typical garden features tree crops (mainly banana and papaya, though avocado, mango, guava, guanabana, fig, and pacay (Inga *feuillei*) can also be found), fruit-bearing climbers (e.g. passion fruit), vegetable staples (maize, roots, and tubers), and some leaf and fruit vegetables and beans. Herbs, medicinal plants, and flowers complete the cropping list. Vegetables not native to the region and poorly adapted to the harsh tropical desert environment are only found in the larger plots of experienced gardeners or of people with field horticultural backgrounds who are provided with good soil and water.

Water is the major factor limiting urban gardening. Frequently, kitchen waste water is used for producing small numbers of plants and rearing animals. On a limited scale, extra water is purchased for gardens where metered lines are not available. The cost of water for a household and an average-size garden (10 x 20 m) in late 1983 was around US$3.50 per month. During the warmer months, water is periodically unavailable in many lower-class Lima suburbs, and gardens suffer considerably.

The food gardeners studied all belong to the lower income strata of Lima society. Thirty-two of the forty were housewives with small children or grandchildren; few of the female gardeners are gainfully employed outside the home. Male heads of household work in a wide range of lower-class occupations (cobbler, mechanic, shop assistant, truck driver, chauffeur, guard, factory worker) or are retired. The average monthly net income was slightly over US$60. None of the gardeners had learned about gardening after coming to Lima, although they claim to have gained a lot of first-hand experience since planting their own gardens. Gardening skills were often acquired in family agricultural and field horticultural production before coming to the capital, usually as a child living with parents or relatives. One main difference between male and female gardeners in Lima is that men are usually interested in capitalizing on their backyard enterprises (e.g. establishing a nursery or planting mostly fruit trees with a good market value), while women are aiming to produce food for family consumption.

The preferred location for family gardens is close to the house. In many cases, the back yards are already occupied by household animals and children, or given over to purposes other than the cultivation of plant species, which requires a relatively large horizontal area, so growing space is sought elsewhere. Tropical gardens, of which Lima urban gardens are arid examples, also utilize vertical space for food production; for example, squash, *Cyclanthera pedata,* beans, and climbers grow onto roofs and fences, providing greenery and shade in addition to food. Pigeon peas and sugar cane form natural fences in a multi-purpose arrangement. These species are also able to withstand to a certain degree human and animal backyard activities.

The expansion of protected garden areas occurs close to the house, either onto the family lot or onto public land, such as roadside areas or land earmarked for parks. This expansion of vegetation, especially trees, is encouraged by *pueblo joven* municipalities, who regard such efforts as free beautification projects by citizens in the absence of municipal funds. However, families who expand their food production ventures onto public land have no tenancy rights, which is of great concern to gardeners and a definite constraint to increasing urban household food production.

Economic and Nutritional Benefits of Lima Gardens

The economic and nutritional benefits of sample gardens were assessed for two growing seasons. Seventy-six gardens were visited twice during a nine-month time-span, beginning in August 1983, in different low-income suburbs and neighbourhoods. Forty gardens were studied in detail employing the methodology described below:

- the garden area was measured and crops were observed with attention to the physiological condition of plants and production potential during the growing season;
- information by gardeners on labour requirements was recorded;
- gardener information on amounts harvested, participant observation, and weighing were used when feasible to establish yields;
- comparable purchased or otherwise obtained produce was used for checking weight;
- a control garden was established under similar conditions by the investigator.

Garden economic benefits were calculated by comparing market prices for garden produce, using weight, unit, or standard sales unit, such as *atado* or bunch. Nutritional output was measured using weight estimates and the known weight of harvested produce, and calculating its nutritional value from the INCAP/ICNND (1961) food composition tables for Latin America (cf. table 1). The resulting quantitative information gives us an insight into an average Lima food garden:

- size: 200 m^2
- daily labour requirements: 50 minutes
- capital inputs: US$2.80
- growing season: 5 months
- economic benefits: US$28.33

(Daily labour requirements include soil preparation, planting, cultivating, watering, and harvest activities.

Capital inputs were calculated for one growing season and include chemical fertilizers and pesticides, seed, fencing material, and water. Extensive soil improvers, if purchased, were not counted but considered a long-term investment.)

Removed from their socio-economic context, these figures do not strike the outside observer as spectacular enough to warrant major promotional involvement. However, when seen in relationship to the household economies these gardens serve, their real significance appears. Over five months, earnings for the average family amount to an average US$300. Garden produce adds an indirect income of almost 10 per cent, not counting the convenience of having a ready supply of basic foodstuffs and/or animal fodder.

This corresponds very favourably to information for developed-country garden return, where capital is more readily available for garden inputs and a better garden infrastructure [5; 18, p. 197]. A 10 per cent increase in earnings helps considerably in Peru's continuing struggle against increasing prices and monetary devaluation. At the macro-level, the cumulative benefits of seemingly insignificant household gardens are staggering. Calculated on the basis of this average garden, an annual US$56,660,000 of food could be produced by the larger metropolis if, out of the seven million inhabitants of Lima, one million families were to plant only a small food garden.

The nutritional benefits of Lima household gardens can be stated in terms of higher-quality carbohydrate sources, decreased loss of nutrients through freshness, and increased consumption of fruits and vegetables not otherwise available due to high prices, especially as regards tropical fruits from eastern Peru (table 1).

Contemporary Lima "native" food gardens are thus – in terms of capital, time, and technology – low-input production systems which, none the less, yield a considerable amount of plant and animal food in an environment where no other form of food production is possible and where nutritionally high-value food categories are high-priced and have fostered unsound consumption patterns. The value and extent of present urban food production in urban Lima should not be discounted by nutrition-oriented garden programmes because they do not conform to the textbook image of model gardens.

HOME GARDEN CAMPAIGNS IN LIMA: WORKING AT HALF-POTENTIAL

Functional household-garden technology that is ecologically and socio-economically adapted to the locality has not been a part of applied home garden projects in Latin America. Seemingly operating in a vacuum, programme design is based mainly on temperate-climate models and fads (such as the French intensive method and the raised-bed method), which are often maladapted or totally inapplicable to local ecology and target population socio-economics. National and international institutions attempting to promote urban family food production among Lima's poor display an extraordinary similarity in approach and methodology, and a lack of technology transfer.

Project Analysis: No Return on Investment

Several years ago a Catholic agency began a family food production project in a recently established Lima slum while inhabitants were in the process of replacing straw and lumber shacks with modest brick buildings. Infrastructural facilities (including water) were lacking. The project appropriately advocated water-conserving container production of leaf vegetables. For several reasons – the newness of the idea of producing vegetables in wooden boxes, a choice of species not essential to customary diet, the high price of lumber, the competition between containers and construction for lumber and water, and inopportune timing – the idea did not catch on, despite the fact that containers are generally used to raise seedlings. Disillusioned, the agency gave up and has not since attempted another project in the city slums.

A locally represented private international food and nutrition institute also worked with the "box-method." The institute's worldwide audience are middle-class organic hobby gardeners who wish to produce their own food for ideological and health reasons rather than seeking to supplement income or improve family diet by household-level food production. Followers of this philosophy are willing and able to invest in their gardening ventures in order to harvest small amounts of leafy vegetables and herbs usually associated with temperate gardens and most of which are care-intensive under local ecological conditions.

Despite its middle-class orientation, however, the institute has made a considerable contribution to low-income gardening programmes because of the availability of its textbook and slides, which have been used by two agencies, one foreign and one Peruvian, and presented to *pueblo joven* residents. In the process, school and community model gardens have been established.

The foreign agency contracted the institute to present its gardening course to schoolchildren in a low-income neighbourhood. A school garden was established, and the experience of the students with home gardens proved to be superior to the instructions they received in the course: some students built terraces on the sloping terrain

chosen for the garden, others opted for "sunken beds" rather than the raised-bed method. Under conditions of irregular watering and poor soil, the crops of the students who followed traditional methods fared better than those of students who followed course instructions.

The community gardens were planted in conjunction with newly built day-care and women's instruction centres in *pueblos jovenes*. An estimated 70 per cent of instruction content was taken from the institute's course. Soil preparation, however, was insufficient for species ill-adapted to sandy, in some locations highly saline, growing conditions with little irrigation water available. Assistance was not continued beyond garden installation, although produce from the gardens was supposed to provide vegetables to supplement the "aid" food supplied to day-care centres and, eventually, to bring income to the community through sales.

Six months after installation, these community gardens had dried up. In the case of one community, the people themselves had no interest in maintaining the garden without assistance, as the day-care centre also served children from a neighbouring but disliked settlement. Also, the difficulty in obtaining seed for the species promoted, the poor quality of small packaged amounts, and the cost discouraged the community from continuing with the garden.

The reason for the failure of communal programmes least considered by promoters is the artificial nature of the main vehicle used to put garden programmes into operation: the *club de madres* or mothers' club. A remnant of Peace Corps work in Peru, mothers' clubs function, with much internal conflict, for the duration of "aid" programmes, and have no roots in the community structure.

Garden Acculturation: The Evolution of a Project Garden

The community of Llanavilla, a Lima suburban low-income housing development, hosted two home garden development projects in a twelve-month period from 1983 to 1984. The first project was not rewarded either by transfer of the technology from the model garden site to individual homes or by continuation of the model garden. The second has met with more success owing to more thorough preparation and some follow-up by technical personnel.

The programme was initiated with an experiment in innovative energy production that could possibly be adapted to the low-income situation. A biogas plant was established on government grounds adjacent to Llanavilla. On a selected garden spot within the compound, a gas by-product was mixed in a 50:50 ratio with the sand substratum, and a model garden was planted by collaborating technicians from the Agrarian University. Species represented were urban, field-horticultural crops in straight-row, raised-bed arrangements, mono-cropped or with two species to a bed, with no regard for plant-symbiotic relationships.

An identical garden was planted on community land at the same time and with the same layout and cultivars. Labour, expenses, and technical assistance were provided. Active community participation in any production-related activity was minimal to non-existent.

After two short seasons of fast-maturing vegetables (radishes, chard, lettuce, zucchini squash, beets, green onions and tomatoes), programme supervision ceased. The programme-paid worker who regularly watered and cultivated the garden left, and the community was in control of its *huerta* (garden). Although no new planting of commercial species was undertaken, what happened provides valuable insights for the improvement of home garden programmes.

Following the second planting of short-term crops by programme technicians, community enthusiasm had risen. Members decided to extend the garden, as plenty of community land was available and the water situation had improved. This enthusiasm was in part due to a dynamic community president who was able to coerce about 20 residents into participation.

The community-initiated garden addition was double the size of the model garden, and offered a distinct picture: instead of long, 80 cm raised beds, sunken, 1 m^2 beds had been installed. By that time, the biogas plant no longer functioned and manure was hauled in. These square beds were planted with giant squash, a better adapted variety, and more widely consumed by this social stratum than zucchini. The other part of the garden addition was planted in maize inter-cropped with sweet potato and triple-cropped along the borders with peas.

The model garden plot, with programme species now fading, was also newly planted with maize, sweet potato, cassava, and rustic beans, as well as climbers (*Passiflora, Cyclanthera pedata*) and trees (banana, papaya). The caretaker of the garden by now was the custodian of the day-care and community centre, with the president and his wife showing the most individual interest in maintaining the garden and adding a guinea pig and poultry project. However, during the water-scarce months of early 1985, the garden ceased to function altogether. The lack of community co-operation coupled with scarce water resources made the project unfeasible in the long-term.

The process of garden acculturation that has occurred in Llanavilla is none the less indicative of several factors important to the success of such projects:

A garden in Cochahuasi, Peru, with a variety of crops (photo by Vera Niñez)

1. *Availability of seed:* Seed planted by the community was highland-derived (maize) or came from vegetables purchased for daily meals (*Cyclanthera* spp., giant squash, beans, tomatoes). Individuals with their own gardens furnished seed, young plants, and saplings (*Passiflora*, banana, cassava, sweet potato).

2. *Species adaptability:* Low-income gardens, whether at community or family level, must be low-input, high-output undertakings with species adapted to arid conditions, sandy and/or saline soil, and little care.

3. *Socio-economic expectations:* Gardens at this social level are not an object of leisure activity but one way in which women can add indirectly to family income while caring for house and children. Women expect to plant those foods in the garden that are required in the daily diet and not easily obtained otherwise. They will plant those fruits and vegetables or staple crops which they know will yield under their particular ecological and economic circumstances.

4. *Cultural food preferences:* Although perhaps not so important in the urban as in the rural environment, food preferences that are ingrained in traditional food preparation and consumption habits play an important role in indigenous gardens.

5. *Prevalence of staple crops:* The predominantly rural background and agricultural experience of many urban gardeners, as well as the adaptability of some important root and tuber crops (e.g. sweet potato, cassava), tree crops (banana), and maize, determines their presence in urban, low-income gardens. Their "filling" quality, i.e. their high energy value, is of major interest to housewives trying to feed a sizeable family.

6. *Cropping patterns and spatial arrangement:* Native gardens are not row-cropped vegetable gardens but mixed associations of a multitude of species producing at horizontal and vertical levels.

7. *Community orientation:* Garden projects, for strategic reasons, prefer to work via communal organizations (schools, clubs, or communities). Household-level food production, however, is a family undertaking. At the low-income economic and social level, labour, space, and time are valuable resources. If invested in basic food production, even on a small scale, they cannot be risked on the uncertain participation of a number of other individuals.

One unfortunate aspect of this programme was that families who had small traditional gardens around their homes were not considered for technical assistance or consultation during the project. Thus, while no transfer of technology has taken place from programme implementers to programme recipients, the success of the undertaking and the return on the funds invested must be sought in a reversal of the transfer process: programme designers and implementers need to accept this lesson and learn from target populations to assist and develop on-going indigenous gardening.

Home Garden Centre: Suggestions for an Extension Outreach Project

As an alternative to past and present programmes which work in isolation from target populations, each other, and the wider social infrastructure, the approach suggested here takes advantage of existing agricultural extension services by adding a home garden component and adapting the expertise of national extension officers to traditional and innovative home garden production [13]. It is also suggested that the Ministry of Agriculture establish model garden centres which combine traditional technology with functional innovations, and where home gardeners can obtain production-related inputs (including quality seed, seedlings, and soil amendments) while being served by a team of extension and garden horticultural experts. The establishment of a model garden combining old and new gardening materials and methods in a meaningful way will help prospective gardeners most effectively.

Except for "introductory gifts" aimed at creating interest

and stimulating gardeners to use the centre, inputs should be offered at cost. High-cost inputs (like compost, peat, synthetic soil amendments, and fencing material) may require government subsidies to enable low-income gardeners to buy them. Subsidies should be kept to a minimum, however, to reduce costs and avoid misuse of the programme. A number of inputs – compost, seed, seedlings, saplings, seed-boxes, and containers for growing seedlings – can be produced on the model garden grounds. Clients can either purchase these inputs or receive instructions on how to produce them.

Special "introductory offers" are preferable to "gifts," since experience shows that people tend to value things more which require investment on their part. This approach also legitimizes the centre as more than another attempt to "help the poor," a philosophy rejected mainly by the poor themselves.

To translate a theoretical home garden centre (*centro de servicio: huerta casera*) into reality in the wider Lima area, one needs to identify suitable suburbs containing already functioning gardens, however small. The underlying philosophy is that where self-help efforts already exist, a programme of this kind will be successful. Areas in which there have been few or no attempts at planting gardens should be incorporated slowly, using an "evolutionary" approach rather than the overnight "revolutionary" one so typical of past home garden campaigns.

From the centre, gardeners receive crucial information and inputs at appropriate times. Extension personnel should make periodic visits to establish a bond and an exchange of information between clients and the centre. Also, printed information and classes should be available on traditional and less-adapted or less well-known crops or technology, as should more marginal but none the less vital information on the relationship between nutrition, sanitation, and health. Depending on the success of the selected pilot projects, more centres can be established to cover the entire metropolitan area. Hand-in-hand with the formation of a garden-service network, the improvement of infrastructural facilities, especially the water supply, has to be tackled by responsible national and municipal bureaucracies in order to help create a more sanitary environment, and garden production must be stimulated through regulated allotments accessible to everyone at a set basic fee. Also, a serious, well-informed public media campaign to foster pride in family food production at many socio-economic levels will help raise national awareness and stimulate people to action.

In contrast to previous efforts at garden development, this approach is viewed as "development from below" rather than as the imposition of preconceived but not necessarily effective methods. Both programme designers/implementers and target populations need to make a serious learning effort if they are to achieve the common goal of increasing household food production and raising the nutritional standard of low-income urban families at the grass roots level.

CONCLUSION

Household purchasing power has been suggested as the most meaningful indicator of malnutrition, on the assumption that the poor do know what traditional foods and food combinations provide a satisfactory nutritional base. In this regard, applied nutrition programmes advocating mainly food supplements and subsidies have been criticized for treating the effects of malnutrition rather than attacking its underlying causes and for helping, often, the budgets of the better-off social strata more than those of the poor [11, 17].

The species on the model cropping lists provided by applied nutrition programmes tend to be relatively uniform the world over, owing to the similarity in the formal training of specialists designing programmes and the transfer of programmes from one world region to another. In many world regions, however, and especially in the tropics, culti-

A well-managed urban garden in Lima, Peru (photo by Vera Niñez)

vation in home gardens of species generally associated with temperate climates is often not feasible because of the intensive care such species require under local conditions, including good quality land, costly soil amendments, and the use of chemical pest control methods. A self-help strategy potentially invaluable for improving family nutrition thus loses its raison d'être, which is to produce at low cost locally adapted food species for immediate family consumption.

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URBAN AGRICULTURE: Who Cultivates and Why? A Case-study of Lusaka, Zambia

Bishwapriya Sanyal
Massachusetts Institute of Technology, Cambridge, Mass., USA

INTRODUCTION

Urban cultivation has become a permanent part of the landscape in many cities in Asia, Africa, Latin America, and other parts of the world [1, 14, 16, 21, 22]. This is surprising and often embarrassing to many who had envisioned the evolution of modern, industrial cities as symbols of economic development and technological progress in the developing world [3, 4, 11]. Much to the dismay of these proponents of modernization, who range from city officials to international donors, many cities in the developing world currently show growing trends towards squatter housing, street hawking and informal cultivation, none of which contributes to an appearance of modernity, well-being or technological progress. Except for some attractive government buildings, a few office towers and, at most, one or two shopping centres, cities in the developing world, even the colonial capitals, seem to many to have regressed from their earlier beautiful and orderly appearance.

The authorities in the developing world initially responded to these trends with harsh, authoritarian measures. State repression was unleashed in various forms; squatter houses were demolished, street vendors were jailed and, in the case of urban cultivation, plants were destroyed even at times of food scarcity in the cities [5]. The flexibility with which the people responded to state repression was truly remarkable: they rebuilt demolished houses within days, reformulated strategies for petty trading, and replanted seedlings, away from the view of city officials, time and time again. Hart [6], for example, cites the case of squatters in Ghana whose shacks were pulled down more than 13 times, to be rebuilt on each occasion.

Implicit in the harsh reaction of the authorities are assumptions about who cultivates and why, and about the impact of urban cultivation. Most authorities assume that urban cultivation is practised by a small section of low-income families, predominantly recent migrants from rural areas, who have not been assimilated socially, culturally, or economically into the sophisticated social fabric of the monetized urban economy. Thus, urban cultivation is considered the manifestation of rural habits – "a remnant of bush life," as Naipaul described it – that reflects ignorance of the principles of modern urban living.* In terms of impact, urban cultivation has been considered a health hazard on the grounds that it facilitates the breeding of malaria-carrying mosquitoes.** Some city authorities charged that cultivation of maize made it possible to grow marijuana hidden among the maize plants. Others have charged that urban cultivation makes illegal use of public space or simply mars the beauty of the cities [18, 20].

This article, which is based on a survey of 250 low-income housing areas in Lusaka, the capital of Zambia, demonstrates that most of the assumptions that influenced the authorities' attitudes towards urban cultivation are incorrect.*** The questionnaire used in this study was designed to acquire information about two types of urban cultivation: (i) plot gardens in the back and/or front yard, which are cultivated all year round, and (ii) rainy-season gardens, which are usually located on the periphery of the city and are cultivated only during the rainy season, since there is no other source of water in these areas.

The article comprises three parts. The first provides a very brief overview of the survey areas and reveals that nearly 60 per cent of the low-income households cultivate one or both types of garden. The second part analyses the various factors that affect a household's decision to cultivate, and demonstrates that urban cultivation is not an activity predominantly undertaken by unassimilated new arrivals but one that, in the majority of cases, is only embarked upon after a period of seven to eleven years in the city;

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* V. S. Naipaul described the African city in the following way: "When it is hot the gutters smell; in the rain the streets are flooded. And the unregulated city spreads: meandering black rivulets of filth in unpaved alleys, middens beside the highways, children, discarded motor car tires, a multitude of little stalls, and everywhere, in free spaces, planting of sugar cane and maize: subsistence agriculture in the town, a remnant of bush life" [13, p. 215].

** This was mentioned in a circular from the Health Consultative Committee of the Local Government Association of Zambia, which asked for "more authority to control the ever-increasing street vending and the cultivation of maize in residential areas" [10].

*** The survey was conducted in May and June 1980 by Zambian interviewers under the guidance of the World Bank-Lusaka Housing Project Evaluation Team. The author was a consultant for the World Bank and was based in Lusaka from July 1978 to October 1980.

TABLE 1. Characteristics of Survey Areas[a]

Characteristics	Survey Areas				
	Kalingalinga	Jack-Extension	Mutendere	Matero	Chilenje (South)
Monthly income					
– Percentage of households below K60 (US$45)	15	34	14	4	10
– Percentage of households between K60 and 150 (US$45-112)	46	44	62	46	64
– Percentage of households over K150 (US$112)	12	22	24	50	26
Plot sizes in m^2	190-210	250	324	324	290
Year settlement started	1960-1965	1978-1979	1969-1970	1979-1980	1970-1971
Distance from city centre (in km)	7	12	8	4	11.7
Access to peripheral open land (highest: 1; lowest: 5)	5	1	2	5	4
Level of services					
– Access to water	No formal water supply; use of bore	1 standpipe for 25 households	1 standpipe for 25 households	1 standpipe for 4 households	Individual water connection to each household
– Electricity	None	Along boundary road	Along boundary road	At home	At home
– Toilet	Pit latrine	Pit latrine	Pit latrine	Flush toilet	Flush toilet

a. The data on Kalingalinga, Mutendere and Chilenje are based on the Department of Town and Country Planning, *Low-Cost Residential Development in Lusaka*, report prepared by Development Planning and Research Unit (1972).

by this time most residents have been fully absorbed into the wage economy. Ten years or so is also the average time required before any investment decision, such as deciding to embark upon urban cultivation, can be made by poor urban residents, who lack both access to land and a minimum threshold of predictability of return on any investment during the first few years in the city. The third part of the article summarizes the findings and concludes with some additional remarks about their policy implications.

EXTENT OF CULTIVATION

Low-income housing areas in Lusaka are made up of five types of settlements: two types of squatter areas, one of which lacks even basic services and one which has been provided with some services; two types of serviced plots, one provided by the local authorities and the other built under a World Bank plan; and official low-cost public housing areas. For the survey, the following five areas, one from each of the five categories, were selected:

(i) Kalingalinga, an old squatter area which had virtually no services; (ii) Jack-Extension, a squatter area with some services; (iii) Mutendere, a serviced area provided by the local authorities; (iv) Matero, a serviced area constructed under the World Bank plan; and (v) Chilenje (South), a public housing area built by the local authorities. As indicated in table 1, although all the five selected areas fall into the category of low-income housing areas, they differ significantly in terms of the average monthly income of families, plot sizes, age of settlements, level of services, distance from the city centre and access to peripheral land.

