Protected cropping in Martinique

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ABSTRACT
The agricultural production sector in Martinique could be improved through protected in-soil and soilless cropping systems. Research under way on parasite pressure, climatic constraints and the fertility of soils suitable for protected cropping should help in overcoming problems linked with these cropping systems.

Les cultures sous abri à la Martinique.

RÉSUMÉ
La production agricole martiniquaise peut être améliorée par l'utilisation de systèmes de culture sous abri, que ce soit en pleine terre ou en hors sol. Les recherches entreprises sur la pression parasitaire, les contraintes climatiques et la fertilité des sols propres à la culture sous abri devraient lever les contraintes liées à ces types de culture.

Los cultivos protegidos en la Martinica.

RESUMEN
La producción agrícola martiniquesa puede ser mejorada con la utilización de sistemas de cultivo protegidos, sea en el campo o nó. Las investigaciones emprendidas sobre la presión parasitaria, los apremios climáticos y la fertilidad de los suelos propios al cultivo protegido deberían levantar los apremios ligados a estos tipos de cultivo.

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KEYWORDS
Martinique, protected cropping, soilless culture, choice of species, harmful factors.

MOTS CLÉS
Martinique, culture sous abri, culture sans sol, choix des espèces, facteur nuisible.

PALABRAS CLAVES
Martinica, cultivo protegido, cultivo sin tierra, selección de especies, agentes nocivos.

introduction

In tropical environments, protected cropping is an efficient way of boosting agricultural intensification, as shown by the current rapid increase of protected cropping systems in Martinique. This type of cropping system was developed by CIRAD in French Guiana during the 1970s and applied in Martinique at the beginning of the 1980s.

Analysis of these cropping systems, under Martinique conditions, was based on CIRAD research results and on a survey conducted between April and May 1993, carried out jointly by CIRAD and the Martinique Chambre d'agriculture, in conjunction with local farmers.

Martinique, a relatively small island, has more than 300 000 inhabitants and is visited by about 200 000 tourists yearly. The population pressure is therefore intense (300 inhabitants/km^2), with high demand vegetable crops. Vegetable production is, however, limited by two major constraints:
– the hilly landscape on the island reduces cropland availability;
– the tropical climate includes a long rainy season during which field cropping is virtually impossible.

These two constraints have to be overcome in order to increase vegetable production: protected cropping alleviates rainfall constraints and allows crop intensification on small-sized fields; and with soilless cropping, soil parasite constraints (fungi, bacteria, nematodes) can be eliminated and agricultural production improved.

protected crops in Martinique

The steady increase in the extent of protected cropland in Martinique since 1980 is presented in figure 1. In 1993, there was a total of about 13 ha of protected crops on about 80 farms.

protective structures

In the tropics, crop shelters can be quite simple because of their essentially protective role: the tunnel is the most common protective structure used in Martinique, ie, a metallic frame covered with polyethylene sheets. Most farmers currently buy these structures from tunnel manufacturer sales representatives in Martinique. Consequently, there are almost no more homemade protective shelters.

main types of protected cropping systems

There are generally two types of protected cropping systems:
– in-soil protected cropping, using the existing soil;
– soilless protected cropping, using inert substrates (pumice, pozzolana, sand, etc); constraints linked with soil fertility (in the broad sense of the term) are thus overcome, but irrigation must be perfectly controlled.

Protected cropping was first used at the beginning of the 1980s with soilless cropping systems, then the in-soil technique was developed, and now accounts for 40–45% of all protected cropping on the island.

The distribution of protected cropland in Martinique, per farmer and for both cropping systems, is shown in figure 2:
– Most in-soil protected plots are small, and often attached to regular vegetable cropfields, the farmers' main focus. Field crop equipment can thus be used for the protected crops.
– Most large-scale producers use the soilless system, their main activity. There are also farmers growing protected crops on small plots — they often have dual activities.

The ultimate reasons for using either of these cropping systems differ categorically, thus producers usually do not convert from one system to the other.

protected crop species

The percentage of each species cropped in protected soils, as determined in the April 1993 survey, is shown in table I:
– in the soilless system, two crops dominate, lettuce (46%) and flowers (26%), on over 70% of the area under this production system;
– in the in-soil system, crop specialization is less marked: five crops (tomato, flowers, lettuce, greenpepper, green bean) are grown on approximately 60% of surface area. This diversification

Table I
Percentage of protected soilless and in-soil cropland, for various vegetable crop species in Martinique (1993 data).

Soilless		*In-soil*	
Species	*%*	*Species*	*%*
Lettuce	46	Tomato	19
Flowers	26	Flowers	15
Local onions	7	Lettuce	14
Cucumber	4	Greenpepper	10
Tomato	3	Cucumber	4
Empty	5	Empty	14

is related to the crop rotation necessary to control weeds and various soil-borne causal agents.