Fifty households were randomly selected from each of the five areas. The selection was based on the official listing of renters in the public housing areas and home-owners in the squatter and site-and-service areas (areas that have been provided with a service, such as a standpipe for water, and then sold by the government at subsidized prices). Though this process gave a representative sample of low-income households in Lusaka, it excluded tenants who either rented rooms in the squatter and site-and-service areas or were subletting rooms from the tenants in the public housing areas. No official estimate of the number of these tenants exists, though it is generally understood that they constitute as much as 25 to 35 per cent of the low-income population of the city. Since the tenants' socio-economic profiles and relative access to land are likely to be different from those of the owners who live in the low-income housing areas, their exclusion from the survey to some extent biased the results. This caveat should be borne in mind when interpreting the survey findings.

Table 2 indicates the extent of cultivation among the residents of low-income housing areas in Lusaka. It is apparent that urban cultivation is a fairly common activity: nearly 40 per cent of the families cultivate plot gardens alone; 25 per cent cultivate rainy-season gardens alone; and 19 per cent cultivate both kinds of garden. As indicated earlier, these averages do not indicate cultivation, if any, by tenants and subrenters, who comprise between 25 and 35 per cent of the households in the low-cost housing areas. It is likely that their inclusion in the survey would have reduced the overall estimates, since tenants usually lack access to land for plot gardens. If a revised estimate were made under the assumption that the tenants are not cultivating at all, then plot-garden cultivators would be reduced to 17 per cent and cultivators of both gardens to 13 per cent. It is possible, however, that some tenants may be cultivating rainy-season gardens, and this may raise the average figures by a few percentage points.

One area that stands out in our sample is Jack-Extension. As shown in table 2, nearly 40 per cent of households in Jack-Extension, as compared to 14 per cent in other areas, cultivate both gardens. Thus, compared to elsewhere, Jack-Extension stands out as an exceptionally bountiful area, particularly since the average plot size is smaller than that of all the other areas except Kalingalinga.

One possible explanation for such an exceptional rate of cultivation in Jack-Extension is that the area received special attention from the American Friends Service Committee (AFSC), which encouraged the residents to cultivate vegetable gardens. According to Mr. Harrington Jere, director of the AFSC mission in Zambia, residents of Jack-Extension were provided with seeds and technical assistance for gardening. Some residents were also guided to good peripheral land, which was not expected to be used by the local authorities in the near future. This, of course, biases the findings of the survey to some extent; however, it also indicates that with some assistance, as provided by AFSC with a very limited budget, significant improvements in cultivation can be achieved.

To sum up, then, urban cultivation is a fairly common

TABLE 2. Extent of Cultivation

Nature of Cultivation	Percentage of Households			
	Jack-Extension	Other Areas	Total	Total (weighted average)[a]
Plot garden only	18	44	39	27
Rainy-season garden only	28	24	25	17
Both gardens	39	14	19	13
None	15	18	17	43
Total	100 (n=50)	100 (n=200)	100	100 (n=200)

a. This estimate includes tenants who live in low-cost housing areas.

activity; an estimate that includes the tenant population indicates that nearly 60 per cent of all households in low-cost housing areas in Lusaka have urban gardens (table 2). Cultivation of plot gardens is more prevalent than cultivation of rainy-season gardens, and 13 per cent of the households cultivate both types of garden.

WHO CULTIVATES AND WHY?

Contrary to common belief, urban cultivation is not practised exclusively or even primarily by recent migrants. As indicated in table 3, neither do the relative newcomers cultivate the most nor do the rates of cultivation decrease with time, as one would expect to be the case if rural habit were the primary driving force behind a household's decision to garden in the city. On the contrary, according to the findings of this study, the percentage of households not cultivating any garden at all decreases with increased duration of stay in Lusaka, while the percentage of households cultivating both types of garden increases.

This increased propensity to cultivate with longer duration of stay is, in part, the result of an initial time-lag between the migrant's first arrival in the city and his or her first garden. According to the survey, more than 60 per cent of the households who cultivated plot gardens had lived in Lusaka for more than five years before starting them; the median duration of stay before cultivation of plot gardens was 7.3 years. As for rainy-season gardens, the initial time-lag was even longer. Nearly 45 per cent of this sample did not cultivate for the first ten years of their stay in Lusaka, and around 75 per cent did not cultivate during the first five years; the median period was 10.8 years. These are considerably long periods of time, at the end of which most migrants would be fairly acculturated to urban living.

TABLE 3. Duration of Stay in Lusaka and Practice of Urban Agriculture

Nature of Cultivation	Number of Years in Lusaka and Type of Garden Cultivation (percentages)		
	0–5	6–10	10 +
Plot gardens only	52	47	33
Rainy-season garden only	12	20	31
Both gardens	13	14	23
None	23	19	13
Total	100 (n=42)	100 (n=60)	100 (n=14)

Hence the argument that urban cultivation is a manifestation of rural habits does not really hold true.

What, then, affects the patterns of cultivation? Why do some low-income households prefer to cultivate plot gardens, while others may cultivate either rainy-season gardens or no garden at all? One hypothesis is that the variations may be the result of two sets of factors that shape a household's decisions regarding cultivation. The first set is related to the household's need for cultivation, while the second involves "supply factors," such as availability of land, labour time, and financial resources, all of which are essential for cultivation.

The need for cultivation is guided by the logic of survival. The lower the purchasing power of a household, the more threatened is its survival, particularly within an exchange economy. And since purchasing power is directly related to income, we can assume that the lower the income of a household, the more precarious is its survival. As a result, the need for strategies of survival devised with extra-market means are likely to be more acute as a household's income decreases. In other words, one could hypothesize that the lower the income of a household, the higher will be its level of cultivation.

However, the actual level of cultivation by a household may not be decided by its level of need alone. The "supply factors" may be more instrumental in shaping the final outcome. The logic of the supply factors is the logic of investment. According to this logic, household cultivation may be considered a form of investment by low-income households – an investment that requires land, domestic labour time and financial resources for purchasing other material inputs such as seeds, water, and fertilizer. As an investment, the extent of household cultivation may be guided by two principles, the first demanding a certain threshold of minimum predictability of return on the investment, and the second relating to the need for maximization of return on land, domestic labour, time and financial resources, limited amounts of which are available to the households.

One factor that is expected to influence a household's predictability of return on cultivation is its duration of stay in the city. A new migrant, unsure of his or her foothold in the urban economy, is likely to be hesitant to invest in urban cultivation, the benefits of which do not materialize instantly. As one would expect, when migrants first arrive in the city they are often unsure how long they will be staying, and consequently may defer making any long-term investment. The decision not to invest may also be influenced by the migrant's lack of familiarity with the formal and informal rules of the city, which can be intimidating.

Another question that is particularly significant in influencing investment decisions about urban cultivation is access to land. Many researchers have observed that when a migrant first arrives in the city he usually lives with relatives or friends, often for months, before he finds some income-earning opportunities [7, 8, 15, 17, 19]. The migrant at this stage has no access to land for cultivation, except that he may occasionally help with garden work if his friend or relative has a garden. But the primary objective of the migrant at this stage is to search for a way of earning money, either by doing casual work at his relative's workplace, and thus learning some skills on the job, or by looking for work in other parts of the city, using information provided by friends or relatives.

After finding a job, which usually occurs not immediately but within a reasonably short period of time, the migrant may decide either to live on his own in a rented room or to share a room, or sometimes even a bed, with other renters. Since most work opportunities are usually found near the centre of the city, he may rent a room in a low-cost housing area near at hand. There is virtually no access to land even at this stage, unless the migrant is the sole renter of a house, which is very unlikely since his income is usually still very low.

After renting for a few years, the migrant, by now quite familiar with the city, may decide to look for his own house. There are at least two possible reasons for doing this: first, he may want to bring his family to the city; and, second, he may want to reduce the overhead cost of renting, which is usually fairly high [12]. Since by this time he has perhaps saved a little money, he may decide to buy a one-room mud-brick house in a squatter area at the city's edge. If he lacks the necessary capital to buy such a house and cannot borrow from other sources, he may erect a small structure in one of the unauthorized squatter areas, probably after paying a small amount to the local leader in the area [2]. In the case of Lusaka, the average migrant has another option: he may apply for a plot in one of the site-and-service schemes provided by the government. Whether he erects his own shelter, buys a mud-brick home or qualifies for a plot in one of the government-sponsored schemes, it is only at this stage that he has access to land. And, as the findings of this study indicate, by this time he may have been in the city for seven to eight years.

Once a household decides to invest in cultivation, one would expect it to try to maximize the return from it. And to maximize the return, the necessary inputs for cultivation – land, domestic labour time, and financial resources – must be used efficiently. The efficiency of input use may be guided by (i) the availability or scarcity of each input, and (ii) the competing demand for these inputs for other household activities.

The nature of competing demands in a household is expected to change with increased monetary income. One aspect of this change, particularly relevant for our understanding of the variation in the extent of cultivation, is the changes in time-use that accompany changes in income. As Linder indicated, productivity of time rises with increased income, and this leads to the re-evaluation of time by households [9]. As the valuation of time increases, households may devote less time to growing their own food and more to higher-yield production activities.

To what extent does the empirical evidence from the survey confirm or disaffirm the hypothesis that a household's need for cultivation affects its decision to cultivate and that supply factors such as availability of land, labour time, and financial resources shape the pattern of cultivation?

Household Cultivation as a Response to Low Income

Tables 4 and 5 show that 78 per cent of the households who cultivate plot gardens and 85 per cent of those who cultivate rainy-season gardens identified lack of purchasing power as the primary reason for doing so. However, it is not the only reason. As indicated in table 4, nearly 17 per cent of the households cultivated plot gardens because they either liked gardening or associated it with a settled life-style. As for rainy-season gardens, the percentage of such households is smaller: at most between 5 and 10 per cent. In other words, urban agriculture is predominantly a coping strategy adopted by households whose monetary incomes are insufficient for purchasing adequate amounts of food. To a very limited extent, however, it is also practised by households who enjoy cultivation, perhaps because of their past experiences.

A few more explanatory remarks must be made regarding tables 4 and 5. First, though the responses in both tables are grouped into two broad categories – one related to financial and the other to non-financial reasons for cultivation – there are differences in the nature of the responses within each of these two categories. The differences with regard to financial reasons are particularly important since they suggest differences in the degree of inability to pay for food, and consequently in the degree to which cultivation is essential to a household as a basic element of subsistence. For example, while 13 per cent of the households who cultivated plot gardens clearly expressed their inability to pay for food, another 10 per cent indicated that the vegetables from the garden serve as a safety net if and when these households are out of money. The need for cultivation is perhaps more acute for the former than the latter.

Similar observations can be made regarding cultivation of rainy-season gardens. While 23 per cent of the households

TABLE 4. Frequency Distribution of Household Responses regarding the Reason for Starting Plot Gardens

Household Responses	Percentage
Financial reasons	
1. Could not afford to buy vegetables	13
2. Wanted to save money; wanted to reduce expenses on food	16
3. Vegetables became very expensive	38
4. To provide my family with relish when we run out of money	10
Other reasons	
5. To eat well	1
6. We also wanted a garden like our neighbour	4
7. Got enough land in the new plot for starting a plot garden	9
8. We felt settled in the new plot	7
9. I like gardening	1
Total	100 (n=149)

TABLE 5. Frequency Distribution of Household Responses regarding the Reason for Starting Rainy-Season Gardens

Household Responses	Percentage
Financial reasons	
1. Could not afford to buy enough	23
2. Market prices are too high	23
3. Wanted to reduce expenditure on vegetables and maize	20
4. Wanted to be self-reliant for food	3
5. Wanted enough vegetables for relish	13
Other reasons	
6. We finally secured a plot for rainy-season gardens	6
7. We were given the land	4
8. We like cultivating	3
9. After we felt settled in the city, we started our rainy-season garden	2
Total	100 (n=114)

cultivate rainy-season gardens because they cannot afford to buy enough, another 20 per cent, who may not necessarily be the poorest of the poor, cultivate as a result of inflationary pressure in the economy. The impact of inflation is also evident in some other responses. According to table 4, nearly 55 per cent of the households who cultivate plot gardens do so because of the rising cost of food. As for rainy-season gardens, the corresponding households add up to nearly 50 per cent.

It is fairly evident by now that insufficient income is a primary reason for the practice of urban cultivation. But is the relationship between lack of income and extent of cultivation uniformly positive? In other words, can one expect that the lower the income of a household, the greater will be the extent of its cultivation?

The findings of this study suggest that the relationship between lack of income and extent of cultivation is not necessarily uniformly positive. As illustrated in figure 1, although cultivation of rainy-season gardens steadily increases with decreasing income, cultivation of plot gardens behaves more erratically. In fact, the rate of cultivation of plot gardens is lowest among the poorest group. However, households with no gardens are also least prevalent among the poorest group.

Hence, though insufficient income clearly stands out as a primary reason for urban cultivation, it is not the only factor that affects the nature of cultivation by low-income households. Earlier, it was suggested that "supply factors" might also be significant, and it is to the analysis of these that we turn next.

Urban Cultivation: A Reflection of Household Investment

A household's decision to cultivate is also its decision to invest its resources. And as an investment, households are likely to prefer plot gardens over rainy-season gardens for at least four reasons. First, security of tenure is more assured for residential plots than peripheral land in the city over which households have very little control. Second, since rainy-season gardens are far away from home – on average, 40 minutes' walking distance there and back – they not only require more time expenditure but are also relatively less safe for female household members.* Third, the practical impossibility of irrigating rainy-season gardens limits their use to certain crops and to a single season. Fourth and last, rainy-season gardens are more vulnerable to theft than plot gardens.

* In 1979 and 1980, five women who were on their way to their rainy-season gardens were reported to have been raped (personal interview with Mr. Mulenga, Branch Chairman of Mutendere, on 14 June 1980). The actual number of cases, reported and unreported, was probably higher.

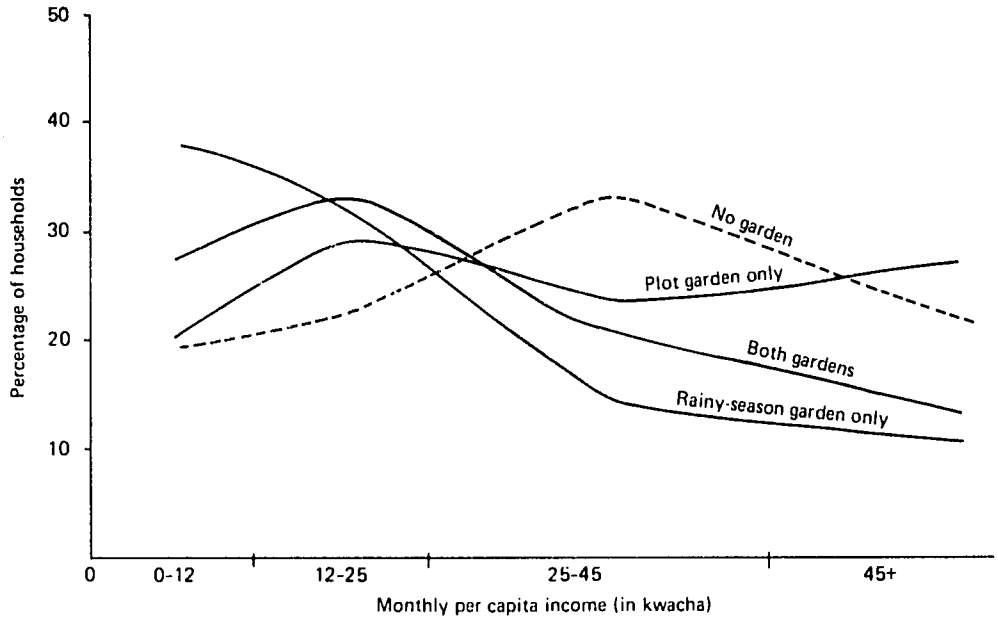

FIG. 1. Nature of Cultivation by Per Capita Income (1 kwacha = US$0.75 in 1980)

All households, however, may not have the option of choosing between the two types of garden. For example, households who live on plots too small to grow anything in may need to cultivate rainy-season gardens more frequently than those who live on relatively larger plots, since the latter are free to opt for plot gardens instead. Moreover, even if a household cultivates a relatively small residential plot, there may be so little produce from the garden that the household also needs to cultivate a rainy-season garden. Since low-income households usually reside on quite small plots, a higher percentage of them may need to cultivate rainy-season gardens or both types of garden. On the other hand, households who reside on fairly large plots and cultivate plot gardens may not need to cultivate rainy-season gardens as well because their income is usually higher.

There is evidence that suggests that this proposition may have some merit. As indicated in table 6, there is a significant correlation between the rank order for plot size in the five survey areas and the rank order for the percentage of households cultivating plot gardens in each of these areas. There is also a significant rank order relationship between the survey areas ranked by their plot sizes and median incomes. This suggests that since the poorer households reside on smaller plots, they are less likely to cultivate plot gardens than the better-off households, even if the need for subsistence production of the former may be higher. This is further supported by the finding that when households were asked why they did not cultivate plot gardens, 55 per cent replied that their plots were too small for cultivation. And of these respondents, a majority lived in Kalingalinga – the squatter area with the smallest plot sizes.

As for rainy-season gardens, it is evident from figure 1 that the frequency of cultivation decreases with rising per capita income. As indicated earlier, increased household income is expected to lead to a higher valuation of time, which is then reflected in the rebudgeting of time-expenditure with less emphasis on lower-yield and more on higher-yield production activities. Since a rainy-season garden is usually farther from home and requires more time for cultivation than a plot garden, it is not surprising to observe the pattern of cultivation documented by the survey.

The household responses regarding the reasons for not cultivating rainy-season gardens also confirm the hypothesis. Nearly 30 per cent of the households indicated that they had not even looked for a plot for a rainy-season garden; and 65 per cent did not find land either adjacent to their residences or nearby. In other words, the first group of households was not willing to spend any time cultivating rainy-season gardens. As for the second group, the time-expenditure that would have been required for cultivation of rainy-season gardens farther away from home outweighed the expected benefits from it.

Patterns of Cultivation: A Reconfirmation of Rational Investment Decisions

We have observed so far that variations in the extent of cultivation are the outcome of rational investment decisions

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TABLE 6. Rank-Size Distribution of Survey Areas

Survey Areas	Rank in Terms of Plot Sizes	Rank in Terms of Median Monthly Income of Households	Rank in Terms of Percentage of Households Cultivating Plot Gardens[a]	Rank in Terms of Percentage of Households not Cultivating Rainy-Season Gardens	Rank in Terms of Distance from Peripheral Land[a]
Matero	1.5	1	3	1	1
Mutendere	1.5	2	1	3	4
Chilenje (South)	3	3	2	2	2
Jack-Extension	4	4	4	5	5
Kalingalinga	5	5	5	4	3

a. The distance from the centre of town for each survey area may not be inversely proportional to the distance from nearest peripheral land. For example, though Kalingalinga is nearer to the city centre than Chilenje (South), it has relatively more access to peripheral land.

by low-income households who may prefer plot gardens to rainy-season gardens. To what extent does this preference affect a household's decision regarding the types of crops grown in both gardens? One hypothesis is that since low-income households in general try to maximize the return from their investment in cultivation, they tend to cultivate plot gardens more intensely than rainy-season gardens. Moreover, households will be expected to cultivate higher-grade vegetables in their plot gardens since these vegetables require relatively more input investments in terms of time (for tillage, tending and protection of plants from insects and disease), irrigation and fertilizers, all of which are less expensive to provide near one's home. In terms of return on investment, plot gardens will also be a logical choice for high-grade vegetables because not only will the produce be more accessible for immediate use, but it will be less vulnerable to theft than if cultivated in a rainy-season garden. Conversely, rainy-season gardens are more likely to be used for cultivating lower-grade, weight-reduced crops (particularly the type that requires more space and less care) and are less likely to be sanctioned by city officials.

The responses to our survey questions concerning the kinds of crops cultivated confirm this hypothesis. As table 7 indicates, plot gardens are used not only for different types of crops from rainy-season gardens, but also for higher-grade vegetables such as rape, tomatoes, cabbage, onions, spinach and fruits; weight-reduced crops such as maize, beans and groundnuts are grown primarily in rainy-season gardens.

The household responses regarding the reasons for the pattern of cultivation further verify the hypothesis. Nearly 40 per cent of the households mentioned that they grow tomatoes, rape, cabbage and onions near home because they require regular watering. Thirty-two per cent mentioned that vegetables and fruits are less susceptible to theft if grown in plot gardens. And 14 per cent said that it

TABLE 7. Kinds of Produce from Plot Gardens and Rainy-Season Gardens

Produce	Percentage of Households[a]	
	Plot Gardens	Rainy-Season Gardens
Maize	4	99
Ground-nut	–	59
Beans	7	72
Tomatoes	60	2
Rape	90	15
Pumpkin	11	50
Sweet potato	9	19
Cabbage	34	–
Cassava	5	–
Onions	26	–
Spinach	9	–
Okra	2	4
Banana	16	1
Other fruits (mangoes, papaw, guava)	19	–

a. Each column adds up to more than 100 per cent because one household may cultivate more than one type of vegetable.

is convenient to grow vegetables and fruit near home because they can be picked at any time. Five per cent of the households indicated that fruit trees also provide shade for outdoor activities.

As for rainy-season gardens, 77 per cent of the households said that they cultivate maize on the periphery of the city primarily to avoid harassment by city officials who have repeatedly slashed down maize plants in the past. Other households mentioned reasons such as "lack of space in plot gardens" or "everybody grows maize on the periphery."

With regard to cultivation of beans, groundnuts, and pumpkins, nearly 60 per cent of the households thought that rainy-season gardens offer more horizontal space, and 27 per cent that beans and groundnuts are sturdy plants and require less care than tomatoes and cabbage.

SUMMARY AND CONCLUSION

Contrary to the official view that rejects urban cultivation as an irrational activity by a small group of recent migrants who have yet to be integrated into the urban environment, urban agriculture is an innovative response by a majority of the urban poor, who are fully entrenched in an urban economy that currently lacks the capacity to provide them with sufficient real income.

Though insufficient income is a primary reason, it is not the only factor affecting a household's decisions regarding cultivation. Low-income households consider urban cultivation as a form of long-term investment that requires a minimum threshold of predictability of return on the investment. To be sure of this return, most households must decide to live in the city on a permanent basis and gain access to land, which usually requires seven to eleven years of urban residence.

Once the decision to invest is made, variations in the pattern of cultivation among households result from relative differences in access to land and the need to maximize the return on domestic labour time, the opportunity costs of which vary with household income. Variations in the pattern of crops between plots and rainy-season gardens also occur as a result of rational decisions by households to maximize the return on land at two different locations.

The policy implications of these findings are at least threefold. First, since urban cultivation allows urban workers to survive with insufficient monetary income, not only should the harassment of cultivators be stopped but efforts should be made to encourage cultivation, particularly since the opportunities for these workers to increase their monetary income, at least in the short term, are minimal.* Second, one sure way of encouraging cultivation is to provide assurance to low-income households regarding the return on their investment. This would involve ensuring that they have access to land through the granting of legal titles, either for renting, leasing, or owning land. Third, there is scope for further increases in the productivity of rainy-season gardens, for instance by providing better access to the peripheral areas and taking some measures to reduce the theft of produce.

To be sure, bringing about changes in official attitudes towards urban cultivation and formulating new policies to encourage it are not easy tasks. There are interested social groups who benefit from the rising price of urban land, and they are bound to object to policies which will not contribute to property inflation. It is hoped that this article will at least help explode some of the myths about urban cultivation that are currently used to legitimize the arguments of these interests.

* Even if income were increased through some form of minimum wage legisiation, most of the benefit would probably be neutralized by the increase in the inflation rate that is bound to result from higher wages.

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THE TROPICAL GARDEN AS A SUSTAINABLE FOOD SYSTEM: A Comparison of Indians and Settlers in Northern Colombia

Florence Pinton
International Centre for Environmental Research and Development (CIRED), Paris

INTRODUCTION

Development efforts directed at shifting cultivation economies throughout the world have often been based on the premise that shifting cultivators regularly suffer months of food shortages and consequently severe periodic malnutrition. In addition, since shifting cultivation is based on small-scale subsistence-oriented exploitation of garden-like fields with mixed cropping and an abundance of different species growing vertically as well as horizontally, it has not been taken seriously or understood by field agriculture-oriented governments.

Frequently, official efforts are made to restrict the movement of shifting cultivators in order better to incorporate them into national societies and economies. These efforts usually go hand-in-hand with government-supported colonization by agriculturists, reducing the land area available to shifting cultivators. The result of thus disrupting a traditional production system can soon be periodic or permanent underproduction and underprovision. At the same time, open-field agricultural exploitation strategies can destroy the precarious tropical forest ecological balance, rendering cultivation uneconomical after a short period of diminishing production with increasing inputs. The end effects are two disrupted societies, culturally and economically, and a tropical forest set on a downward spiral.

This article describes the situation in Colombia's province of North Santander, where native American Indian populations are faced with a changing life-style due to colonization efforts promoted by the Colombian Government. The Bari Indians' traditional food production system is compared with: (i) their present deteriorating economic and nutritional situation, (ii) the agricultural system introduced by settlers, and, (iii) the case of more successful adaptation by a neighbouring Indian population. In conclusion, suggestions applicable to similar situations in other tropical regions are offered for the improvement of the nutritional and social situations of both the Bari and the settlers.

THE SETTING

The tropical forest region of Catatumbo in north-eastern Colombia is presently characterized by two distinct societies: the *colonos* (settlers), landless peasants who entered the jungle region following the 1960s agrarian reform, and the native Bari Indians. These two groups perceive and relate differently to the same environment, representing two opposing techno-economies: field agriculture and semi-nomadic shifting cultivation.

Around 1772, the Bari came into contact with missionaries, who adopted the indigenous cultivation system, introducing some plant species and domesticated animals. Early descriptions by missionaries mention plantains, sugar cane, cassava, pineapple, cotton, and chillies being cultivated in Indian "tropical kitchen gardens."

By the time of independence and the expulsion of the missionaries, however, the Bari had adopted only a few Spanish words and tools to facilitate their traditional way of life. They continued a communal life-style centred around small family groups of 50 to 80 individuals sharing collective houses. Each extended family controlled its own "fire" and garden, although labour-intensive tasks were performed collectively (e.g. clearing of new forest land and hunting and fishing). The collective house was located in the centre of the horticulturally exploited area, and each house controlled a region of up to three kilometres in radius. Depending on soil fertility, the house and community moved every 12 to 15 years to a new location within the larger area inhabited by the Bari.

New contact with non-selvatic populations ensued with the 1910 oil explorations, which also brought settlement and agricultural exploitation to the jungle. During the 1960s,

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The research underlying this article was conducted during a 12-month period in 1983 and 1984, during which time the author lived in the Catatumbo region and shared the daily lives of both Indian and settler families. Her major focus was the economic position of women, family nutritional status, and food production and consumption in both societies.

colonization was intensified, and the physical and cultural demise of the Bari accelerated because of the restriction of their food production system, epidemics, and forced settlement in nucleated villages.

The settler approach to economic and social survival in the jungle was totally different from that of the Indian. Being of peasant origin from higher altitudes, settlers had a mentality of exploitation rather than of long-term colonization of the tropical forest, which was perceived by them as inexhaustible. Coming from different ethnic backgrounds, settlers failed to form coherent social units with reciprocal relationships. Settler families have continued to trade with a far-off national society and economy; they depend on outside markets for the sale of their products and the purcha[illegible] cultural inputs, as well as for food to supplement cassava and maize, which they need because they never learned to balance their diet with locally available species.

THE BARI FOOD SYSTEM

The basis of the Bari economy is the forest garden worked mainly by women. Men in traditional Bari society are responsible for fish and meat procurement, as well as the more energetic agricultural tasks. The collective house is surrounded by a strip of ground devoid of vegetation, followed by a fringe with climbers and creepers, sweet potato, and barbasco. Along this cultivation belt are cotton, sugar cane, and chillies, followed by manioc fields intercropped with numerous minor cultigens. Banana clusters occupy the exterior margins, marking the tropical forest border.

Thus a gradual change in the size of the vegetation can be observed between the house location in the centre of the cultivated area and the surrounding jungle. The plot exploited by each family is an extension of their part of the collective house. However, one family's gardens do not appear to be separated from those of other families. Less than one hectare in size, the garden assures each family unit permanent economic equilibrium.

Garden space is selected in areas of primary forest. The plots (*chacras*) around the houses are divided up in such a way that intermediary zones of virgin forest remain between the individual parcels. The plots are small and dispersed, which makes them less vulnerable to ants and predators. These patches of virgin tall forest also provide shade, which keeps the soil temperature relatively low and thus helps to retard bacterial and fungal growth. The gardens in each *bohio* (settlement) are proportionate to the number of adult women and the productivity of the soil, which depends in part on the altitude. Cutting, clearing, and burning are done collectively by the community, while cultivation and harvesting are mainly carried out by women and children.

The Bari spread their production over three successive fields at two-year intervals. When a parcel returns to secondary forest, the perennials planted previously continue to be harvested. A Bari cultivator can thus find himself in any one of three food-producing situations:
- collecting residual perennial species from a former garden now lying fallow;
- harvesting the parcel under production;
- preparing a new parcel.

Each parcel has a productive period of four to five years, followed by a short fallow period of three years. Then a second cycle begins, after which the area is abandoned and the collective house moved to a new region with primary forest.

The main food items produced and consumed are cassava and plantain. Cassava covers around 80 per cent of a cultivated area. However, cassava fields are inter-cropped throughout with other roots – sweet potato and yam (*Dioscorea trifida*) – and sugar cane, peppers, and cotton along the margins. Finally, there are some pineapples and watermelons. The transition from shifting garden to field is thus gradual; the Bari do not perceive the two as separate.

About once a week, according to family needs, women harvest cassava, which is usually eaten boiled. A daily consumption of 1.8 kg is estimated per person. Members of the Musa family are collected green and stored in the house until ripe. Five varieties of Musa are cultivated: two types of cooking bananas and three sweet varieties, which are eaten between meals. The average consumption varies between 0.5 and 6 kg per capita, depending on availability and total food choice. Qualitatively important is the cultivation of associated minor crops (chillies, sugar cane, sweet potato, and squash).

In addition to cultivated species, a wide range of collected plant and animal foods is added. Of these, approximately 15 species of palm are the most important. The most frequently consumed animal foods are crustaceans, molluscs, reptiles, frogs, and larvae. Collecting activities, although seemingly insignificant, add a considerable source of regular protein to the Bari diet, and also provide a certain security in times of low yield from cultivated plots. Likewise, as hunting and fishing are seasonal activities, gathering of protein-rich plant and animal food sources helps bridge the seasonal gap in dietary protein supply. Protein is perceived as an important dietary ingredient and the Bari, like shifting cultivators in other parts of the world [6], will temporarily abandon other activities in order to obtain extra protein.

The key to successful adaptation and sustained exploitation

of the tropical forest ecosystem is the diversification of resources. Bari society has achieved a food production technology and food procurement strategies that are fully compatible with their environment while providing balanced nutrition and utilitarian household items. It is difficult, therefore, to support the thesis that the Bari suffer months of acute food shortages. The research done for this study indicates that, although varying in composition, the traditional Bari diet is balanced and sufficient throughout the year.

The shifting garden is a place for food production as well as social interaction and collaboration. Integrated perfectly into the sylvigenetic cycle, the forest garden appears to give a high return on energy [1]. Daily energy intake is derived mainly from tuber crops and starchy fruits. The need to gather, hunt, and fish to supplement the diet is not indicative of limitations within the shifting cultivation system but rather symptomatic of a general weakness of agricultural production, which fails to supply all essential nutrients.

THE SETTLER ECONOMY OF CATATUMBO

The settler society centres on small-scale agriculture, oriented toward market production of commercial crops. Settlers utilize simple technology — such as the slash-and-burn method and hoe cultivation — to transform the natural ecosystem. In contrast to the native population, settlers live and work in isolated family units and depend on hired help for labour-intensive tasks. Settler families find themselves on the margins of the national economy and the labour market, while depending on both. Meanwhile, their means of production are greatly weakened by the absence of both appropriate production technology and an immediate frame of social reference and co-operation. In contrast to Bari society, settler society has a strict sexual division of labour that places the burden of agricultural production, as well as the marketing and fishing activities, mainly on the men, while women are in charge of domestic tasks.

The agricultural system of the settlers has brought about a systematic deforestation and destruction of the natural ecosystem. As population pressure is high, the production area available to each family is insufficient to allow a fallow period during which secondary forest can become re-established. Holdings are divided between space for home consumption (0.5 to 10 hectares) and market production (0 to 80 hectares). The size the cultivated surface depends on socio-economic factors, on the extent of production for the market, and on the labour force available. Food production for home consumption is considered an "act of survival." With the progressively lower yields due to soil depletion and erosion, labour becomes increasingly intensive and prohibits the achievement of a favourable balance between energy expenditure and return.

Settler subsistence agriculture is limited largely to cassava, cooking bananas, and sugar cane produced in monocultures. Small livestock — poultry and pigs — furnishes eggs and meat on an irregular basis. Despite poor pastures, livestock production along with cocoa are market-oriented enterprises supported by the Columbian Government. Other than basic subsistence foods and market products, the production of minor cultigens capable of providing a balanced diet is neglected. Kitchen gardens, traditionally kept by settler women in their places of origin, have disappeared in the jungle, although women are conscious of the danger of malnutrition, especially to children. Not knowing how to supplement their children's diet through locally grown species and tied to seasonal income from their cash crops and processed foods, they are forced to wait until their husbands provide funds for purchased dietary supplements.

Theoretically, substitution of market production for subsistence production should enable the settlers to provide a balanced family diet through the purchase of foods. In this case, however, there are infrastructural deficiencies in the marketing and transport systems which fail to supply remote areas regularly and at prices affordable to farmers, who face a continuing decrease of productive potential and thus of purchasing power.

A number of adverse factors have worked against the settler families, placing many of them in a situation of poverty. Prominent among these factors has been a limited understanding of the ecology of the tropical forest in terms of crop production. Settlers have intensified their labour efforts without a higher return, in the face of a deteriorating environment. They live in isolated family units dependent on often unaffordable or unavailable wage labour for agricultural chores while women remain unproductive. Nutritionally, they are growing dependent on irregular and expensive external food supplies owing to lack of knowledge about how to balance their diet with locally available plant and animal species; at the same time they are depleting their valuable natural resources. In comparison to the Bari, who traditionally obtain their food from various sources as much as possible, settler families have minimized their chances of survival in a delicate forest ecosystem, tied as they are to a remote market economy of which they are only marginally a part.

Paradoxically, the Colombian development project for the Bari (INDEC/INCORA) is aimed at involving them in field agriculture, participation in the market economy and resettlement in villages. As a result, the Bari have become dependent on a cash economy, and their nutritional balance has suffered.

A MODEL FOR DEVELOPMENT: THE BIRINKAIRA INDIANS

Some relatively isolated indigenous populations have escaped the destruction of their social and agricultural traditions and also managed to incorporate, to their advantage, certain traits of modernization into their culture. The Birinkaira, for example, have been able to add marketable species to their traditional cropping list while continuing to harvest forest, fallow perennials, and garden. They have successfully integrated maize, cocoa, and beans into their layered forest gardens. No substitution or interruption has taken place, as this cash crop production has remained on a small-scale.

Also, by introducing these new crops into the family garden, women are not excluded from their production, although men take care of the marketing. The family group is in charge of its own production, while collective tasks are still carried out communally by the *bohio*, thus preserving basic community structure. The forest garden remains an important place for subsistence food production from a variety of species; subsistence remains the major focus of production, although the sale of some products allows access to manufactured items.

CONCLUSION

Today, both Indians and settlers face the same problem: reduced fallow which does not permit maintenance of soil fertility. Still, a crucial difference between the agricultural systems of the two societies remains. The indigenous method of exploiting the tropical ecosystem through the household garden and associated multi-cropped shifting fields can be classified as a food production system that is self-supportive and capable, within limits, of adaptation to new economic environments. The colonist approach, however, cannot be regarded as a starting-point for a long-term food production strategy. It must be seen as a negative example with no future.

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THE CHAGGA HOME GARDENS: A Multi-storeyed Agro-forestry Cropping System on Mt. Kilimanjaro, Northern Tanzania

E. C. M. Fernandes, A. Oktingati, and J. Maghembe
International Council for Research in Agroforestry (ICRAF), Nairobi, Kenya

INTRODUCTION

The Chagga are Bantu speakers descended from various tribes who migrated into the once-forested foothills of Mt. Kilimanjaro, and who began the process of transforming the native forest. Trees that provided fodder, fuel, and fruit were retained while the less useful ones were eliminated and replaced with new tree and crop species. This process is still continuing on Mt. Meru, a neighbouring mountain.

Mt. Kilimanjaro is one of the most densely populated areas in Tanzania, largely because of the ecological and economic success of the Chagga cropping system. The home gardens enable the farmer to sustain production with a minimum of external inputs, and they thus provide a good model of land use for extrapolation to other areas with similar ecological and socio-economic characteristics.

But although the Chagga home gardens are often cited as an example of model land use [1, 8], the system has not been described in any detail. This article identifies the major components, describes their interactions and management aspects, and presents an evaluation of the system's ecological stability, productivity, and sustainability.

GENERAL DESCRIPTION OF THE AREA

Geographic Location

The Chagga home gardens are found on Mt. Kilimanjaro in northern Tanzania (fig. 1). The bulk of the mountain covers about 3,000 km^2 and the highest peak is 5,895 metres above sea level. The area above the 1,900 m contour is a designated forest reserve and national park.

Biophysical Environment

The Mt. Kilimanjaro region has a bimodal rainfall pattern; 'short rains' from October to December and 'long rains' from March to May. The average annual rainfall ranges from 1,000 to 1,700 mm with marked variation depending on elevation, exposure, and aspect. Thus, Kilimanjaro gets more rainfall on its south-eastern and eastern flanks (where the Chagga home gardens are) than on its northern and western sides, which are sheltered from the wet south-east winds.

The soils in the region fall into four major groups [2]:

1. Humic nitosols and associated humic andosols.
2. Chromic cambisols and associated eutric cambisols.
3. Orchric andosols and associated chromic cambisols and vitric andosols.
4. Mollic andosols and associated eutric nitosols.

In general, these volcanic soils are fertile with a high base saturation and cation exchange capacity. A major limitation is the steep slopes which prevent mechanization and require substantial erosion control work. Other limitations include stoniness or a shallow petrocalcic horizon.

Climax vegetation is montane rain forest. The forest varies in composition and structure along altitudinal and rainfall gradients. On the wetter south-eastern slopes, there is a zone of *Ocotea usambarensis* and *Podocarpus usambarensis*, which occurs at an altitude of 1,900 to 2,400 metres above sea level and a rainfall of 1,500 to 1,800 mm. The drier end of *Ocotea* forest sometimes grades into a forest with much *Cassipourea malosana* associated with *Myrica salicifolia*. At lower altitudes what little remains of the forest is characterized by the following species: *Newtonia buchanii, Macaranga kilimandscharica* and *Parinari excelsa*. At around 1,200 metres above sea level and 1,300 mm rainfall, species include *Albizia* spp., *Bombax schumanianum, Chlorophora excelsa, Diospyros mespiliformis, Khaya nyasica, Newtonia paucijuga*, and *Terminalia kilimandscharica*. In contrast, the drier north-western slopes (1,000 to 2,800 m) have *Juniperus procera* as the dominant species in association with *Olea africana* and *Olea welwitschii*, and sometimes in pure stands.

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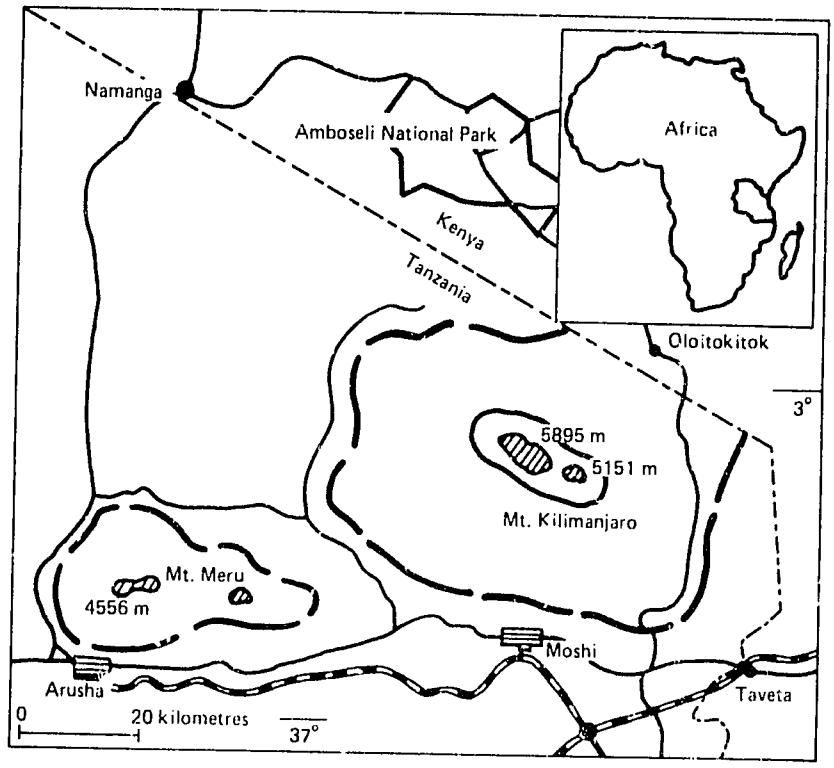

FIG. 1. Location of Mt. Kilimanjaro in Northern Tanzania

[illegible]ld-use Systems

The south-eastern and eastern slopes are characterized by intensive smallholder production of both subsistence and cash crops. Individual homesteads are densely grouped and food crops are grown under the canopies of banana and coffee. In addition, there are state-owned coffee estates and farms. The drier northern and western slopes are used mainly for extensive grazing by the Masai.

Major plantation species are *Cupressus lusitanica* and *Pinus patula*, of which there are about 3,000 ha in the west and 3,500 ha in north-eastern Kilimanjaro. The Forestry Department carries out various silvicultural operations in natural forests to encourage the regeneration of root suckers of *Ocotea usambarensis, Podocarpus gracilior, Podocarpus milanjianus* and *Juniperus procera.*

The intensive cropping system of the Chagga involves the integration of several multi-purpose trees and shrubs with food and cash crops and livestock on the same unit of land. Within this cropping system several agro-forestry practices can be identified, including the use of multi-purpose trees and shrubs:
- to provide shade for coffee,
- as live fences,
- for fodder and mulch production,
- for bee forage, and
- for anti-pest properties.

STRUCTURE OF THE SYSTEM

The Chagga home gardens (*vihamba*) cover about 1,200 km^2 (120,000 ha) on the southern and eastern slopes of Mt. Kilimanjaro. Recent estimates indicate that the southern slopes have a population density of 500 per km^2 and an annual population growth rate of at least 3 per cent. Marketing facilities are fair. Moshi town (fig. 1), the nearest major market, is linked by a good road with Arusha, Tanga, and Dar es Salaam.

The home gardens are located mainly between 900 and 1,900 metres above sea level. In addition, each family has another plot (*kishamba*) 10 to 16 km away in the drier plains below the southern and eastern slopes. The *kishamba* has only very few trees and is used mainly for growing annual crops.

Components of the Home Garden

Banana (*Musa* spp.), beans (*Phaseolus vulgaris*), cabbage (*Brassica oleracea*), cow pea (*Vigna unguiculata*), chilli (*Capsicum* spp.), eggplant (*Solanum melongena*), maize (*Zea mays*), onion (*Allium cepa*), potato (*Solanum*

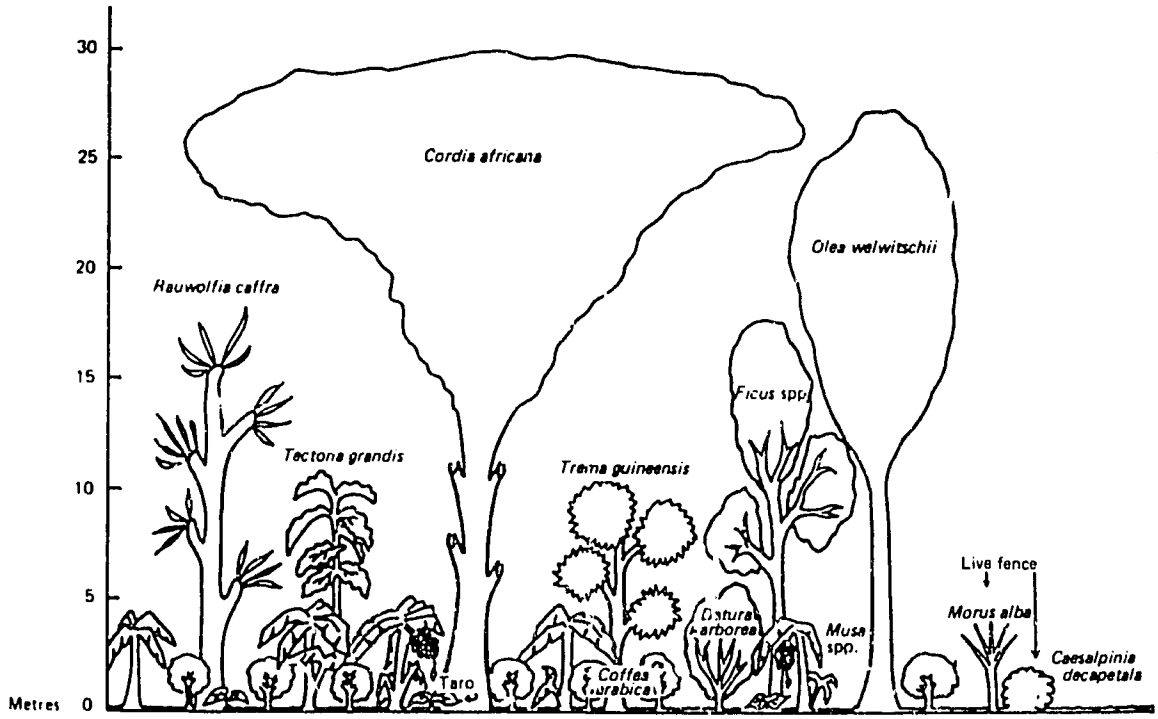

FIG. 2. Typical Vertical Zonation in a Chagga Home Garden

tuberosum), sweet potato (*Ipomoea batatas*), taro (*Colocasia* spp. and *Xanthosoma* spp.), tomato (*Lycopersicon esculentum*), and yam (*Dioscorea* spp.) are food crops grown in the home garden.

Coffee (*Coffea arabica*), cardamom (*Elettaria cardamomum*), surplus bananas and other food crops are sold as cash crops. Women are responsible for marketing the surplus bananas, vegetables and milk, and they keep the proceeds. Men get the money from coffee, poultry, and egg sales.

There are at least 15 different types of banana grown in the home gardens, including cultivars for food, brewing, and fodder. In addition to the fruit, the leaves and pseudostems are also used for fodder while the stem sheaths and dried leaves are used as mulch for coffee bushes.