The survey also revealed that 14% of the protective shelters for in-soil crops were empty. This could be explained by the insufficient control of weeds or other harmful factors which could limit crop development, and the survey period (April), during which field cropping is not constrained by rainfall. Farmers thus prefer this system.

investment required

The investment required was estimated at 150–180 FF/m^2 per in-soil protective structure, and 200–240 FF/m^2 per soilless protective structure.

protected cropping constraints

insects and diseases

In the microclimate created under protective shelters, there is particularly high pest insect development, with a relatively low leaf disease problem, contrary to the situation concerning field crops.

soil fertility

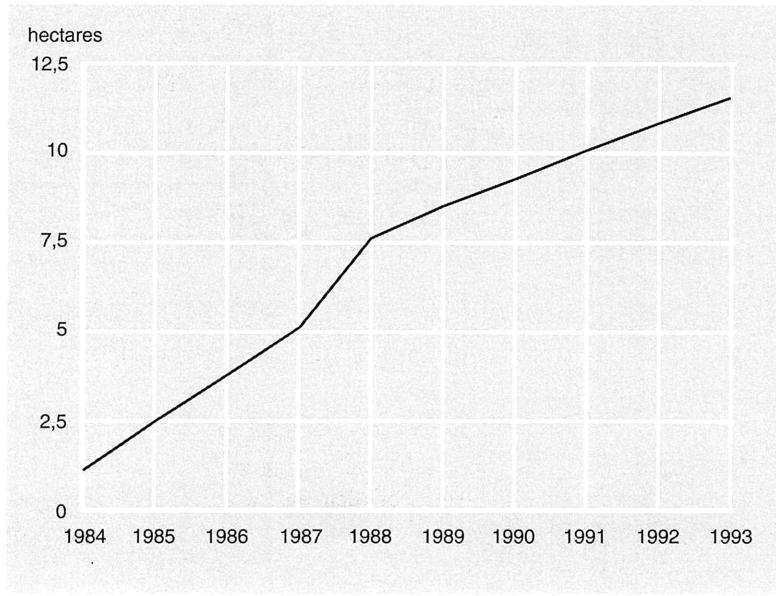
Protective structures represent a considerable investment for farmers – these shelters will only be cost effective if farmers can use them over a long period of time under good conditions. Soil fertility and maintenance are therefore essential.

Many cropping problems are linked with soil-borne parasites, chemical and organic fertility and weeds:
– the main soil-borne parasites are nematodes, fungi and bacteria, especially *Pseudomonas solanacearum*, which markedly limits the choice of solanaceous varieties that can be cropped;
– chemical element deficiency or toxicity due to poorly planned fertilization;
– installation of protective structures can lead to scouring of the fertile topsoil horizon; subsequent organic manuring of the soil can be extremely variable, ie, farmers may only apply fertilizers monthly or not at all;
– in some cases, the extent of the weed cover will limit crop production.

climate

Polyethylene tunnels are efficient for crop protection, while increasing the temperature inside the structure *via* a greenhouse effect. Although

Figure 1
Increase in protected cropland in Martinique from 1984 to 1993.



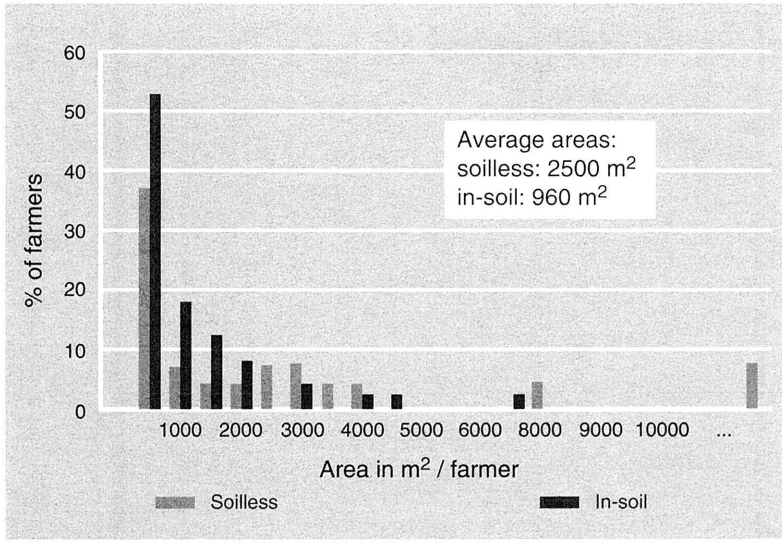


Figure 2
Distribution of protected cropping areas per farmer and according to the cropping system.

farmers in temperate countries seek this effect, it is considered to be a constraint in tropical areas where temperatures are already higher than necessary for optimal plant growth. Moreover, radiation is reduced by 30% under the shelter when the polyethylene is new, and by up to 50% as it ages.

CIRAD-FLHOR research in Martinique

In 1986, CIRAD set up a research program aimed at overcoming the main constraints outlined here, thus enhancing the development of these protected crops. These studies are currently under way in experimental plots at the Petit-Morne research station (Martinique) which includes 6.5 ha of land, 1 000 m^2 of protective structures for soilless crops, 1 100 m^2 of structures for in-soil crops and 300 m^2 of nurseries.

Research is aimed at assessing parasite pressure, constraints due to climate and soil fertility.

parasite pressure

Integrated pest and disease control for vegetable crops should be developed.

climatic constraints

The climatic factors studied are temperature and radiation. Various topics were selected for this research:
– effect of tunnel structure on the temperature under the structure (top and side openings);
– testing different cover materials;
– plant function (tomato): TOMGRO model studied in collaboration with INRA (Institut national de la recherche agronomique), France. Avignon (France);
– development of crop nutrient solutions for use under Martinique climatic conditions;
– choice of varieties relative to heat tolerance and temperature/radiation imbalances.

soil fertility

Several collaborative projects were considered to investigate soil fertility:
– an overall survey of soil fertility under protective shelters is being carried out jointly with the ORSTOM (Institut français de recherche scientifique pour le développement en coopération, France) Martinique Centre;
– parasite- and heat-resistant varieties will be chosen in collaboration with the INRA Guadeloupe Centre;
– nematode control will be conducted with the assistance of ORSTOM Martinique.