Although a little maize is grown in some home gardens, the bulk of the crop is grown inter-cropped with beans on the lowland *kishamba*. Finger millet (*Eleusine coracana*), an important crop used for brewing and making porridge, is also grown in the lowlands.

Chagga farmers grow numerous species of trees and shrubs in home gardens. Table 1 gives an idea of the different species and their uses. The men are responsible for lopping the fuel and fodder trees while the women harvest the fodder grasses and herbs.

Cattle are kept for milk, while goats and pigs are reared for meat, either for sale or home consumption. Recently some farmers have started keeping improved cattle; the more popular breeds are Fresian, Jersey, Ayrshire, and crosses between these and local breeds. Farmers on average have three cows, two goats, and six chickens [7]; in some cases a pig is also kept. Livestock are stall-fed with fodder from trees and shrubs, banana plants and grasses grown on the homestead. Supplementary fodder is harvested from the *kishamba* in the plains or bought at Tsh 20* a headload (30 to 50 kg).

The spatial arrangement of components is irregular and looks very haphazard, with the trees, shrubs and food crops closely intermingled. Vertically, however, several distinct zones can be distinguished (fig. 2). In terms of canopy depth, the lowest zone (0 to 1 m) consists of food crops like taro, beans, and fodder herbs and grasses. Included in this zone is the regeneration of the overstorey trees and shrubs. The next zone (1 to 2.5 m) is mainly coffee, with a few young trees, shrubs and medicinal plants. Next is the banana canopy (2.5 to 5 m) with some fruit and fodder trees. Above the "banana" layer, vertical zonation is less distinct with a diffuse zone (5 to 20 m) of the preferred fuel and fodder species and another zone (15 to 30 m+) of the valuable timber trees and other

* US$1 = 12.45 Tanzanian shillings (TSh) (January 1984).

fodder and fuelwood species. There is considerable overlap of the storeys with continuous recruitment to the various zones.

The intimate arrangement of components results in interactions between components in both time and space. The nature of interactions varies and can be:

- *direct:* fodder trees and shrubs and livestock;
  trees and shrubs and bees;
  cattle manure and crops, trees and shrubs.
- *cyclic:* crop residues and cattle.
- *competitive:* bananas and coffee;
  trees and shrubs and crops.

No data are available to indicate the magnitude of the direct or cyclic interactions. Trials conducted at the Coffee Research Station, Lyamungu, and over a part of the main coffee area on Mt. Kilimanjaro showed that bananas interplanted with either young or mature, or lightly shaded or unshaded, *Coffea arabica* significantly reduced coffee yields [9]. Other trials elsewhere showed that, provided farmyard manure was applied to the banana clumps, the yield of bananas planted at 960 stools per ha was not greatly affected by the presence or absence of interplanted coffee. Reduction of the density of bananas interplanted in coffee from 960 to 480 stools per ha resulted in a lower total banana production, which was partially offset by the higher rate of fruiting and larger bunches from the more widely spaced plants [3]. This is significant, since bananas and not coffee are the Chagga's primary crop.

Management Aspects

The Chagga have an intimate knowledge of the various crops and plants and their ecological requirements. Management techniques applied today have been continuously refined and tested over the ages and handed down from one generation to the next. Thus, when the farmers think the time is right, they carry out various operations such as opening up the canopy to ensure better fruiting of the coffee, spacing out the banana stools, and manuring the different crops. They maintain plant species (e.g. *Datura arborea, Rauwolfia caffra*) that repel or eradicate various pests and know the best fodder trees and shrubs and when and how to lop them.

Each home garden has a network of irrigation and drainage furrows linked to other home gardens in the vicinity. The farmer is thus able to tap and use runoff from the forest reserve and other home gardens on the slopes above.

The number of banana clumps and coffee bushes on a home garden varies not only with altitude and aspect but also with the management capabilities and preferences of the owner. In general, the range of banana clumps per home garden varies from 200 to 800 (330 to 1,200 per ha) and coffee trees from 300 to 1,000 (500 to 1,400 per ha).

There is, in addition, an average of 39 other trees and shrubs retained and managed in the home garden. Shade-tolerant crops, e.g. taro, yams, and beans, are inter-cropped between the coffee and bananas, while the more light-demanding species are grown in a section of the home-garden over which the canopy has been thinned to minimize shade.

Coffee extension services provide advice on pruning and spraying against coffeeberry disease and leaf rust. Most of the coffee trees have a single stem, while each banana clump is maintained with three to five pseudostems of different ages so as to encourage a continuous banana harvest.

Most Chagga farmers either plant new trees or encourage the natural regeneration of valuable timber species (table 1). These young trees in the understorey are well shaded, and this encourages straight stems with few branches. When appropriate, the overhead canopy is thinned to allow the trees to grow into the upper storeys. They are allowed to grow to a size approaching 0.6 to 1 m^3, i.e. a rotation of 60 to 80 years. A large tree (about 1 m^3) of *Olea welwitschii* can fetch a price of Tsh 10,000. If such a tree is felled during the lifetime of the present owner, then he in turn plants a new one, so that the next owner will also inherit a valuable tree.

It is important to note that although the great majority of home gardens are intensively cultivated and well managed, one also encounters some that are neglected, overgrown and sometimes abandoned.

TABLE 1. Woody Species Commonly Found in the Chagga Home Gardens and Their Uses[a]

Species	Uses
Albizia schimperiana	Fuelwood, building material
Bridelia micrantha	Building poles, fodder, roots used medicinally
Caesalpinia decapetala	Live fence
Calpurnia aurea	Coffee shade, poles, tool handles, leaf decoction as anti-helminthic for cattle
Carica papaya	Fruit, mosquito repellent
Cassia didmyobotrya	Medicinal uses, poisonous to cattle
Cedrella mexicana	Fuelwood, timber
Chlorophora excelsa	Valuable timber
Citrus spp.	Fruit
Commiphora spp.	Fodder, anti-insect properties, live support for yams, fencing material
Cordia africana	Coffee shade, fuelwood, building material, beehive construction

Species	Uses
Croton macrostachys	Coffee shade, fuelwood, fodder, anti-insect properties
Datura arborea	Bee forage, anti-Armilaria mellea, anti-nematodes
Diospyros mespiliformis	Valuable timber
Dracena usambarensis	Live fence, boundary marker
Dracena afromontana	Live fence, boundary marker
Ehretia spp.	Poles, tool handles, antibiotic properties
Eriobotrya japonica	Fruit, building material, hedge tree
Ficus spp.	Fodder, charcoal
Gardenia spp.	Utensils, anti-insect properties
Grevillea robusta	Coffee shade, fuelwood, building material
Iboza multiflora	Live fence, leaves fed to cattle as anti-helminthic, roots have anti-Bilharzia properties
Markhamia platycalyx	Termite proof building poles, fuelwood
Morus alba	Fodder, fuelwood, reinforces live fence of *Caesalpinia decapetala*
Newtonia buchananii	Fuelwood
Olea welwitschii	Valuable timber, fodder
Persea spp.	Fruit
Psidium guajava	Fruit, fuelwood
Rauwolfia caffra	Fuelwood, bark for brewing, anti-pest properties, used as store for maize cobs which are hung in its branches
Rauwolfia inebrians	Coffee shade, fuelwood
Ricinus communis	Seed oil used medicinally, seeds in bait as rodent poison
Syzigium africanum	Fuelwood, fruit
Tectona grandis	Valuable timber
Trema guineensis	Fodder, anti-insect properties, used medicinally
Trichilia emetica	Fuelwood, root decoction as anti-helminthic
Uvaria spp.	Fuelwood
Vanguerie tomentosa	Fruit, roots as snake-bite remedy and anti-helminthic
Other useful plant species maintained in home gardens	
Aloe volkensis	Antibiotic properties, grave marking
Cynodon dactylon	Fodder grass
Pennisetum purpureum	Fodder grass
Senecio kilimandscharica	Medicinal use, especially against kidney ailments
Setaria sphacelata	Fodder grass
Veriveria zizanoides	Grass planted along contours for soil erosion control, roof thatch

a. Over 100 crop and other plant species that appear in the Chagga home gardens have been listed in a separate publication [5].

THE FUNCTIONING OF THE HOME GARDEN SYSTEM

The average size of a home garden is 0.68 ha with a range of 0.2 to 1.2 ha. Traditionally, the land was divided only between the sons, but nowadays daughters can also inherit all or part of the home garden. Land tenure is based on a strongly held traditional belief that there is a close spiritual link between one's ancestors and the soil [1]. Thus, once a member of the immediate family has been buried in the home garden, tenure is assured for the current owner and his descendants and such a plot may even be abandoned for several years without the danger of someone else assuming ownership. This is in contrast to the lowland *kishamba* (allocated by the state and whose size is proportional to family size) where tenure is on an annual and usufructuary basis. If this land is not used for one or two years it may be claimed by another person.

An average household size of 9.9 people provides a workforce of four family members. In the home gardens, planting, tending and harvesting of bananas, taro and yams occurs throughout the year. Coffee harvesting usually starts in August and continues till January. The peak labour period is between January and March [4]; this is because coffee harvesting coincides with land preparation and planting of crops both in the home gardens and on the lowland *kishamba*. In contrast, April to June is a slack labour period before the harvesting of maize, beans, and finger millet from the lowlands. In the home gardens all operations are performed by human labour, whereas in the lowlands tractors are sometimes used for ploughing. Each farmer has an average of Tsh 560 worth of farm implements (axes, hoes, and pangas). Only a few farmers own tractors, which they lease to others for ploughing the lowland *kishamba*.

Seeds are obtained mostly from previous crops, although it is possible to buy seed from the Tanzania Farmers' Association. Dung from the stall-fed livestock and other household wastes are spread around the banana clumps and coffee bushes, but chemical fertilizers are generally not used. The Kilimanjaro Uremi Co-operation (KUC), a co-operative concerned with the production and marketing of coffee, supplies pesticides free of charge for use against coffeeberry disease and leaf rust. In addition, the Chagga use a variety of plant species with anti-pest properties (see table 1). Credit facilities are offered by the KUC and the Tanzania Rural Development Bank (TRDB). The TRDB also offers soft loans for dairy cattle and pig production.

An average home garden of 0.68 ha produces about 125 kg of beans (184 kg per ha), 280 kg of parchment coffee (412 kg per ha) and 275 bunches of bananas (404 per ha) annually. In August 1983, coffee fetched Tsh 16.85 per kg while the average price of a bunch of bananas was Tsh 30.

The maize harvest from the lowland plot averages 360 kg per year. Almost all the coffee produced is sold, although the poore · quality beans obtained towards the end of the harvest are retained for home consumption. No production data are available for taro, yams, cardamom, and onions. Local sources indicate that crop failure involving coffee and/or maize and beans occurs once every three or four years. However, total failure involving in addition bananas, other fruits, root crops, and livestock has never occurred.

Each farmer keeps between three and five traditional beehives, and it is conservatively estimated that each hive produces at least 5 kg of honey per year. Milk production by traditional breeds under stall feeding conditions is low (1 to 4 litres per day), whereas improved cattle produce between 8 and 16 litres per day. Pigs are fattened up and sold within a period of 6 to 12 months. It is difficult to estimate the quantity of fodder produced in the home garden, but most of the Chagga farmers are almost self-sufficient in fodder production for their livestock.

Fuelwood production in home gardens is estimated at 1-2 m^3 per year (1.5-3 m^3 per ha per year). If we assume a minimum consumption of 1 m^3 per adult per year, then each family requires 4-6 m^3 per year. Thus a home garden supplies one-quarter to one-third of the fuelwood requirements. The rest is obtained from the forest reserve or from the *kishamba* in the form of *Acacia* spp. and *Combretum* spp.

THE DYNAMICS OF THE HOME GARDEN SYSTEM

There is no more land (outside the forest reserve) on Mt. Kilimanjaro that is suitable for the Chagga home gardens and thus expansion is no longer possible. Furthermore, the existing home gardens are reaching the limit of intensive use at the present level of management. They are also becoming increasingly fragmented due to subdivision. This land scarcity has led to the migration of some Chagga to Mt. Meru (70 km south-west of Mt. Kilimanjaro), an area that has ecological conditions similar to those on Mt. Kilimanjaro. Local sources indicate that there has been some intermarriage between the Chagga and Meru (the indigenous tribe on Mt. Meru), and this has probably been an important factor in enabling the Meru, who were formerly pastoralists, to adopt successfully the complex Chagga home garden system within a period of about 50 years.

Although the Chagga cropping system has been stable for at least a century, it is only recently that it has come under pressure from rapid population growth, diminishing land resources and changes in dietary habits (maize replacing bananas as the staple food). The migration of youngsters to urban areas not only leads to labour shortages but also disrupts the traditional transmission from one generation to the next of the knowledge and experience required for the successful management and perpetuation of the complex multi-cropping system. In recent years, coffee prices declined markedly on international markets and this, combined with the labour-intensive nature of the crop, resulted in some Chagga farmers threatening to remove the coffee bushes from their home gardens. Despite these pressures, however, the system still appears to be working well for the majority of farmers. Nevertheless, if the system is to remain sustainable, then its productivity will have to be increased to cater to the rapidly increasing population.

EVALUATION

The following are the primary advantages of the Chagga home gardens:

1. Because of the continuous ground cover and high degree of nutrient cycling, the Chagga home gardens have remained sustainable on the erosion-prone slopes of Mt. Kilimanjaro.

2. Coffee produced by the Chagga contributes significantly to Tanzania's foreign exchange earnings. Over 52 per cent of Tanzania's export coffee comes from Kilimanjaro, and in 1982 this represented an earning of US$65 million

3. The various crop species and varieties in the home garden represent years of both natural selection for survival and farmer selection for easier production and better quality. These species have a good resistance to prevalent pests, compete well with weeds, and have a generally high level of genetic variability. The Chagga home gardens thus represent a valuable gene pool for use in breeding programmes that seek to improve crop varieties for multi-storey cropping systems.

4. There are many advantages claimed for the multi-species, multi-storey home gardens, including soil conservation, nutrient cycling and efficiency, microclimate enhancement [5], and other benefits such as labour efficiency, risk minimization, and continuous production.

The home gardens also have several weaknesses.

1. Although the Chagga home gardens are stable land-use systems, their productivity is relatively low, and must be increased if they are to meet the demand for food of a rapidly growing population. The problem lies in the need to increase productivity while retaining the stability of the present system.

Chagga home garden showing large trees, e.g. *Cordia abyssinica*, *Albizia* spp., and *Grevillea robusta* in the uppermost storey. Next are the banana and coffee canopies, and here the lowest layer is made up of fodder herbs and grasses (photo by E. C. M. Fernandes)

2. With the present trend of young people migrating to urban areas, it is mostly the older people who are left to manage the home gardens.

3. The present extension workers focus on individual crops and components. The absence of an integrated approach and consequent lack of awareness of the possible interactions of the various components and the repercussions of altering these interactions can result in problems for the farmer and a loss of faith in the extension service.

Development Potential of Home Gardens

On Mt. Kilimanjaro, the home garden's potential as a productive and sustainable system can be enhanced by:

1. Replacing the less productive trees and shrubs with fast-growing, nitrogen-fixing species, e.g. *Leucaena leucocephala, Calliandra calothyrsus, Gliricidia sepium*, and *Lespedeza bicolor*. These would provide increased fuel, fodder, and green manure in the home garden and would reduce the time spent in travelling long distances to gather supplementary fuel and fodder.

2. Improving animal husbandry so as to achieve, for example, a lactation period for cows of around 300 days per year.

3. Improving apiculture by, for example, the use of top bar hives, better bee strains, and improved harvesting and honey-extraction methods.

4. Introducing new crop species and breeding for higher-yielding crop varieties using the gene pool developed by natural and farmer selection not only in Tanzania but also in home gardens in other parts of the world.

5. Using fertilizers for which credit could be provided by the Tanzania Rural Development Bank. Purchasing, storage, and distribution of the fertilizer could be carried out by the Tanzania Farmers' Association or the Kilimanjaro Uremi Co-operation.

Extrapolability

Despite the need for an intimate knowledge of the components and a high level of management capability, the Chagga home gardens can be extrapolated to upland areas, such as the Kenyan highlands, South-West Ethiopia, and South-West Rwanda, where ecological conditions are similar and farmers now practise less intensive multiple cropping. Preferences for local species and varieties can be catered to by appropriate substitution or introduction. A demand for maize cultivation in such home gardens could be accommodated by growing the maize between rows of trees. Shade could be minimized by an east-west orientation of the rows and ground cover maintained by inter-cropping the maize with beans or cow peas.

Research Needs

Information is required on the following possibilities for improving the overall productivity of the home gardens.

1. Optimal spatial and temporal arrangement of the various components.

2. Optimal crop associations. This includes component crops and varieties differing in morphology, maturity period, shade tolerance, rooting depth, and photoperiod sensitivity.

3. Since chemical pest control is no real alternative in smallholder cropping systems, information is required on crop and species combinations with a greater potential to reduce pests, diseases, and weeds. The effectiveness of the plant species with anti-pest properties that are already used by the Chagga could be investigated as a first step.

4. Better soil management techniques, such as using green manure and mulches, and applying them only at the most appropriate times.

5. Appropriate fertilizer prescriptions for the intimate multi-species associations existing in the Chagga home-gardens.

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HOUSEHOLD GARDENS AND THEIR NICHE IN PORT MORESBY, PAPUA NEW GUINEA

Daniel E. Vasey
Chairperson, Department of Sociology, Divine Word College, Epworth, Iowa, USA

INTRODUCTION

In recent years, small-scale urban food production at the household or community level has increasingly attracted the interest of policy-makers, urban planners, and development specialists [20, 25, 26]. With accelerating worldwide rural-urban migration, food pressure in cities and towns will no doubt assume greater nutritional and political importance than it already has. Many national governments face the choice between increasing national food output and importing often costly basic foodstuffs. The policy of importation has two pitfalls: it depletes foreign exchange earnings and it creates a national dependency on subsistence food commodities from the outside.

As efforts are made to promote urban food production, those concerned with policy design should take into account the fact that in many Third World countries urban food production in backyard gardens already exists. A study of these small-scale urban agricultural systems can aid in the formulation of potentially more successful plans for projects. An understanding of locally adapted methods that function well will serve to guide the promotion and improvement of urban food production on a larger scale.

The purpose of this study of urban gardening in Papua New Guinea is threefold: (i) to analyse the economic importance of urban food production in the National Capital District, (ii) to place urban food production within its ecological niche, and (iii) to provide specific information that can be used to derive general principles for the improvement of future household garden programmes in Papua New Guinea and other areas of the world.

Traditional urban food production in Papua New Guinea is of particular interest because it is such a widespread phenomenon [21]. In the National Capital District (NCD), which comprises the Port Moresby wider metropolitan area, about four-fifths of all households take part in some form of food production with a mean area per garden of 372 square metres, which seems considerable for an urban setting.

METHODOLOGY

For the present study a survey was made of 700 households selected at random from the total of 19,000 in the entire NCD. Householders were interviewed and gardens were observed over a three-month period from March to May 1981. Observations and interviews were successfully carried out in 482 households. In 35 of the households I was able only to conduct interviews, while an additional 110 did not have a garden. I was able neither to observe gardens nor to conduct interviews in the remaining 73 households.

Additional information which has a bearing on the present study has come from observation and unstructured interviews which I conducted in a smaller sample of households at various times during 1980, 1981, and 1982. As a basis for comparison, readers may also be interested in several earlier studies conducted by Fleckenstein [5], Harris [6], Hernandez [7], and Thaman [19]. Vasey gives a detailed description and analysis of 1981 survey methods and socio-economic factors [24], and discusses methods of garden management and allocation of labour [22].

URBANIZATION AND HOUSEHOLD GARDENS IN PORT MORESBY

According to Norwood [14], Port Moresby is a city "designed by and for car-owning foreigners." Formerly a small colonial administrative centre that discouraged urban migration and settlement, Port Moresby rapidly expanded during the post-colonial period, reaching 123,000 in 1980, with a growth rate oscillating between 5 and 12 per cent [1]. Urban and suburban development was irregular and essentially unplanned, with large undeveloped areas between suburbs of various socio-economic levels. Neighbourhoods of variable size and density arose incoherently, often with large tracts of unused land between them. Outer city planning was minimal, except for household allotments on government housing estates. Today, Port Moresby is a remarkably diffuse city built along the slopes and valleys of a coastal hill range and the adjacent portions of an inland plain.

In Papua New Guinea a subsistence economy survives alongside a commercial one, the latter based on the export of tropical crops, mining products, commerce, and manufacturing, which still consists principally of import substitution and minor processing of local raw materials. The

commercial sector is supported in several ways by the subsistence sector [2, 16]. Smallholder cash cropping is an important linkage between the two, with coffee and other export crops as major sources of income. Close to major cities and towns, gardening is increasing in importance as a source of income for smallholders because of the high price of fresh fruit and vegetables in these areas.

A high proportion of present-day residents are migrants from "rural" villages who, in spite of a return flow, must be considered permanent residents of the capital city [10]. Another large contingent of the urban population are descendants of the pre-colonial Koita and Motu, whose tribal areas have been incorporated into the larger metropolitan area as urban villages.

Port Moresby's population includes numerous households whose adult members participate only marginally in both subsistence and commercial economies because of their recent-migrant status. For example, they may have lost rights to tribal land in their home villages and yet are not able to find regular employment in Port Moresby.

Approximately one-quarter of Port Moresby's population is unemployed or underemployed and lives in what are often called "squatter settlements"; some authors prefer the term "migrant settlement" or the non-committal "settlements." Norwood [14, 15] uses all three terms. All of the communities in question are unplanned and in several respects informal, but "squatter" seems a more apt description in some cases. No rent is paid for squatting on unused government land, but is sometimes charged for what is called customary land. Some settlements are occupied by migrants with traditional ties to the landowner community.

Government housing estates, which require one householder at least to be employed, provide homes for over 60 per cent of low-income residents.

LAND FOR GARDENING: THE SPATIAL NICHE

Although social and political circumstances largely determine location and size of household gardens, there is some scope for community and individual initiative in finding space. The spatial niche into which urban food production has spread is provided by (a) "bush" gardens, which are village or clan-owned, (b) vacant lots adjacent to settlements, and (c) hillsides.

Port Moresby first spread east along the seaward slope, then to Boroko on the inland plain and west along the inland slope to Hohola, Tokarara, and June Valley (fig. 1). Most recently, settlement has expanded to Gordons, Morata, University, Gerehu, and several other squatter settlements on the inland plain and some isolated inland hills. Within the coastal hill zone, the tendency is to occupy valleys and footslopes while avoiding steeper slopes; only hillsides near the city are built up to a greater extent. Most gardeners in the inland housing estates are far from the boundaries of developed land, but vacant undeveloped land is seldom used for gardens even where it is available. Therefore, apart from household plots, the main areas left for gardening are on fairly steep slopes.

Unfortunately, much excellent gardening land goes uncultivated because of land tenure patterns. Many gardeners have access only to marginally arable land, which means that they are unable to supply a large percentage of family food needs – particularly critical in the absence of secure and well-paid employment. For example, gardeners expanding from housing-estate allotments onto hillsides have to contend not only with slope problems but also with poor topsoil and an inadequate water supply.

Space for household food production was a consideration in the government plans for housing allotments, which provided plots of between 300 and 400 m^2. To date, many gardens have grown well beyond the confines of the allotments, while others have been established away from the house – a fact that clearly indicates the insufficiency of the allotted plot size. Also, unplanned squatter settlements allowed themselves enough space around dwellings or close by for family food gardens.

Older squatter settlements on the seaward slope tend to be densely packed, with the notable exception of Horse Camp, which is located on prime, moist bottom soil and contains several houses with large garden plots. There has been some expansion of houses onto larger plots on steep slopes above older squatter settlements in an effort to secure land for cultivation. Newer squatter settlements inland tend more often to be built on, or adjacent to, large garden tracts.

The garden area attached to the lower-income settlements of Port Moresby ranges from zero (for example, the houseboat section of Hanuabada village) to well over 1,000 m^2, with a mean of 372 +/- 42.4 m^2. Where the intra-community settlement pattern is dense, garden plots tend to be smaller. The largest cultivated areas, "bush gardens," are worked by residents of the urban villages, and are often several kilometres away from the settlement.

Few residents of the housing estates work gardens away from their allotments or immediately adjacent to undeveloped land. However, it appears that in general gardening away from the allotment and the immediate vicinity of the house has become more common in recent years [5, 7]. None the less, a government effort to allocate plots for

FIG. 1. Some Port Moresby Neighbourhoods

cultivation away from housing in a densely populated part of the district failed because of the difficulty of guarding against theft and vandalism. Bush gardens, in contrast, appear relatively secure in this respect, being comparatively remote and guarded at times by hired watchmen.

GARDENING FOR FOOD AND CASH: THE NUTRITIONAL NICHE

Household gardens in Port Moresby cannot be readily or meaningfully divided into commercial and subsistence categories. Also, it is difficult to draw a dividing line between gardens producing mainly for family consumption, with some marketable surplus, and small market-garden enterprises, which supply a large proportion of family subsistence needs. In general, true market gardens are around 2,000 m^2 in area, are located in the hinterlands and represent an important source of cash income. However, produce from very small gardens may also be sold.

Within garden boundaries, this lack of distinction between "pure" market and subsistence crops prevails: physical separation of the two is not a consistent practice. One form of separation that is found in large gardens is to grow a cash crop like peanuts on unirrigated hill land and species mainly or entirely for home consumption on irrigated flatter land near the house.

To assess the relative importance of garden crops, a measure was obtained in a previous study for all gardens in the study by rank-ordering, and a score was compiled for the entire sample [22]. As a result, cassava, banana and plantain (in order of importance) emerged as the most important garden crops, followed by sweet potato, *aibika* (*Abelmoschus manihot*), pumpkin, maize, beans, *Saccharum* spp., yam, taro (*Colocasia esculenta*), peanuts, various Brassicas, *Xanthosoma* spp., and other minor crops. Pumpkins are grown mainly for the green tips and beans for their immature pods.

Tree crops were not included in this score. Fruit trees are commonly grown where long-term occupancy is assured, and tend to be more abundant in older neighbourhoods. *Carica papaya*, which was the most common, was found in 25.7 per cent of the 1981 sample [22]. A composite score was calculated for fruit trees, vine fruits, and vegetables eaten as greens or pods. The measure arrived at is approximate: an average garden might contain 3½

plantings of trees, vines, or vegetable crops, or one mango tree and 1½ vine and/or vegetable plantings.

Gardens are multi-cropped with staples predominating; these correspond to the traditional energy crops of rural subsistence agriculture. The emphasis in Port Moresby on staples in low-income gardens should not be seen simply as evidence of a starchy diet; rather, these staples provide much-needed energy as well as other nutrients. For example, some varieties of sweet potato, banana, sweet corn, and, more rarely, taro are rich sources of carotene. Also, fruits and vegetables seem to occupy an increasingly significant place in city gardens, possibly due to nutrition campaigns during the past years [7, 21-3].

The direct contribution of garden production to family food energy consumption is 4 to 6 per cent. This is impressive considering that most of the food consumed by lower-income groups consists of imported rice, meat, and fish. Low-income households without gardens subsist on imported rice with additions of canned meat and fish, a diet lacking in nutrient variation as well as total energy supplied. In a 1978 survey, daily intake for the lowest income decile was found to be 1,435 kcal with 38.1 g protein, as compared to the NCD average of 3,009 kcal with 92.2 g protein [12].

It has been estimated that, given the prevailing methods of management, a garden of 1,000 to 1,300 m^2 is required to meet the energy needs of one adult male equivalent [24]. If the entire garden area were irrigated, that figure could be reduced but would still be considerably above the present mean.

As low-income gardeners have a comparative advantage in the Port Moresby vegetable and fruit market, they are also able to multiply the energy value of home-grown food by selling and using the cash to purchase cheaper imported foods. For example, banana, cassava, sweet potato, taro, and yam can all be sold at a price that will buy rice equivalent to several times their energy, together with canned mackerel to give more protein in the diet.

CITY MARKETS FOR GARDEN PRODUCE: THE ECONOMIC NICHE

The coastal ecology of Port Moresby permits the cultivation of a wide variety of tropical fruits and vegetables all year round on rain-fed land. With the lure of urban employment, subsistence and surplus smallholder agriculture declined in the urban villages, and the demand for fresh fruit and vegetables in the metropolitan area quickly outgrew supplies and provided attractive price incentives for home gardeners.

Household gardeners have created their own economic niche within the larger city-wide food distribution system. Beginning in the 1930s, a system of open-air markets appeared under the sponsorship of the city council [3]. This development follows the spread of urban settlement and reflects the degree of neighbourhood food production.

Open-air markets are highly individualized affairs: a member of the productive unit always accompanies and sells the produce. Although other marketing opportunities exist, for example through a government corporation or supermarkets, no one represents a serious challenge to the system of open-air markets. They offer an exceptional opportunity even for small-scale urban growers, as prices are high, intermediaries absent, and the marketing cost low. The equivalent of US$1.37 (1 kina) in 1981/82 would buy one of the following: five bunches of greens, five mangoes; one small pineapple; ten dozen peanuts; 2 kg of sweet potato; or 3 kg of bananas. Consumers must pay these prices or look to their own gardens.

The owners of large gardens tend more often to sell their produce, but small-scale gardeners can also be seen in the markets. Squatter settlements have a higher percentage of sellers (42.1 per cent in 1981) than the housing estates, whose percentage is comparable to the district average (25.8 per cent). Where the owners of large gardens do not sell any produce, one cannot assume that all produce is consumed by the household; it is more likely that informal exchange and redistribution networks are in operation. The majority of gardeners in any type of neighbourhood are not sellers, however, and even sellers unanimously reported retaining for household consumption some of every kind of crop they sold.

Of the 33 gardener-sellers with gardens of 500 m^2, 32 lived in six neighbourhoods [24]. In three neighbourhoods, peanuts were the dominant cash crop. During the 1970s, according to informants, peanuts evolved as an urban cash crop of considerable importance for low-income city gardeners, for several reasons:

- they can be grown on rain-fed land away from the house plot;
- they are highly seasonal, allowing subsequent cultivation of another crop;
- they can be sold in quantity on a few trips to the market.

A fourth neighbourhood in the 1981 sample served an institutional buyer, while a grass-roots co-operative in another assisted the marketing of produce in open-air markets by organizing some sharing of selling tasks.

It appears that the increase in garden size noted since earlier surveys [5, 7] is related to the saleability of garden produce. For example, in June Valley, a peanut-growing neighbour-

hood, mean garden size was reported as 125 m^2 (N=146) in 1974 [7]. In 1981, mean garden size appeared to have increased to 817 m^2 (using a smaller sample of N=31). Two further sizeable increases were registered in Morata and Nine Mile Quarry, neighbourhoods with many owner-built houses and ready access to moist soils on low ground favourable to gardening.

Some increase has occurred in seven of the nine neighbourhoods for which there are comparable data [7]. In all neighbourhoods, informants attributed the growth of gardens to opportunities to sell produce; other possible reasons are the extension of the water supply and the trend in many neighbourhoods towards gardening away from house plots where more land is available.

There are indications that household gardening expands as income falls. While the percentage of gardening households does not vary significantly by class of neighbourhood, mean garden size does. Gardens in squatter settlements and government housing estates, neighbourhoods with a high proportion of unemployed or underemployed, tended to average 469 to 513 m^2, some 29 to 35 per cent above the NCD mean. Male unemployment in the squatter settlements was 31 per cent in 1974 [1] and has probably risen since, as immigration is believed to occur at higher rates than the growth of employment.

THE TECHNOLOGICAL NICHE AND LABOUR ALLOCATION

Household gardening in Port Moresby is neither capital-intensive nor energy-intensive and is on a different technological level to the subsistence agriculture practised in the migrants' home villages, even though some crops are duplicated. In general, adjustments must be made by all gardeners to (i) reduced cropping space, (ii) reduced fallow time, (iii) irrigation during the long, dry season peculiar to Port Moresby's coastal eco-environment, and (iv) the soils of the NCD.

Most household gardeners are unwilling or unable to invest much capital in gardens and the use of industrial inputs is minimal. Mainly hand tools are used, although a few gardeners are able to have their gardens ploughed by tractors supplied by the city council or Department of Industry. Few gardeners use chemical fertilizers. The most important single "industrial" input is potable, piped irrigation water, which is always expensive, especially in Port Moresby where water shortages are often serious during the dry season.

Water is perhaps the costliest resource used by NCD gardeners but ways seem to be found around the regulations and high cost. Watering restrictions in periods of critical shortage are often not observed, and either the high cost of water is not passed on to householders, many of whom have non-metered supplies, or the cost is offset by the high price of produce. Those on metered supplies cited cost as a reason for not watering during the dry season. About 77 per cent of the total garden area was within reach of watering equipment in 1981.

To conserve moisture, the Motu and Koita indigenous to the NCD area have long used trash mulching and wide spacing. These techniques are not widespread among migrants from rural villages, who use some mulching, albeit much less frequently than the urban villagers and in quantities too small to be effective.

Soil conditioners are also the only means available to household gardeners for boosting the level of soil organic matter and nitrogen [17]. Increasing the nitrogen content is most important for Port Moresby soils, as it is typically the limiting nutrient. The practice of cover cropping was not encountered. Few gardens are large enough to make it practicable; there is very little ground in Papua New Guinea that would support a cover in the dry season; and the practice is not traditional in the area. Some of the legumes grown, such as peanuts and long beans, are either poor contributors of nitrogen or, like winged beans, occupy little garden space.

Labour allocation in Port Moresby household gardens is determined by a household's socio-economic situation and is much more flexible than in the migrants' home villages. In rural subsistence agriculture, women overall contribute the most labour. In urban food gardening, male garden tasks usually consist of clearing and breaking ground, while women do most of the work spread out over the entire growing season. However, regional variations and a complex set of rules govern the allocation of specific tasks and the distinction between "male" and "female" crops [8, 9].

In the urban setting, an individual's role within the household and participation in the wage sector is an important consideration in allocating household and garden tasks. A household member who works full-time often takes part in gardening chores but is seldom the principal gardener. Where the principal gardener is not a household head, it is usually a relative or live-in *wantok*, a person from the household's home village.

In the 1981 survey, women were named as 61.9 per cent of all gardeners and 66.7 per cent of the principal gardeners. This predominance of women working family gardens must be seen as a reflection of their secondary place in the workforce. Accordingly, the proportion of female gardeners was highest in the housing estates in which one household member's employment is ordinarily a condition of residence. Women represented 70.9 per cent of all gardeners

in these neighbourhoods, 65.6 in the urban villages, 51.4 per cent in squatter settlements, and only 18.7 per cent in Morata. The squatter settlements and Morata have a large number of all-male households, a consequence of the high ratio of male versus female migration – 2.24:1 in 1971, according to Skeldon [18].

CONCLUSION

The strength of household gardening in Port Moresby can be explained by:

1. A rapid expansion in urban settlement and the contested ownership of large tracts of land open to settlement.
2. A great contraction in local village subsistence agriculture with a large number of urban migrants of rural background.
3. A shortage of fresh produce in NCD urban markets and corresponding high prices for fruit and vegetables.
4. The economic necessity of low-income population groups to produce some of their own food supplies and find alternative sources of income.

Although household gardens in the NCD make efficient use of many resources, there are a number of constraints including: insufficient garden space; the unavailability and high cost of water; and the unavailability, unsuitability, or high cost of other inputs, such as soil conditioners. An additional and even greater constraint is the factor of theft and vandalism in gardens separated from permanent housing.

Removal of these and related constraints to increased and improved urban food production could be accomplished by:

1. Instituting land allotments. There are large vacant areas of land that would be ideal for gardens, some very near present settlements, the majority along the periurban fringe. Ambitious household-cum-small-market gardeners could exploit these areas if long-term tenancy and security against vandalism and theft could be assured.

2. Supplying water at an appropriate cost. Specialists would need to determine the real cost of water at present used in irrigating gardens, weighing return against production cost. Also, alternatives to present water supplies for irrigation should be investigated.

3. Providing appropriate expanded garden extension and accompanying nutrition education services.

Household-level food production has been shown to be functional in partially feeding the urban centres of the developed world in both normal times and times of crisis [13]. The institution of a full-scale garden allotment programme in the NCD and other growing urban areas could mean improved nutrition for low-income producers, an increased total food supply through direct production or sale and purchase of alternative foods, economic benefits from the sale of garden produce to non-gardening urban consumers, staples of higher nutritional quality than purchased staples, and more fresh produce available for growing urban centres, as well as a more efficient utilization of local natural and human resources.

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THE JAVANESE HOME GARDEN AS AN INTEGRATED AGRO-ECOSYSTEM

Otto Soemarwoto, Idjah Soemarwoto, Karyono, E. M. Soekartadiredja, and A. Ramlan

Institute of Ecology, Padjadjaran University, Bandung, Indonesia

INTRODUCTION

In the countryside of Java, the existence of a village is indicated by a clump of dense vegetation amidst rice fields. The houses are almost completely concealed by this vegetation; from the air the villages look like dark-green islands in a sea of light-green or yellow rice fields.

A closer look at the village reveals that the dense vegetation consists of plants in gardens surrounding the houses. This is particularly true of Central Java. In West Java the houses, surrounded by gardens, are often clustered together with hardly any open space in between. The village may also be fenced in by a hedge of bamboo or other plants.

TERMINOLOGY

The most widely used Indonesian term for home gardens is *pekarangan*. Before the Second World War the Dutch term *erfcultuur* was in common use in Indonesia. After the war, Terra, a well-known authority on *pekarangan*, used the term "mixed garden" in accordance with the suggestion of Willis, while Pelzer's term was "garden culture" [9]. Penny and Singarimbun [4] used "house-compound land," Ramsay and Wiersum [5] "home-garden," Harwood [2] "homestead area," and Stoler [8] both "mixed garden" and "house garden." We prefer to employ the term "home garden" in order to stress the close relationship between the garden and the home. For the villagers it is both a dwelling-place and a production unit. In fact it is an ecological system involving interactions between human beings, plants, animals, soil, and water.

THE STRUCTURE OF THE HOME GARDEN

The structure of the home garden varies from place to place and is influenced by both ecological factors, such as climate and soil, and cultural factors. According to Terra [9] the home garden was particularly well developed in Central Java and parts of East Java, though it was also found in West Java, as we ourselves have verified.

As salient feature of the Javanese home garden is the wide variety of plant species. For example, in the two adjacent sub-districts Cinangka and Padarincang in Banten, West Java, 179 plant species were found in the home gardens, including annuals and perennials of different heights ranging from ground-creepers to trees of about 25 m, as well as several climbers. Not all species were found in every garden.

The plant diversity was actually greater than that indicated by species differences, since many species were represented by several varieties – for example, varieties of banana with the local names of *raja, kapok, susu, ambon, mas*, and *klutuk*; yellow and red varieties of papaya; and yellow and green varieties of coconut. The varieties of plant species are now being inventoried.

In addition 62 weed species were found in Cinangka and Padarincang. The term "weed" should be used with extreme care, since the villagers had uses for many weeds. From a preliminary survey we found that of these 62 species, 18 were used for herbal medicine, one for roofing and fodder, four for vegetables, and almost all grass species for fodder. More in-depth studies would probably reveal that even more weed species were used by the villagers. Thus, in these villages a so-called weed may in fact be a spontaneously growing, but useful, plant species.

Not all Javanese home gardens, however, show such great diversity as those we have mentioned in West Java. In villages close to cities and at higher altitudes there is less diversity. For example, in two villages near the capital of Banten, which seem to have similar ecological conditions to those found in Cinangka and Padarincang, only about 80 planted species were found. These villages are all located at an altitude of a few metres above sea level. In Gandsoli and Karoya, also in West Java, at an altitude of about 200 metres, there were 125 planted species.

The diversity apparently lends the home garden biological

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stability, for even though the villagers do not use pesticides, there are seldom serious pest outbreaks.

Animals are raised by the villagers in home gardens. The poor family may have only a few chickens and the rich one a few water buffaloes or cows, while goats and sheep are owned by people at the intermediate level. Other animals commonly found are horses, ducks, rabbits, and guinea pigs, as well as pet animals such as dogs, cats, and birds.

The animals are not confined and receive only minimal feeding. The chickens run around in the garden eating leftovers from the kitchen and table, in addition to whatever they find in the garden. Buffaloes, cows, goats, and sheep are grazed on the village common land and at night given additional feed, which is cut by boys from hedge-plants growing on the dykes of rice fields, along streams, and elsewhere. Goats roaming in market-places and eating all kinds of vegetable garbage are a customary sight in villages.

In West Java, particularly in the Priangan region, fish ponds often form part of the home garden system. The fish are fed partly on kitchen waste, and the pond is also fertilized by animal and human waste, which is why the horses' stable and the bathroom toilet are built above it. The other animals' pens, however, are not built like this, although they may be located close to the fish pond; instead, their wastes are composted and used as manure in the garden and fields. Presumably for hygienic reasons, the villagers do not use the contaminated water of the fish pond; the water for the bathroom comes through bamboo pipes from higher ground.

ROLES OF THE HOME GARDEN

From the description given above one can see that a village with its home gardens is not merely a dwelling-place but also an important agro-ecosystem. It is an integrated unit in which the solar energy is channelled through the plants to animals and man, and matter is cycled and recycled. This cycling and recycling process, together with the layered plant cover, protects the soil of the home garden from exhaustion, leaching, and soil erosion. For instance, in the heavily eroded areas of South Solo and South Jogjakarta in Central Java, the soils of the home gardens are still in good condition and the villages look like green oases in a desert of eroded hills. For this reason it has been suggested that home gardens be used as a means of preventing soil erosion and rehabilitating eroded areas [7]. It has also been stressed that animals should be considered an integral part of the home garden system (fig. 1).

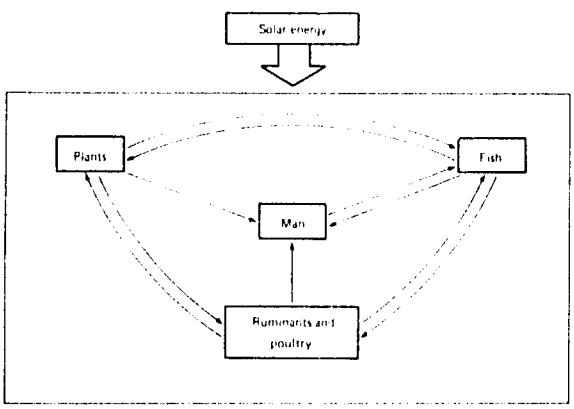

FIG. 1. The Integrated Home-Garden System in a West Javanese Village, with Cycling and Recycling of Matter. This Process is Fuelled by Solar Energy

In a study in Kutowinangun, Central Java, Ochse and Terra [3] showed that 20 per cent of the total income of the people came from the home garden, but only 8 per cent of the total income and 7 per cent of the total labour were spent there. According to McComb, as cited by Ramsay and Wiersum [5], the income from an average farm of 1.68 ha consisted of 28 per cent from home gardens, 26 per cent from dry fields, and 46 per cent from *sawah* (wet rice fields). Stoler [8] reported that in a village in South Central Java garden cultivation alone was the largest single source of income for the smallest land-holding group, while for the largest it was half the contribution of *sawah*. Under certain conditions the income per hectare from home gardens may even exceed that from *sawah* [4, 8, 9].

At the macro-level it is difficult to assign monetary value to home-garden products, because a large part of the common vegetables produced are directly consumed without ever entering the market system; also, in many cases statistical figures do not differentiate between home gardens and dry fields, the so-called *tegalan*. However, figures for the production of fruit and livestock may be used as a rough indication of the importance of the home garden in the village economy, since they are almost exclusively produced in the home garden, and little is consumed by the people.

From official statistical reports of West Java for the years 1968 to 1973, the average annual value at the farm-level of fruits, fish, eggs, and cow and buffalo leather was estimated to be about US$163 million, while the average annual total value for rice was about US$277 million. Thus, even this partial list of home-garden products, exclusive of those directly consumed, had a value of about 60 per cent of that of rice.

Home gardens also play an important role in the nutrition of the people who cultivate them. Ochse and Terra [3] reported that 44 per cent of the total food calories and 32 per cent of the total proteins produced in their Java sample came from the home gardens. When computed on the basis of consumption, 18 per cent of the calories and 14 per cent of the proteins were supplied by the home garden. The

diversitv of the food from the home garden also makes an important contribution to the quality of the diet by providing essential vitamins and minerals. In this connection an interesting finding was reported by Stoler [8]: poorer households were not consuming less but more leafy vegetables than wealthy households. One reason given for this was that the leafy vegetables – a good source of vitamins and minerals – were cheaper than other vegetables and almost always available. According to Harjadi [1], home gardens with more perennial crops produce more proteins and calories, while those with dense annual plants produce more vitamin A; the average daily intake from home gardens in a village in Lavang, East Java, was 983.4 calories, 22.8 g proteins, 16.4 g fats, 185.0 g carbohydrates, 381.4 mg Ca, 555.0 mg P_2O_5, 14.4 mg Fe, 8,632 IU vitamin A, 1,181.2 mg vitamin B, and 305 mg vitamin C.

Supplemented by wood from forests, home-garden plants are also an important source of building materials and firewood.

A great economic advantage of the home garden is that villagers can harvest something daily for their own consumption, for sale in the market or for raw materials for their home industry. Because of the climatic conditions of Java, annual plants can be grown all year round in almost every part of the island, even in the drier parts of East Java. In the dry season plants are usually grown near wells, fish ponds or open sewage ditches. Leaves of some perennials, e.g. *melinjo* (*Gnetum gnemon*), are always available. Some perennials flower and bear fruit throughout the year; these include coconut, banana, salak (*Salacca edulis*) and jackfruit. Others have definite flowering and fruiting seasons, but differ from each other. For example, the flowering season of *jambu Semarang* (*Eugenia javanica*) is from April to June, of mangoes from July to August, of durians (*Durio zitbethinus*) from June to September, of mandarins from September to December, and of *duku* (*Lansium domesticum*) from December to January, and the corresponding fruiting season is a few months thereafter [3]. Therefore fruit of some kind is available throughout the year. Likewise, the products of livestock are available throughout the year.

For poor people with little cash, this year-round availability of food, building materials, firewood and sources of income is crucial to economic stability, particularly in the time between rice harvests, the so-called *paceklik* season.

POTENTIAL FOR DEVELOPMENT

Although the home garden has many important roles in village life, it has not attracted the attention of agriculturists, economists, and sociologists. As a result, an understanding of its structure and functioning and its role in the village economy is still fragmentary. Reliable quantitative data are lacking, and many people do not appreciate its importance because of ignorance. The home garden is threatened on the one hand by misguided development and on the other by lack of development.

In an effort to modernize the village, for example, the bathroom toilet above the fish pond was considered inappropriate and unaesthetic, and was replaced by indoor toilets. The result was that human waste was not recycled; it was flushed into streams and contributed to the eutrophication of surface waters and the growth of aquatic weeds and algae. Thus, valuable protein from fish was lost or decreased in yield.

In another case the home garden was considered haphazard, and efforts were made to regulate the plantings with the intention of making the garden look nicer and of increasing yields. This alteration resulted in a reduction of the density and diversity and the loss of the layered pattern. Consequently, disease and pests became more prevalent, particularly among plants with a market value which had become the dominant form of planting. Special efforts also had to be made to control weeds, and the risk of soil erosion increased.

Perhaps the biggest threat to the home garden is the encroachment of cities onto the rural areas. The growth of Jakarta, for example, has already destroyed many hectares of home gardens with valuable fruit trees.

Since home gardens are still undeveloped, the potential for increasing their production and economic value is still great. But their development should be carried out with care and with a full appreciation of the ecological principles underlying their existence, including the socio-economic aspects. Many of the plants and animals can still be improved by selection from the local varieties, followed later by a hybridization programme. In this respect the high diversity of the home garden provides a rich genetic resource.

Since the villagers are poor and the unemployment rate is high, there is a need for simple labour-intensive technologies. But even these technologies could displace people and disrupt the social structure of income distribution [6]. The introduction of plants which in theory give high economic returns could be disastrous under certain conditions: if it increased the need for capital investment, such as for the purchase of expensive seedlings, fertilizers, and pesticides, and disrupted the daily income and food supply, people could be driven into the hands of moneylenders. Marketable plants would also have the disadvantage of

being sensitive to fluctuation in market demands and prices. Therefore, in the development process it is essential that the introduction of marketable plants in home gardens should not eliminate those plants and animals that are essential to the subsistence of the people. The diversity of the typical home garden must be maintained, because this diversity is important for its stability, for assuring the villagers an adequate food supply, and for reducing the need for energy subsidies. Consequently, the technologies needed to improve the living standards of the people should be geared to an ecosystem of high diversity and not to that of a monoculture. It is also essential to develop an effective credit system in order to prevent the villagers from becoming the victims of moneylenders.

The crucial factor for development is, of course, educating the people to enhance their technical and managerial skills as well as their general knowledge.

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THE TALUN-KEBUN: A Man-made Forest Fitted to Family Needs

Otto Soemarwoto, Linda Christanty, Henky, Y. H. Herri, Johan Iskandar, Hadyana, and Priyono
Institute of Ecology, Padjadjaran University, Bandung, Indonesia

INTRODUCTION

Shifting cultivation has rightfully been called the "Cinderella of agriculture," existing at the margins of mainstream agricultural production, and receiving no official recognition and assistance [8]. Yet an estimated 250 to 500 million of the world's population living in tropical forest regions depend on this method of extracting a livelihood from a fragile ecosystem.

In contrast to field-agriculture-oriented scientists, ethnographers and ecologists have long pointed to the relative virtues and adaptability of shifting cultivation, its prehistoric existence in the Northern Hemisphere, and the ecological dangers associated with introducing maladapted agricultural systems [1, 2, 4, 5]. The high productivity of swidden techniques is seen as a reason for the continuing importance of this form of agriculture throughout the tropical regions of the modern world [3]. However, many national governments still consider that their tropical forest areas should contribute to the national cash economy through large-scale exploitation for cash crops, such as lumber, oil, rubber, and coffee, or to the national breadbasket through traditional open-field plough agriculture or ranching. Only recently have attempts been made to study contemporary systems of shifting production in order to develop appropriate technologies for a more intense, but preservationist, cultivation of tropical forest areas [6].

This article is an attempt to contribute to this new direction in controlled shifting cultivation or agro-forestry by presenting an example of a spatially confined yet well-adapted, small-scale system of forest exploitation oriented toward both subsistence and commercial production in West Java, Indonesia.

EVOLUTION OF THE TALUN-KEBUN SYSTEM

Inhabitants of the Priangan region of West Java have practised *huma* or shifting cultivation since ancient times. The principal crop of huma cultivation is upland rice, and in some areas, such as Banten, so-called huma flocks – stretches of forest reserved for huma cultivation – still exist. Along with shifting cultivation, *sawah* or wet rice production and the *talun-kebun*, a mixed-cropping form of forest cultivation, are found. Huma cultivation is practised mainly in mountainous regions, on higher slopes and areas that cannot be irrigated. Sawah cultivation has traditionally been confined to lower slopes and valleys where water is available and the dangers of soil erosion are reduced.

The talun-kebun is a form of cultivation that falls between huma and sawah in terms of location, management, and production, and whose historical development is still poorly understood. According to Terra [9] the talun-kebun originates with Sundanese agriculture. It is synonymous with the Malang *kebun*, the *dusun* of Ambon and Ceram, the *mamar* of Timor, the *porlak* of Batak, and the *krakal* as used in Purworejo in Central Java.

The huma is believed to represent the evolutionary base both for talun-kebun and for sawah, which was introduced from Central Java towards the middle of the eighteenth century [9]. On land where sawah production was not possible, people began to select forest plants and to introduce species from other areas in order to obtain greater benefits from their land, so that gradually part of the natural forest was changed into a "man-made" forest. By planning the planting of tree and bush species, the obligatory fallow of the shifting cultivation system became a productive fallow.

The dynamics leading to the present-day talun-kebun system have not been thoroughly researched. Possibly, with the introduction of wet rice culture, the need for widely shifting cultivation was reduced or even eliminated, since rice could be supplied from the sawah. According to this hypothesis, people then started using the forest near their villages to produce crops other than rice to fulfil their family needs, which, with the advent of a monetary economy, included the need for cash. Another hypothesis explains the development of the talun-kebun system as a response to increasing population pressure following the shift to sawah production. The larger population may have restricted the movement of the shifting cultivators, who had to find an alternative way of exploiting the same land area.

According to yet another thesis, the development of the talun-kebun preceded the introduction of sawah into West Java. Increasing population pressure or cultural develop-

ment may have required more intense exploitation, and cultivators attempted to increase the harvest from their shifting cultivation systems. With the introduction of a market economy, no doubt, cash incentives played an important role in trying to maximize the output of a given parcel of land.

THE STRUCTURE AND FUNCTIONS OF THE TALUN-KEBUN

In shifting cultivation, the cultivated field typically moves from place to place within a natural tropical forest. A small plot is cleared, the organic matter is burned, and the rice seeds are planted, usually mixed with other crops. After two or three harvests, the plot is abandoned and another piece of forest is cleared for cultivation, and so on. In traditional shifting cultivation, little material is exported. After clearing the plot, the organic matter remains to be burnt *in situ*. The cultivators live close to their parcels and most waste products are recycled. After a short productive period the cleared plots return to forest, and very little can be harvested during this fallow period.

The talun-kebun system of shifting cultivation, however, is practised not in the natural forest but in a man-made one. In essence, it combines many species of perennials and annuals in multi-layered and single-layered arrangements forming an often dense canopy of vegetation which protects against soil erosion and leaching. Because it is so rich in useful plant species, the talun-kebun also serves as a natural gene bank. This kind of cultivation is multi-purpose, as it produces marketable crops as well as subsistence food and materials for other household needs.

Structurally, the talun-kebun is divided into two parts: the *talun,* or selected, productive fallow "forest," consists of the overhead cover of essentially long-term perennials. The *kebun* comprises various areas of cleared ground within the talun planted with annual crops destined mainly for market sale. Upon harvest, the kebun is allowed to grow up in perennials and returns to talun within five to eight years. Once the regenerated talun has been entirely or partly harvested, another kebun is planted. Functionally, talun and kebun are the two continuous successive stages of a mixed subsistence and cash-crop production cycle.

The talun is planted with a mixture of many species of trees but may be dominated by one species; if so, it is named after this species (e.g. *talun awi* for bamboo talun). A talun closely resembles a forest in structure, consisting as it does of many species of different ages and heights, but it differs markedly from a natural tropical forest in species composition: some species originate within the local forest while others are introduced from elsewhere.

Species selection in the talun-kebun enables a family to multiply the economic and nutritional benefits obtained from the same parcel of land: when the talun is harvested, larger timbers are sold for lumber while branches are used for firewood. Only leaves and other debris are burnt. This reduces the organic material incorporated into the soil upon burning, a lack which is made up by composting leaves and animal manure. The kebun is planted with a variety of vegetables that are mostly sold for cash but also supply the family's consumption needs. Meanwhile, the varied functions of the natural tropical forest ecosystem are maintained as its structure is imitated: species diversity, protection against soil erosion and leaching, and long-term maintenance of soil fertility. An intermediary stage between talun and kebun is called *kebun-campuran* or *talun-campuran,* depending upon which growth pattern dominates.

CROPPING PATTERNS: THE TALUN

In selecting talun species, a family will attempt to meet its own subsistence needs as well as providing for marketable produce. Species are selected for annual, seasonal, or continuous harvest, with long-term objectives in mind. Rather than a simple process of cutting and burning, clearing the talun is a means of harvesting marketable lumber. Food for the household is supplied by taro (*Xanthosoma* spp.), yam, chilli pepper, leunca (*Solanum nigrum*), banana, jackfruit, and coconut. Bamboo and albizzia are used as building materials, while the small branches and dead wood serve as fuel. Bamboo and fruit can also be sold in the market.

Because of the mixed culture, the harvest is spread over the entire year. For example, banana, jackfruit, and coconut do not have distinct flowering and fruiting seasons, so they can be harvested at any time. Taro and yam can also be planted and harvested continuously. Bamboo is selected for cutting depending on need and on the sizes available in the bamboo groves. This lack of seasonality greatly enhances the economic value of the talun, as harvests can be adjusted to household cash needs. Other crops, such as *duku* (*Lansium domesticum*), coffee, *kupa* (*Syzygium polyanthum*), cloves, and citrus have distinct fruiting seasons.

Owing to the great diversity of species, the talun also contains considerable genetic resources. Many species are semi-domesticated or represented by various strains, and thus the natural gene bank is enriched through species heterogeneity.

An important aspect of talun management is the accumulation of organic refuse. Fallen leaves and harvest residues are left to rot – a factor that, together with the protective

cover formed by tall growth, guards effectively against soil erosion. This function of soil-protection is crucial to the survival of the production system, as taluns usually occupy the higher and steeper slopes of the mountainous regions of West Java, while villages and wet rice fields are found on the lower slopes and in valleys.

The talun, in summary, has at least four important functions, which are important both for household survival and for ecological preservation: (i) subsistence production, (ii) commercial production (iii) gene banking, and (iv) soil conservation and sustained productivity.

CROPPING PATTERNS: THE KEBUN

The kebun is part of the talun that has been cleared for the cultivation of annual crops. This clearing can take one of three forms: total cutting, selective cutting, or pruning. In selective cutting, only certain species or trees of certain dimensions are cut; in pruning, only the branches of trees are cut, to allow more sunlight to penetrate the overhead canopy.

Total cutting and selective cutting represent total or partial harvest of the talun. The tops of bamboo trees are used for poles to support vines subsequently planted in the kebun. Usually, following an old social custom, neighbours also have the right to collect branches. Smaller branches and leaves are collected, dried in the sun, and burnt, after which the ashes are mixed with animal dung brought from the village. Ash and manure are composted together in a pile under a protective grass roof to prevent leaching.

The kebun, like the talun, may feature one main crop but it is usually mixed and multi-cropped. A typical kebun planting succession is as follows:

1. After clearing, seedbeds are prepared in a small part of the kebun for chilli pepper, *leunca* (*Solanum nigrum*), Chinese cabbage (*Brassica juncea*), and *surawung* (*Ocinum basilicum*). Poles of bamboo are set up to support the rows of *roay* (*Dolichas lablab*); the distance between rows is about 4 m and within rows about 1.5 m. Between these rows, a line of smaller bamboo poles is set up, each about 40 cm apart, to support *paria* (*Momodica charantia*) or bitter lemon. Seeds of *paria* are planted near the smaller poles, usually two seeds per hole. The soil is worked lightly with a hoe after planting.

2. Two weeks after the *paria* has been planted, holes are made near each of the larger bamboo poles for two to three seeds of *away*, which are covered with compost. At about the same time, cassava is planted along the edges of the kebun to serve as protection, as a boundary marker, and for food. Between the rows of *paria* and *roay* shallow ditches are made, where, two to three days after the *roay*, cucumber seeds are planted at intervals of 40 cm.

3. Two weeks after this planting, the cucumbers have formed one pair of leaves – a stage of growth referred to as *tumpang daun*. Vegetable seedlings from the seedbeds are now transplanted near the cucumbers and all plants are manured with a mixture of compost and urea. A few days later, the kebun is weeded and soil heaped up around the plants.

4. The first harvest begins with cucumbers 40 days after planting, and continues at three- to five-day intervals for about two months. Chinese cabbage is next, followed by *paria*, which is harvested for three weeks consecutively. At this time also, *leunca, surawung,* and chilli pepper begin to be harvested. Their productive season extends over four months, with *leunca* picked weekly, chilli pepper once a fortnight, and *surawung* irregularly depending on the productivity of the plants. *Roay* is harvested seven months and cassava nine months after planting.

The annual production cycle of the kebun is over with the cassava harvest, and the soil is hoed for a second planting. However, since new starts of bamboo and seedings of perennials have grown, fewer annuals can be cultivated. Gradually, the kebun turns into a kebun campuran or mixed garden, or a talun campuran or mixed talun, depending on growth patterns. The term "mixed" refers to the mixture of annuals and perennials. Thus, in the kebun-campuran, talun perennials have already reappeared and are allowed to grow, reducing the space available for planting typical kebun crops. To keep up production, another plot is cleared within the talun and planted to first-year kebun as part of the cycle in which it, like all kebun, will revert back to talun.

CONCLUSION

Undoubtedly, the talun-kebun system of shifting cultivation will continue to evolve as a result of demographic and socio-economic factors. One possible evolutionary trend is overexploitation leading to severe soil depletion and the subsequent demise of the system. An indication of such a danger might lie in the fact that today mainly older people are familiar with the term talun, while the younger generation is more familiar with the term kebun. Talun appears to be a term that is disappearing in West Java, due either to the rapid spread of the Indonesian language, which designates any cultivated dryland plot as *kebun*, or to the diminishing significance of the talun stage in the production cycle. If this phenomenon is more than pure linguistic substitution, it may be the result of an intensification of cultivation and a corresponding reduction in talun.

When population pressure and economic incentives become more powerful than traditional conservationist trends, cultivators begin working against their own interests for short-term gains. They reduce fallow or talun plots in size or duration and over-concentrate on commercially valuable species at the sacrifice of species diversity – one of the trade marks of the talun-kebun. Such a development will not only have certain ecological repercussions, but will also affect household nutritional status even though more cash may be available periodically.

To prevent this situation arising, studies are required on the dynamics of the talun-kebun, ecologically and as part of the peasant economy. Means must be designed to preserve this valuable system, so that it can continue to sustain the lives of the people with whom it originated. The improvement of agricultural techniques and plant materials to obtain quantitatively and qualitatively higher yields are two points of departure. At the same time, improvement of extension education and training in new technologies may contribute to improving the system.

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WEST INDIAN KITCHEN GARDENS: A Historical Perspective with Current Insights from Grenada

John S. Brierley
Department of Geography, University of Manitoba, Winnipeg, Manitoba, Canada

INTRODUCTION

The islands of the West Indies have long been noted for their small farm subsistence agriculture. However, one important aspect of this production system, the kitchen garden, has received little attention in terms of both basic research and programmes aimed at its improvement.

Caribbean kitchen gardens date back to slave plantation days. They have challenged the descriptive talents of early travellers like Beckford [1], Edwards [5], Kingsley [11], and Trollope [18]. Kitchen gardens sustained slave workers on sugar plantations and provided the basis for future farming enterprises for slave families upon emancipation. Today these gardens continue to be a ubiquitous feature of the agricultural landscape in the Caribbean.

The major point of this article is to highlight the crucial economic and nutritional importance of kitchen gardens for the small farm enterprise. These small units of production surrounding the Caribbean homestead are a microcosm of the farming system: the crop production knowledge and the skills of successive generations are acquired and passed on via the kitchen garden, which can be either a principal component of subsistence farming or the embryo from which a commercial agricultural or horticultural enterprise may develop. Its roles range from that of a farm family's major source of subsistence to that of a minor source of income.

BACKGROUND TO GRENADA

The economic and political crises in Grenada during the 1970s resulted in the coup of 1979 and the formation of the People's Revolutionary Government (PRG). This change of government had direct implications for Grenadian kitchen gardens as the PRG's development strategies aimed at promoting national self-reliance. For the first time in their history Grenadians were given the goal of feeding themselves, an ambitious one at a time when food imports still accounted for one-third of total imports [14].

In this regard, Ifill [7] notes that in 1974 the estimated daily calorie intake per capita was 1,958.4, of which 1,535.9 were supplied by imported food and 422.5 by locally grown food. With respect to protein per capita, daily intake was 46.03 g, of which imported food supplied 31.72 g and local sources 14.31 g. In 1978 the situation would have been much the same.

"Dooryard gardening" was encouraged as part of the campaign geared to produce more food locally [4]. In addition, the Government initiated campaigns to raise Grenadians' awareness and knowledge of farming and nutrition in the hopes of using the nation's human and natural resources more effectively. Grenada's PRG was among the first governments in Caribbean history to identify the potential role of food production in kitchen gardens in improving the domestic fruit and vegetable supply and in reducing the massive imports of basic foodstuffs.

SUBSISTENCE FOOD PRODUCTION IN HISTORICAL PERSPECTIVE

In Grenada, two major forms of rural small-scale food production can be distinguished: kitchen gardens and provision grounds. Kitchen gardens are fragments of land surrounding the homestead with space for livestock, trees, and vegetable beds. Provision grounds consist of larger, separate parcels, often some distance from the homestead, where the same tree and vegetable crops are found. Although serving similar purposes, kitchen gardens and provision grounds each possess a character of their own.

Historically, kitchen gardens were cultivated plots behind slave cabins, close to the sugar mills where water was available [5]. They could be tended and protected better than the more distant provision grounds, and therefore had a greater variety of plant species and, in many cases, goats, pigs, and poultry. The kitchen garden was usually smaller than 500 m^2 and featured plantain, banana, coconut, shaddock, orange, mango, and avocado pear as dominant species. Tropical root crops, such as yams and eddoes, as well as leaf vegetables and peppers are also reported [2, 5]. Provision grounds, however, were more significant in supplying slaves with subsistence needs: they were larger in size, averaging 2,000 m^2 [13], and

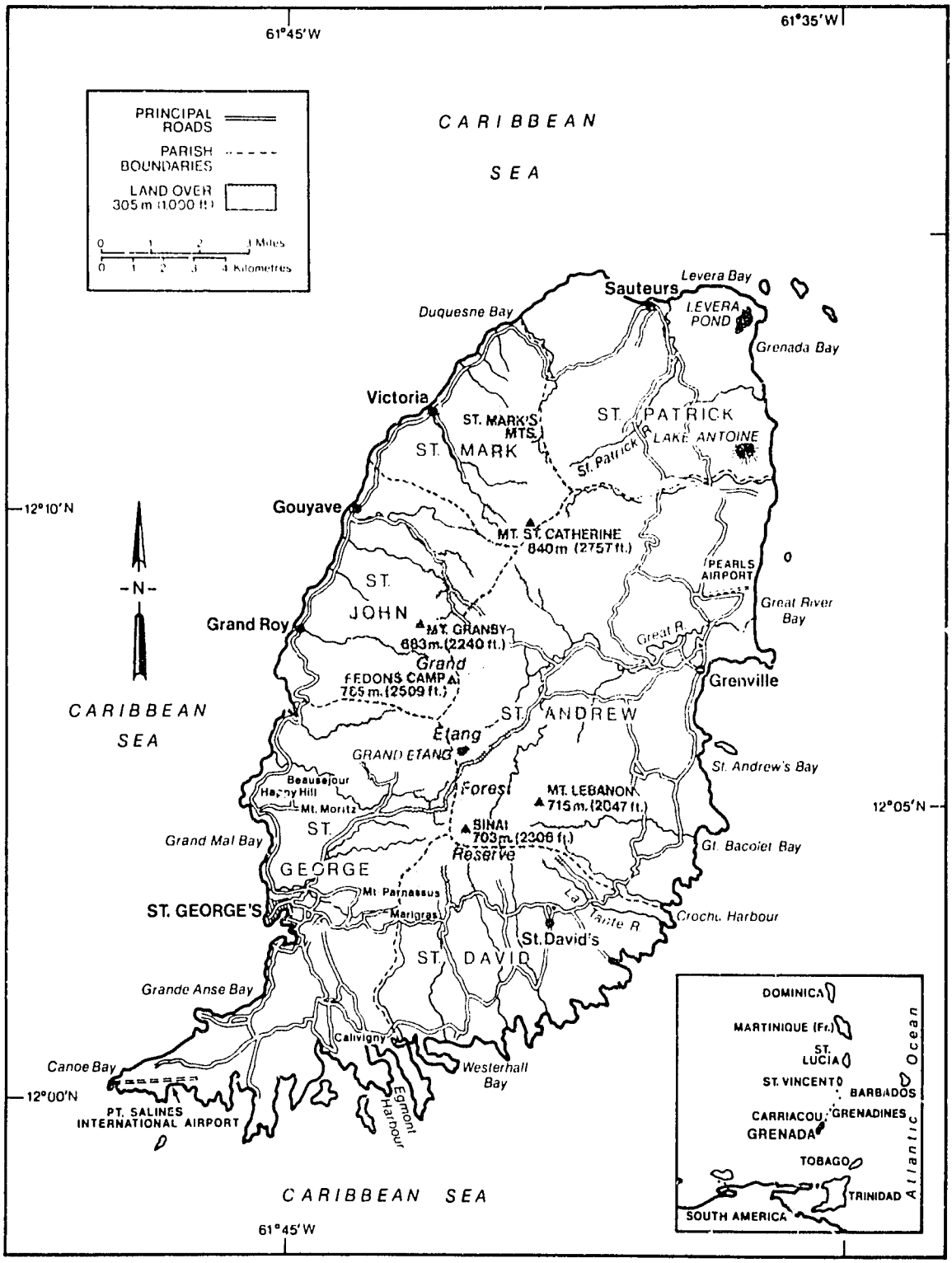

FIG. 1. Grenada

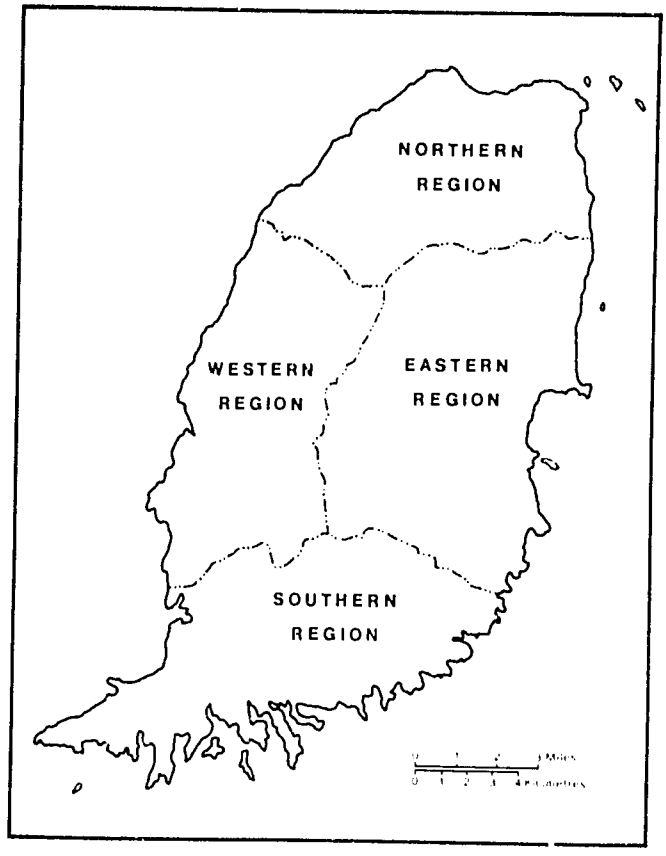

FIG. 2. Grenada: Agricultural Regions

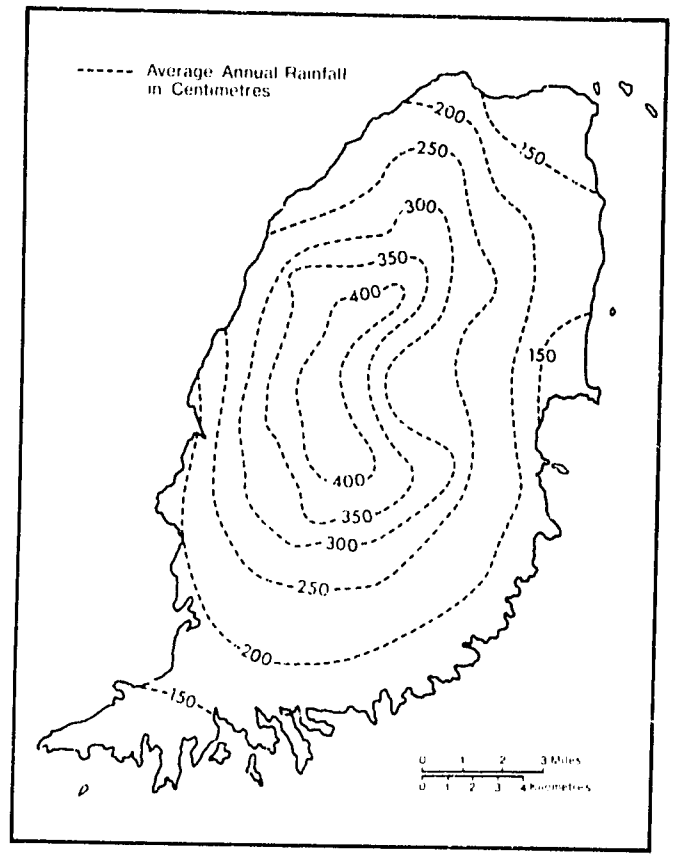

FIG. 3. Grenada: Annual Rainfall (after *Soil and Land-use Survey No. 9,* Grenada, 1959)

located up to 16 kilometres from slave cabins on land unsuited for cane production. The size of the provision grounds depended on the location and size of plantations, on the topography, and on market and political considerations. The time allocated to slaves for working provision grounds and kitchen gardens also varied, the norm being Saturday afternoons, Sundays and holidays, with generally less time allowed during peak labour periods in sugar production. Edwards estimated an average of 16 hours labour input per month for Jamaican provision grounds [5].

Following emancipation in 1834, the West Indian peasantry became firmly established. The traditions and practices of both kitchen gardens and provision grounds were incorporated into post-emancipation small-scale food production systems [6]. Some slaves left the plantation and settled on their provision grounds, which then, by definition, became "kitchen gardens" and nuclei for future farming enterprises. Others migrated from the plantations and became squatters on Crown land in the rugged interior of the island or remained on the plantation until such time as they could acquire their own piece of land [16]. Since independence cost the ex-slaves food supplies previously provided by the plantation owner, they were forced to rely solely on their own food production. As a result, the former provision ground took on a new and greater significance.

In spite of the economic and nutritional importance of kitchen gardens following emancipation, few detailed descriptions of their nature and management exist. Early writers were impressed by cropping density and variety, the dominance of food trees over vegetable crops, and the fact that a small plot could support a "numerous family" [11]. None the less, provision grounds and kitchen gardens were contrasted with gardens in England and Ireland, with a view to recommending European "scientific" gardening and farming practices [1, 18]. Today, over a century later, the character of the West Indian kitchen garden remains, however, intrinsically the same.

PHYSICAL CHARACTERISTICS OF GRENADIAN KITCHEN GARDENS

A land-use survey was conducted in 1982 of 210 farms randomly selected in the four agricultural administrative regions comprising the main island of Grenada (fig. 2). To be included in the sample, a farmer had to occupy at

TABLE 1. Distribution and Characteristics of Kitchen Gardens

Agricultural Region	Kitchen Gardens		Sampled Farmers with a House Spot (no kitchen garden)		Mean Size of Kitchen Garden (ares)	Number of Kitchen Gardens with ≤ 20 Ares
	No.	Percentage of total	No.	Percentage of total		
Northern	37	79	10	21	80	13
Eastern	50	86	8	14	43	25
Southern	47	94	3	6	42	18
Western	38	76	12	24	51	22
Grenada	172	84	33	16	54	78

least 4,000 m^2 of land and could not represent a government-operated state farm. While not all surveyed homesteads had kitchen gardens, all had planted additional parcels – provision grounds – usually within one kilometre of the homestead. Previous research [3] has been primarily oriented toward Grenadian small farming and invariably underlines the role played by these small production units within farming systems.

Although a small island with an area of only 308 km^2, Grenada possesses considerable topographical variations owing to its volcanic origins (fig. 1). These variations, in turn, affect distribution of rainfall (fig. 3) and, hence, the kinds of crops planted in kitchen gardens and provision grounds. Variations in kitchen garden crops are also related to factors such as the age, health, and economic status of the farmers.

Forty-five per cent of the gardens in the sample measured between 1,000 m^2 and 2,000 m^2. Regional differences in size were considerable (table 1). Generally, garden size was affected by the ribbon-like settlement pattern along roads and dirt paths following the coastline or contours of valleys. Where settlement patterns became denser, gardens tended to be smaller, and the combined effects of population pressure and poverty could result in the occupation of a mere "house spot," a fragment of land with the farmer's house and some space for cultivation. This situation was encountered in 16 per cent of the sample. Gardens smaller than 2,000 m^2 in size could not provide all the fruits and vegetables required by a family of five. To be self-sufficient, these households needed to augment their food supply from the provision grounds.

Table 2 shows the nutritional content of a selection of fruits and vegetables commonly found in Grenadian kitchen gardens. An examination of these data reveals that a fairly comprehensive range of household dietary needs are supplied from this source. This nutritional balance of crops must be attributed not to coincidence, but rather to traditional knowledge and a process of selection governed by the dietary needs and ecological potential of the region. Purchased ingredients rounding out the list of consumption items included imported rice and milk (canned or powdered) and fish and meat, which may have been of either local or foreign origin.

Farmers owning over 20 ha showed a tendency to omit the cultivation of vegetables, but maintained fruit trees in conjunction with a flower garden and a lawn. Large holders, engaged in growing bananas, cocoa, and nutmeg for export, considered it uneconomical or below their social status to grow vegetables.

GARDEN MANAGEMENT, CROPPING PATTERNS, AND SPATIAL ARRANGEMENTS

Kitchen gardens in Grenada today still appear "crowded, confused, and haphazard," traits which Kingsley [11] ascribed in 1871 to Trinidadian provision grounds. Innis [8-10], on the other hand, has recognized the virtues of traditional cropping practices, including mixed cropping, inter-cropping, and inter-culture of trees and vegetables.*

In the traditional pattern crops were arranged in natural "storeys": root crops occupied the subterranean level, followed by surface plants (notably beans, melons, and pumpkins), then by taller crops (such as cassava, maize, and peppers), with trees at the highest level, providing a

* Ruthenberg [15] makes useful distinctions between these terms. Mixed cropping refers to the intermingled and simultaneous cultivation of two or more crops; inter-cropping is the simultaneous cropping of two or more plants in alternated rows; and inter-culture is the planting of arable crops under perennial crops.

TABLE 2. Nutritional Contents of Some Tree and Vegetable Crops Found in Grenadian Kitchen Gardens

	Basic Contents (per 100 g)				Minerals (mg/100 g)					Vitamins (mg/100 g)				
	Water (%)	Energy (kcal)	Protein (g)	Fat (g)	Ca	P	Fe	Na	K	A IU[a]	B_1	B_2	Niacin	C
Tree crops														
Avocado	74	*167*[b]	*2.1*	*16.4*	10	42	0.6	4	*604*	290	0.11	0.20	*1.6*	14
Banana	76	85	1.1	0.2	8	26	0.7	1	*370*	190	0.05	0.06	0.7	10
Breadfruit	71	*103*	1.7	0.3	*33*	32	1.2	*15*	*439*	40	0.11	0.03	0.9	*29*
Cocoa (powder)	3	*299*	*16.8*	*23.7*	*133*	*648*	10.7	6	*1,522*	30	0.11	0.46	*2.4*	–
Coconut (fresh)	51	*346*	*3.5*	*35.3*	13	*95*	1.7	23	256	–	0.05	0.02	0.5	3
Lime	89	28	0.7	0.2	*33*	18	0.6	2	102	10	0.03	0.02	0.2	*37*
Mango	82	66	0.7	0.4	10	13	0.4	7	189	*4,800*	0.05	0.05	1.1	*35*
Sapodilla	76	89	0.5	1.1	21	12	0.8	12	193	60	–	0.02	0.2	14
Soursop	82	65	1.0	0.3	14	27	0.6	14	265	10	0.07	0.05	0.9	20
Star apple	74	94	1.3	0.4	23	40	0.5	–	–	10	0.10	0.11	*1.3*	9
Vegetable crops														
Cabbage	92	24	1.3	0.2	*49*	29	0.4	*20*	233	130	0.05	0.05	0.3	*47*
Carrot	88	42	1.1	0.2	*37*	36	0.7	*47*	*341*	*11,000*	0.06	0.05	0.6	8
Cassava	63	*146*	1.2	0.3	*33*	–	0.7	–	–	–	0.06	0.03	0.6	*36*
Corn (ground)	12	*368*	*7.8*	2.6	6	*164*	1.8	1	–	340	0.20	0.06	*1.4*	–
Dasheen	73	98	1.9	0.2	28	61	1.0	7	*514*	20	0.13	0.04	*1.1*	4
French bean	90	32	1.9	0.2	*56*	44	0.8	7	243	600	0.08	0.11	0.5	19
Lettuce	94	18	1.3	0.3	*68*	25	1.4	9	264	*1,900*	0.05	0.08	0.4	18
Pepper (hot)	89	37	1.3	0.2	10	25	0.7	–	–	770	0.09	0.06	*1.7*	*235*
Sweet potato	71	*114*	1.7	0.4	20	32	0.7	10	243	*8,800*	0.10	0.06	0.6	21
Yam	74	*101*	*2.1*	0.2	20	69	0.6	–	*600*	–	0.10	0.04	0.5	9

a. IU = International units.
b. Values in italics denote major sources.
Source: United States Department of Agriculture, *Handbook of the Nutritional Contents of Foods*, Agriculture Handbook No. 8 (Washington, D.C., 1963).

comprehensive cover against soil erosion during heavy downpours and preventing or retarding the spread of disease and pests.

In spite of the limited garden space, sloping terrain, and poor soil of Grenada, only a minimal labour input is needed to produce a year-round supply of crops; it is therefore evident that efficient methods of cultivation were developed and suitable species selected [17]. Acknowledging their African roots, Innis [8] points out that Jamaican gardens "evolved from thousands of years of . . . empirical experimentation" with cropping lists including bananas, plantains, and yams from Africa, New World crops such as cassava, maize, and sweet potatoes, and salad vegetables and crops of temperate origin introduced from Europe. Thus a distinctive crop repertory was created [12].

The frequent presence of the island's three main export crops (banana, cocoa, and nutmeg) in kitchen gardens and provision grounds confirms the hypothesis that kitchen gardens represent an embryonic stage for future farm development. In their kitchen gardens potential export-crop producers can learn the cultivation techniques for these crops, which they may then use when they acquire additional land. It is noteworthy that cocoa beans are not exclusively cultivated for making into powder but are often cooked and eaten as a vegetable.

Cropping traditions in Grenada are highly localized. Each valley community can be considered a unique sub-region with its own features with respect to crops and cultivation practices.

In general, Grenadian kitchen gardens are dominated by trees, many with evergreen characteristics. Besides bearing fruit, these trees perform other functions: shading houses and vegetable plots, and, in the case of taller species, delimiting property boundaries. Members of the Musa family are the most common tree in kitchen gardens, and are found in over 80 per cent of them. Several types of banana clusters are invariably present, each bearing fruit at different times throughout the year, which eliminates long-term shortages of this essential dietary item. Over

TABLE 3. Tree Crops: Percentage Distribution[a] and Indices of Occurrence[b]

Tree Crops	Agricultural Regions				Grenada Percentage
	Northern	Eastern	Southern	Western	
Annonaceous fruits[c]	46	40	74	5	43
Avocado pear	68	44	60	34	51
Banana (export varieties)	27	34	2	39	25
Banana (domestic use)	89	72	94	39	74
Breadfruit/breadnut	81	72	74	34	66
Cashew	5	10	14	5	9
Cinnamon	3	6	15	5	8
Clove	3	2	11	3	5
Cocoa	86	74	74	42	70
Coconut	81	68	81	55	72
Golden apple[d]	19	30	32	8	23
Lime	8	18	26	13	17
Orange	54	42	38	79	47
Other citrus[e]	16	28	30	21	23
Mango	86	62	68	37	63
Nutmeg	59	56	53	47	54
Papaya	-	12	11	5	8
Sapodilla	27	22	21	11	20
Other fruits[f]	11	12	4	3	8
Index of occurrence	0.39	0.35	0.41	0.24	0.34

a. Percentage distribution refers to the percentage of gardens with a given crop as compared to the total number of gardens.

b. Index of occurrence $I = \frac{\Sigma a}{P}$ where a = individual occurrence of a crop, P = maximum potential occurrence.

c. Includes mainly soursop, but also sugar apple and custard apple.

d. Also referred to as Jew Plum and June Plum.

e. Includes grapefruit, citron, and tangerine.

f. Includes guava, pineapple, star apple, pimento, and tamarind.

half the sample gardens also feature avocado pear, breadfruit, cocoa, coconut, citrus fruit, mango, and nutmeg. Regional variation in the distribution of trees is apparent from their indices of occurrence (the actual number of occurrences as a ratio of the total possible number) (table 3). This variation is the result of ecological as well as cultural factors, such as the preference for oranges over mangoes in the western region of the island.

An outstanding feature of Grenadian kitchen gardens is the size of the area given to root and tuber production for home consumption. *Dasheen* (*Colocasia esculenta*), tannias (*Xanthosoma sagittifolium*), and yams often occupied over two-thirds of the tilled garden space in the sample. Of secondary importance was the inter-cropping of maize and pigeon peas (*Cajanus cajan*). Found in over 30 per cent of the sample gardens, but occupying relatively less space, were French beans, peppers, and tomatoes. Beds of cabbage and lettuce were sometimes found in larger gardens. Overall, vegetables varied less across the four agricultural regions than trees (tables 3 and 4). However, the humid tropical gardens in the western region showed the lowest species diversity both in tree and vegetable crops, with indices of 0.24 and 0.20. This ecological selection affected particularly maize and pigeon peas, both crops requiring dry conditions to mature. *Dasheen,* on the other hand, favours a moist climate and was more common in the western region.

Besides their ecological benefits, irregular planting arrangements in the gardens establish visual barriers, which conceal more valuable crops, such as pumpkin and papaya, and make theft less likely. Pigeon pea bushes often serve as a hedge shielding an area of root crops and bananas, followed in turn by a network of tall stakes or maize supporting yam vines. Behind these "barricades," the most valued crops are found – cabbage, tomatoes, papaya, and eggplant. This pattern of planting originated when plantation slaves had to protect their provision grounds against praedial larceny. Today some farmers believe that this cropping arrangement promotes better plant growth.

High species intensity is a functional characteristic of Grenadian gardens. As a result of varied cropping practices,

TABLE 4. Vegetable Crops: Percentage Distribution and Indices of Occurrence

Classes of Vegetables	Agricultural Regions				Grenada Total
	Northern	Eastern	Southern	Western	
Tropical roots and tubers					
Cassava	22	14	26	11	18
Dasheen	43	50	57	61	53
Eddoes	–	2	4	5	3
Tannias	59	62	68	45	59
Sweet potatoes	22	32	34	26	29
Yams	62	40	51	26	45
Temperate roots					
Beetroot	3	2	6	–	3
Carrots	16	12	15	16	15
Onions	–	4	2	–	2
Radishes	5	2	4	–	3
Green leaf					
Cabbage	24	28	26	21	25
Celery	–	4	–	–	1
Lettuce	27	24	23	21	24
Fruit and pods					
Corn	41	42	51	24	40
Cow peas	–	2	9	–	3
Cucumber	22	24	19	13	20
French beans	24	34	32	34	31
Melongene	8	20	9	11	12
Okra	14	20	21	29	21
Peppers	41	44	34	46	41
Pigeon peas	65	56	57	29	54
Pumpkins, melons	–	18	6	3	8
Tomatoes	35	46	36	37	39
Others					
Chive and thyme	19	8	13	32	17
Sugar cane	5	4	9	8	6
Index of occurrence	0.22	0.24	0.25	0.20	0.23

in our sample as many as 18 vegetable varieties and 13 distinct types of food trees coexisted in a kitchen garden of less than 2,000 m^2, with an average of six for each category. Many variations existed in regard to the crop combinations used in both mixed cropping and inter-cropping. One common practice was to plant two or three different vegetables in the same hole. Traditional groupings of species were observed, one of which combined French beans, maize, and tannias. The advantages of this particular grouping method are:

- the leguminous bean increases the nitrogen in the soil, which benefits maize and tannias;
- the soil has a protective cover during much of the wet season; and
- the farmer makes maximum use of the land by cultivating crops which produce in the ground, on the ground, and above the ground.

More commonly, inter-cropping with pairs of crops was found, such as cassava and sweet potatoes, maize and pigeon peas, maize and sweet potato, and yams and tannias. In fact, it was the rule rather than the exception for most tropical roots and tubers, along with maize and pigeon peas, to be inter-cropped.

Monoculture was practised specifically with vegetables associated with temperate regions, including cabbage, carrots, lettuce, and tomatoes. If present, these least adapted vegetables were generally propagated in seed boxes and transplanted. Occupying a mere fraction of the total area, temperate vegetables were regarded as luxuries which supplied variety to the predominantly starchy diet.

Less than one-fifth of all the gardeners in the sample engaged systematically in fallow rotation. Soil fertility was

maintained by the addition of manure or compost, both of which were scarce, at the time of planting. If possible, the gardeners pursued some system of annual crop rotation in their various vegetable beds to help preserve soil fertility and retard a build-up of pests and disease. Farmers who followed a system of fallowing had larger-than-average gardens and/or poor soil. All gardeners, however, periodically fallowed about one-quarter of the land devoted to vegetables for one year. During this time, the surface was protected from erosion by the remnants of the last crop, which also added organic matter to the soil.

Interspersed with the vegetable gardens in the sample were numerous trees whose generally irregular spacing suggested accidental propagation. Where there were a large number of cocoa and nutmeg trees grown as cash crops, however, the trees were spaced uniformly. Young stands of cocoa were often shaded by members of the Musa family. Intentional selection and planting of trees was also found close to the house and along property lines. Coconut and breadfruit often demarcated boundary lines while a variety of evergreens provided the house and the kitchen-shed with shade all year round.

Animal husbandry was a minor aspect of these kitchen gardens, but some mammals and birds were kept by the majority of the households sampled. They provided a source of meat on festive occasions or ready cash in times of financial hardship. Poultry was most common with around twelve animals per flock in over 80 per cent of the sample gardens. Most birds were common fowl, running loose and primarily fending for themselves. Hence, seed

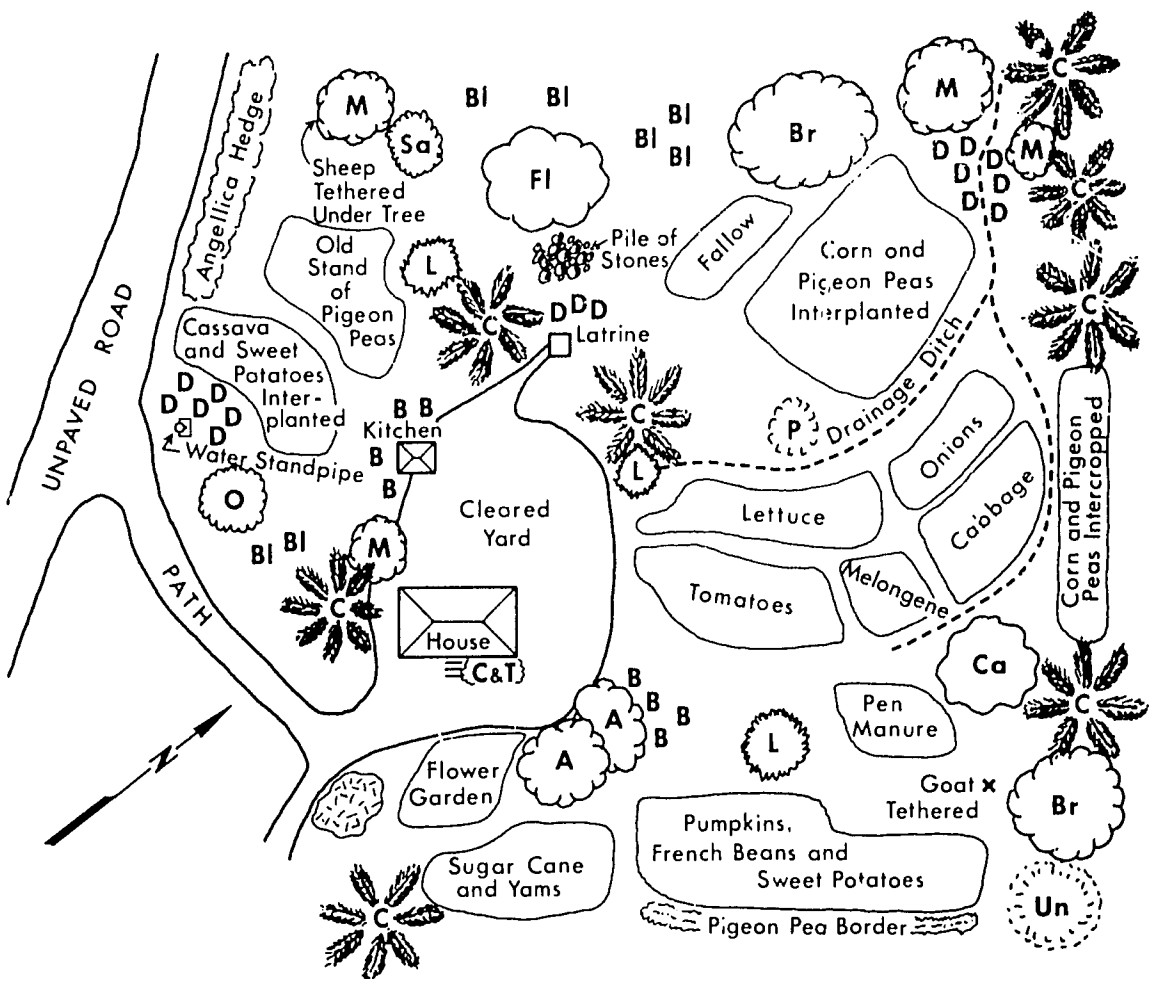

FIG. 4 Plan of Kitchen Garden, Eastern Region

boxes and some vegetable beds needed to be protected. Less than 15 per cent of the sample had enclosed pens for raising better quality birds and collecting eggs. Pigs, goats, sheep, and cattle (in order of importance) were found in less than 23 per cent of the gardens studied. Pigs were usually tethered or penned in the shade of trees; ruminants were grazed along roadways, on common grassland, or on vacant land during the day and were returned to the security of the garden at night.

Many of the basic features of Grenadian kitchen gardens are indicated in figure 4. The garden represented in the figure, which covered 4,000 m^2 and was located in the eastern region, was not typical, however, for it had a greater variety of vegetables and trees than the norm, was situated on relatively flat land, and had a cash-crop component. Although not typical, it illustrates the wide variety of species and the extensive utilization of a relatively small plot of land on the island.

CONCLUSION

Despite considerable social and economic developments that have affected the Caribbean region during this century, kitchen gardens have undergone no fundamental changes. As shown in the Grenadian case, they still possess the hallmarks noted by nineteenth-century travellers. Early writers, like the majority of agricultural extension programme planners today, failed to appreciate that the adoption of different practices would require additional labour and capital expenditures which many West Indians could not – and cannot to date – afford.

The immutability of kitchen gardens is testimony to the reliability of the cropping practices used. The gardens supply satisfactory returns, given human and capital inputs and environmental constraints. It is only within the last 20 years that the agronomic merits of inter-cropping have been recognized as a means of maintaining soil fertility and limiting erosion, while reducing the need to use chemical fertilizers and chemical methods of pest control. During the 1970s, the cost of these chemicals increased dramatically as a result of the energy crisis and became priced out of the reach of small farmers. Thus, the traditional farming practices of the West Indies may continue as a well-adapted, important production strategy.

Also, on these plots of land, children assimilate knowledge about plants and cultivation techniques as they assist parents and grandparents in growing basic food crops. This traditional wisdom has not been altered either by schooling, which historically has omitted agriculture from its syllabus, or by extension officers, who have invariably directed their attention to larger land units and commercial farming.

This official neglect of kitchen gardens and provision grounds has both positive and negative aspects: many traditional cultivation practices have been preserved in the kitchen garden. On the other hand, there is no doubt room for well-informed integrated improvement of present management, in regard to both cash-crop production and family nutrition.

During its brief tenure, the PRG followed development strategies aimed less at transforming local farming practices than at putting idle land into production. Where better to start this process than with popularizing kitchen gardens! It is impossible to quantify the PRG's success in this endeavour. In 1982, there was evidence of renewed interest and activity in kitchen-garden cultivation, with an increasing number of households becoming more self-sufficient in their food needs. As the nation's economic problems continue to worsen, one obviously hopes that this trend will persist. Grenada's new administration must recognize the agricultural significance of kitchen gardens, which is far greater than their small size would suggest.

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SUBSISTENCE GARDENS IN NEWFOUNDLAND

John T. Omohundro
State University of New York, Potsdam, N.Y., USA

INTRODUCTION

Home gardening in Newfoundland should be understood as more than a folkloric anachronism. For centuries, gardens have been a component of North Atlantic survival strategies that governments would do well to encourage. The role of Newfoundland gardens in supporting coastal settlements, or outports, in the last century, for example, reveals much about the way outport economy has operated. As Cole and Wolf observed [5, p. 371], local village tradition is partially shaped by adaptation to the world beyond the village. Analysing how gardening is related to the household economy and how both are influenced by factors in the region at large is thus a valid research strategy for understanding recent changes in both gardening and the household economy.

Without a holistic and regional approach to subsistence production, any well-meaning project for sustaining or changing garden production will misread its dynamics and may propose the wrong solutions. This article, therefore, examines historic and contemporary gardening in the outports of northern Newfoundland as representative of gardening in the broader North Atlantic coastal region.

After placing Newfoundland home gardens in a wider North Atlantic perspective, I shall give an account of the pre-1940 gardening situation and of traditional practices. Changes in gardening patterns in response to recent changes in outport life are treated in the next section, followed by an analysis of the current status of gardening in northern Newfoundland. Finally, government programmes promoting home food production will be examined, and suggestions for improvement will be offered.

A REGIONAL APPROACH

From New England and the St. Lawrence Gulf to Iceland and the British Isles, subsistence activities in coastal settlements have been so similar that they merit consideration as one ethnographic region [11, p. 248]. Settlements along the North Atlantic rim have evolved a pluralistic economy combining fishing, gathering, wage work, and cultivation, the products of which are used partly for sale and partly for subsistence. These mixed fishing-farming villages all have seasonal work cycles, and similar tools and work organization. Although today their larger political and economic settings are different, historically even these were similar.

From a centre-to-periphery perspective [31], North Atlantic rural coastal communities developed into specialized hinterlands supplying a diversified industrial core in Europe and, more recently, in North America. Households traded local resources for essential imported foodstuffs, adjusting their economic operations to ensure a trade or purchase margin within a worldwide mercantile system that they neither controlled nor understood. Living at the periphery of the economically developed centres, coastal fishermen and "crofters," small tenant farmers, contributed by supplying raw materials, but as they were relatively undiversified in their contributions they were ravaged periodically by business downturns occurring at the centre [21].

To compensate for the insecurity of outport life, North Atlantic settlers developed diversified subsistence systems which operated as an alternative economic sphere [3, 30]. Animal husbandry, small-scale plough farming, hunting, plant gathering, and home gardening provide insurance against the fluctuations of the world markets and make up for the dietary shortcomings of the few purchased imports.

Since the Second World War, the North Atlantic coastal communities have undergone pervasive changes. The industrialization of fishing, the resettlement of entire communities, the arrival of new industries such as oil exploration and tourism, and heavy outmigration are common developments. In some areas, the survival of communities is still uncertain [21]. It is within this framework, then, that the island of Newfoundland has to be understood.

Newfoundland was settled relatively recently, a fact which makes it somewhat atypical of the wider North Atlantic region. The year-round population of the island exceeded 10,000 only after 1800. In the early 1800s some of its resources — such as the migrating harp seals — became commodities on the world market and deteriorating economic conditions brought immigrants from rural Britain and Ireland [11, p. 245]. From the outset, Newfoundland coastal residents lived in nucleated rather than dispersed

settlements, a practice which generated a complex social life reminiscent of the settlers' homes in Old World areas.

Newfoundland is also atypical in its socio-political organization. After confederating with Canada in 1949, changes occurred that still influence decisions at all social and economic levels, including gardening. But although gardens in the whole region are now in a state of change, historically they have been a stable element in outport household economies.

OUTPORT GARDENING IN RELATION TO OTHER SUBSISTENCE AND CASH ACTIVITIES BEFORE 1940

Newfoundland gardens have many features in common with those in other North Atlantic regions: they have the same Celtic and Norse origins and have been adapted to similar limitations in labour time, arable soil, and photoperiod [14, 24]. The Newfoundland gardening tradition in the last two centuries can be characterized by six features that constitute a common core and that still hold true for contemporary gardening:

1. The crops consisted of root crops (especially swede turnip), cole crops (mainly cabbage), and potatoes – all hardy, cool weather vegetables.
2. Manual labour predominated, although in some areas horse and plough were used.
3. Sexual division of labour was minimal. Apart from the fact that men rarely handled vegetables other than potatoes, men and women did similar work.
4. Garden tasks were carried out by entire households ("crowds") during brief respites from other subsistence activities.
5. Special bedding and fertilizing methods were used.
6. The crops were raised primarily for household consumption, but surplus might have been sold or traded.

Home food production before the Second World War consisted of small-scale animal husbandry, potato patches, and kitchen gardens. A household's investment in animal husbandry was limited because meadowlands close to the outport were small and, after other primary work, there was little time to collect fodder. Chickens, pigs, a few milk cows, and perhaps a half dozen sheep provided eggs, fresh meat, and milk, but rarely cheese. In some areas of the island, the animals could be fed during the long winters on cereals grown as green fodder grasses, but in many settlements stands of wild grasses were carefully tended and scythed between fishing tasks. Even with women and children performing most of the labour, animal husbandry encountered a growth ceiling that did not exist in the Old World.

One aspect of Newfoundland animal husbandry was remarkable for its novelty: nowhere else in the world have settlers attempted to maintain dogs for pulling sleds, as well as raising other animals. The idea of dog teams was borrowed from Inuit culture. The teams were invaluable until the advent of snowmobiles in the 1960s, when the dog sleds were rapidly and happily abandoned. The incompatibility of semi-domesticated sled dogs with the sheep and chickens in the outports is legendary. The plight of the harried outport householder was the same as that of the farmer in the conundrum involving the fox, the goose, and the grain. Vigilance was required to protect gardens from children and livestock; vigilance, too, was required to protect children and livestock from the dogs. Only the garden was a benign companion: it fed the children, the dogs, and the livestock.

Horticulture production took place on two distinct lots: potato patches, here referred to as "outport gardens," which were some distance from the house, and "kitchen gardens," smaller in size and adjacent to the house for better care and protection. Outport gardens were planted mainly with potatoes and turnips, but could also contain beets and onions. Kitchen gardens near the house might have had cabbages, peas, carrots, lettuce, cauliflower, hops, and chives.

Since the nineteenth century, crops requiring a longer photoperiod or less acid soil, such as tomatoes, cucurbits, and cereals, have been grown in a few locales where the soil is unusually fertile and the average summer temperature adequate. Most coastal settlers, however, have found such crops too delicate for their area.

Home gardening, small animal husbandry, and the hunt provided the bulk of outport diet. Such a combination of complementary survival strategies was insurance against the risk of failure of any one of them. Gardening was subordinate to fishing, but the two were complementary in many ways. When fishing failed, outporters relied on their gardens and other subsistence products [6, p. 99]. Fish provided important fertilizer for the poor soil, and disused fishing equipment was utilized either in working the soil (for example, anchors were used as ploughs) or in storing garden produce (old boats became root cellar roofs). Fishing and gardening also complemented each other in terms of labour and time allocation: they flourished under opposite weather conditions.

In dual economies with both a subsistence and a market sphere, one economic activity will be subordinate to another. In Newfoundland outport household economies, gardening was subordinate to the outports' main means of subsistence – fishing, logging, or trapping – and garden work was done during breaks in the other routines [9, 16]. None the less, gardening was recognized as a vital survival activity that helped prevent endemic malnutrition and

periodic undernutrition accompanied by beriberi, anaemia, and scurvy [15, p. 19; 18, p. 99].

Outport gardens produced all the foods consumed except flour, beef, tea, and sugar, which were imported and distributed through a supply network called the "truck system," as it was tied to the passable roads on the island. Newfoundlanders traded their fish, logs, seals, and furs in an essentially cashless economy [30, pp. 22-23; 27, p. 42]. Outport gardening practices, an essential aspect of outport economies, remained unchanged for over two hundred years. Newfoundlanders' marginal economic role and the harshness of their environment kept them living as "wilderness pioneers," a curious mix of hunter and proletarian [26, 30].

THE ROAD TO MODERNIZATION: THE FALL AND RISE OF HOME GARDENING

By the twentieth century, Newfoundland's Victorian policy of stimulating commercial agriculture in the interior and reducing the island's dependence was no longer implemented. In 1901, most of the 150 km^2 of cropland was under the hoe of subsistence gardeners or part-time, quasi-commercial farmers near the coast [23, p. 183]. Home production was still important before the Second World War, and had considerable economic value: outporters were producing 55 cents' worth of subsistence goods for every dollar of exportable cod [1, p. 22].

Among those subsistence goods were 54 million kg of potatoes from home gardens and small fields (or 205 kg per capita per annum), and 6.39 million kg of cabbage, according to the 1935 Newfoundland census. This produce was consumed by islanders and their livestock, supplemented by another 13.65 million kg of imported vegetables [4, p. 135].

The Second World War generated opportunities for wage work and ended the stagnant economy on the island. Because many family members migrated to areas where wage work was available, subsistence activities received less attention. By the end of the war, according to the census, the total amount of improved land had declined to barely half that in use in 1911 [25]. This decline in subsistence production accelerated when Newfoundland joined the Canadian Confederation in 1949. The precariousness of life that had made gardening necessary began to diminish. Unemployment compensation, retirement benefits, and welfare cheques became a significant part of household income. The fishing and logging industries were revitalized for a time, and they paid well. Roads began to connect isolated communities to regular supplies of groceries, to wage work, and to health care and other conveniences of modern civilization. Since these conveniences were declared essential, residents moved to selected "resettlement centres."

Household food production in the province fell to an all-time low in the 1960s, with less than half the households growing anything [32, pp. 86-92, 33] and with those that were providing only a small proportion of their family income in this way [8; 10, p. 115; 30, p. 41]. Gardens were smaller and contained fewer crops than before. Bad years in fishing or logging, rather than prompting a return to self-sufficiency, led to a mass exodus of young men and women to the factories, forests, and oilfields of mainland Canada. The outports thus lost many strong workers and apprentice gardeners.

By the 1960s, young married couples who should have been starting their family garden often failed to do so because they did not know how. Their own parents had abandoned gardens to do wartime wage work, leaving the younger generation with little experience. As a result, the 1960s saw outport women spending very little time in food production, even though they had plenty of leisure time at their disposal. However, in the early 1970s fish plants were constructed in the outports, and leisure was quickly exchanged for long, irregular hours of heavy work.

The precise reasons why gardening and other subsistence activities declined are debatable. It has been proposed that the loss of discretionary labour time as people took up wage work was responsible [29; 32, pp. 129, 134; 34], and in the North Peninsula outports I surveyed, this was indeed one of the reasons given for reducing the time spent on gardens or abandoning them altogether. On the other hand, it has been argued that transfer payments and the new welfare programmes reduced the value of small gardens as a winter diet insurance [30, p. 54]. A complementary thesis is the decline in family size and the family labour force due to fewer births, increased outmigration, and a demographic shift toward retired couples and elderly single people residing in the outports.

Dyke [8] noted a correlation between the maintenance of home gardens and dependence on inshore fishery, but few systematic tests are available to substantiate such claims. Also, with the arrival of a cash economy, conspicuous consumption appeared and changed Newfoundland lifestyles in emulation of twentieth-century mainland Canada [32]. Consequently, "gardens, goats, and berrypicking" were stigmatized as the remnants of a backward life [2, p. 27; 20, p. 50].

An unpublished 1981 study by Robert Hill [12] examined the full range of non-cash production by residents in three towns, on the west, north, and south coasts, and two villages, one in Labrador and the other near St. John's, Newfoundland. The study of the towns showed that high

employment in plants processing fish or other commodities, as well as the existence of numerous well-stocked shops, caused a decline in gardening. The subsistence gardens still in use were cultivated by households with seasonal and uncertain cash incomes, such as those of fishermen, construction workers, and lumberjacks. In 1980, approximately one in five households tended a garden.

The Labrador logging village studied by Hill was situated inland where the micro-environment was favourable to gardening. When the log market collapsed in the 1960s, the villagers began migrating in the summer to the coast for fishing, and there the environment was unsuitable for gardening. The outporters near St. John's had also gardened, but as they lived only 30 minutes from the city, they gave up tillage for new wage and shopping routines. Only one in seven households had a garden in 1980. Interestingly, in all five communities other subsistence activities, including hunting, fishing, collecting wild berries and firewood, and do-it-yourself construction, have fared better.

It is improbable that one single factor has caused the decline in household-level food production, and several outside pressures have been associated with this phenomenon. These factors include a town's primary occupations, micro-environments, and proximity to market, and vary from one locale to another.

Beginning in the 1970s, the recession, the energy crisis, and inflation devalued transfer payments and sent migrant workers back from mainland Canada to their outport homes. The wholesale rejection of traditional ways slackened, and Newfoundlanders realized that progress toward the great Canadian mean, if it occurred at all, would be much slower than anticipated. Despite drastic socio-economic changes, Newfoundlanders began to value the culture of their elders, including gardening and keeping animals.

Gardening's precipitous decline slowed, and in some places ceased. In order to explain this decline and eventual reversal, I constructed an ethnohistory of gardening for three northern Newfoundland communities: Main Brook, where logging and white-collar jobs predominated; Conche, an inshore cod-fishing community; and Plum Point/Brig Bay, where households were engaged in white-collar work, construction, logging, and fishing. My initial hypothesis was that: those who continued gardening belonged to the lower and riskier income group; they would have more household members available for garden work than non-gardening families; and they would pursue traditional occupations, such as inshore fishing.

In Main Brook, only 50 per cent of the households had ever gardened; migratory lumberjacks and some white-collar workers did not take up gardening when they moved in during the early post-war years. The half that gardened sold to the half that did not. By 1982, 40 per cent still gardened; animal husbandry had disappeared in the 1960s when a town ordinance was passed to control free-ranging animals.

In Conche 80 per cent of households had gardened in 1961, selling vegetables informally to neighbouring outport communities. Animal husbandry was on the decline, and the last animals were slaughtered in 1969 when the road came in. Forty per cent of the households gardened at that time, and the percentage was the same in 1982.

In Plum Point/Brig Bay, contiguous outports on the Straights of Belle Isle, 81 per cent of the families had gardens in 1965. During the next few years, roads and a secure supply of merchandise reached the communities, whereupon gardening slumped in acreage and cropping variety but not in the number of participants. Animals were gone by 1967, but in 1982 85 per cent of the households were gardening!

Research findings show the initial hypothesis to have been incorrect. An analysis of the socio-economic levels of the households indicated that about half the households in the "comfortable" and "average" income categories had gardens, compared to only one-quarter of those in the "struggling" category. The mean number of able-bodied workers per household of gardening and non-gardening households differed only minimally, while participation in traditional occupations, such as inshore fishing, did not imply a higher incidence of gardening. Also, shopping facilities did not have the impact on gardening that was expected (tables 1 and 2).

Thus, when there was no longer an absolute economic imperative for gardening, families who gardened purely for necessity stopped. Those who continued gave various reasons: saving cash for other purposes; the enjoyment of garden work; the advantages of home-produced food, such as better taste; and self-sufficiency as a matter of family pride. Gardening also seemed to be a symbol of a close-knit, hard-working family [15, p. 19]. Such middle-class values were brought out in interviews with gardeners. Non-gardeners' replies were as revealing: gardening was associated with being "peasantish" and with the backward "outport" past. Non-gardeners also thought of themselves as being "lazier."

This outline history of outport subsistence gardening illustrates changes in a local tradition caused by the combined influence of ecological conditions, encompassing political and economic worlds, and community social

TABLE 1. Decision to Garden and Number of Household Workers, Main Brook and Conche, 1982[a]

Number of Household Workers	Number of Households		
	Total	Gardening	Not Gardening
0	4	2	2
1	25	7	18
2	118	46	72
3	38	17	21
4	26	11	15
5	15	6	9

a. An adult-equivalent worker is between 15 and 75 years old.

TABLE 2. Decision to Garden and Socio-economic Level, Main Brook and Conche, 1982

Socio-economic Level of Household[a]	Number of Households		
	Total	Gardening	Not Gardening
Secure, comfortable	38	19	19
Average, middling	107	50	57
Struggling	81	20	61
Total	226	89	137

a. As defined by panels of judges from within the outports.

organization. In the face of continuing uncertainty and relative deprivation, Newfoundland outporters are preserving the one feature of their past which supported them by its resilience and diversity: the household subsistence economy. Gardening, rabbit snaring, berry picking, and rearing an occasional heifer or pig helped soften the blow of downturns in the economic cycle.

GOVERNMENT SUPPORT FOR HOME GARDENING

Newfoundland's traditional policy of stimulating local food production to reduce the island's dependence upon imports had waned by the twentieth century. The interior development strategy had appeared not to pay off [1, p. 29]. But when the island went bankrupt in the Great Depression, a British caretaker government assumed control, returning to the idea that improving self-sufficiency was one of the few alternatives to the uncertain venture of codfishing [7, p. 47]. Bonus incentives were awarded for agricultural land development and a disease-resistant potato stock was successfully introduced. Agricultural extension efforts increased. Indigent families were resettled on farmland, while fishermen were exhorted to take up the supplementary cultivation of subsistence crops.

None the less, the caretaker government inherited the long-standing official bias toward the promotion of commercial, mechanical agriculture and the denigration of home-gardening traditions. Outport cultivation and fertilization techniques are contrary to modern agronomic thinking and were decried by some publications. Others, in an attempt to diversify the garden vegetable crop, recommended maladapted species, like tomatoes and maize.

After confederation in 1949, the official attitude toward subsistence gardens was an ambivalent one. The Canadian Ministry of Agriculture made impressive advances in breeding canker-resistant potatoes and sought innovative outport gardeners to experiment with the new strains. Unfortunately, the ministry had no programmes for home gardeners, as these were viewed as conflicting with efforts to help the struggling commercial farmer.

Finally, in the 1970s, emphasis again shifted to self-sufficiency, development from inside, and the need to

adjust "to a pattern of consumption somewhat different from that of the mainland" [1, p. 37]. Local institutions, such as the Memorial University and the Newfoundland Provincial Government, explored ways of assisting outport gardening as one alternative to a welfare culture [13]. The programmes undertaken included: making available certified seeds at planting time; sponsoring gardening seminars; building greenhouses and community pastures; weekly radio broadcasts; newspaper columns; and inclusion of gardening in the school curriculum. Many of these were generated by locally run rural development associations, which receive assistance from the Provincial Government.

LESSONS FOR POLICY DESIGN

Far from registering success on all levels, the Rural Development Program has supported projects which have failed – community greenhouses, for example [19]. The failure rate of projects seems highest following the construction phase, when managerial skills are needed for the establishment of a routine. Local initiative in programme design and implementation is important. However, problems resulting from local ecological and social conditions as well as from external influences exist at all levels of the gardening complex and must be confronted before even locally initiated gardening projects can succeed. Solutions are often simple but require perseverence by all parties involved. Examples from the recent Newfoundland efforts to revive family gardening illustrate this point.

Root and tuber crops are vital to Northern Hemisphere household food production. However, diseases that attack root and tuber crops are endemic in Newfoundland soils. Introducing disease-resistant crop varieties helps, but outporters often prefer the taste of susceptible varieties.

Related problems have resulted from co-operative enterprises. Community garden plots permit an economy of scale in liming, fertilizing, and cultivating. Unfortunately, some of the most popular potato varieties are not resistant to disease, which is transmitted by contact. The use of one machine by community garden personnel for all family plots rapidly spreads the disease.

Roads, while aiding intercommunity mobility, have also increased the possibility of theft, while retail shopkeepers, offering imported vegetable produce, oppose government programmes in support of home production. Moreover, changes in architecture caused by the modernization efforts of the post-war years have reduced the number of suitable places for overwintering garden produce.

While the Government subscribes to the policy of increasing small-scale food production locally, government unemployment and welfare regulations, on the other hand, discourage gardening principally by defining home-grown produce as unreported income. Also, Crown land, which is what surrounds the outports and borders the roads, is becoming more tightly regulated, making it increasingly hard for individual families to claim suitable garden land.

Finally, well-meaning development agents exhibit a relative ethnocentrism as regards modern technology. Natives themselves, they tend to feel that gardens need more machines and a higher cash input. Outport gardeners, on the other hand, are looking for a secure return on small investment. I interviewed an agent who was raised in a Newfoundland region where gardens were ploughed by horses and who to date adamantly rejects the hand-tilled "lazy beds" typical of other Newfoundland regions. Another agent related the following story:

> I saw my old neighbour picking out rocks from one of his gardens, throwing them into his other garden rather than separating them. What a stupid thing, I thought. But when I inquired what he was doing, he said, "This is my cabbage bed: you can't tolerate any stones in cabbages. But the other's my potato patch: stones warm the earth, make 'em grow better." I realized he might have a point.

Fortunately, many provincial development agents have positive attitudes toward gardening and understand outport ways. Nevertheless, garden extension services should be increased and more professional advice given to local projects on a continuous basis. To date, no scientific understanding of the functioning of outport gardening technology has been developed although the need has been officially acknowledged [15, p. 10]. As Niñez [17] has pointed out, promotional campaigns must be based on a thorough knowledge of contemporary practices and their rationales. This article has attempted to assemble knowledge of the Newfoundland case and incorporate it into a historical, regional, and holistic view.

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