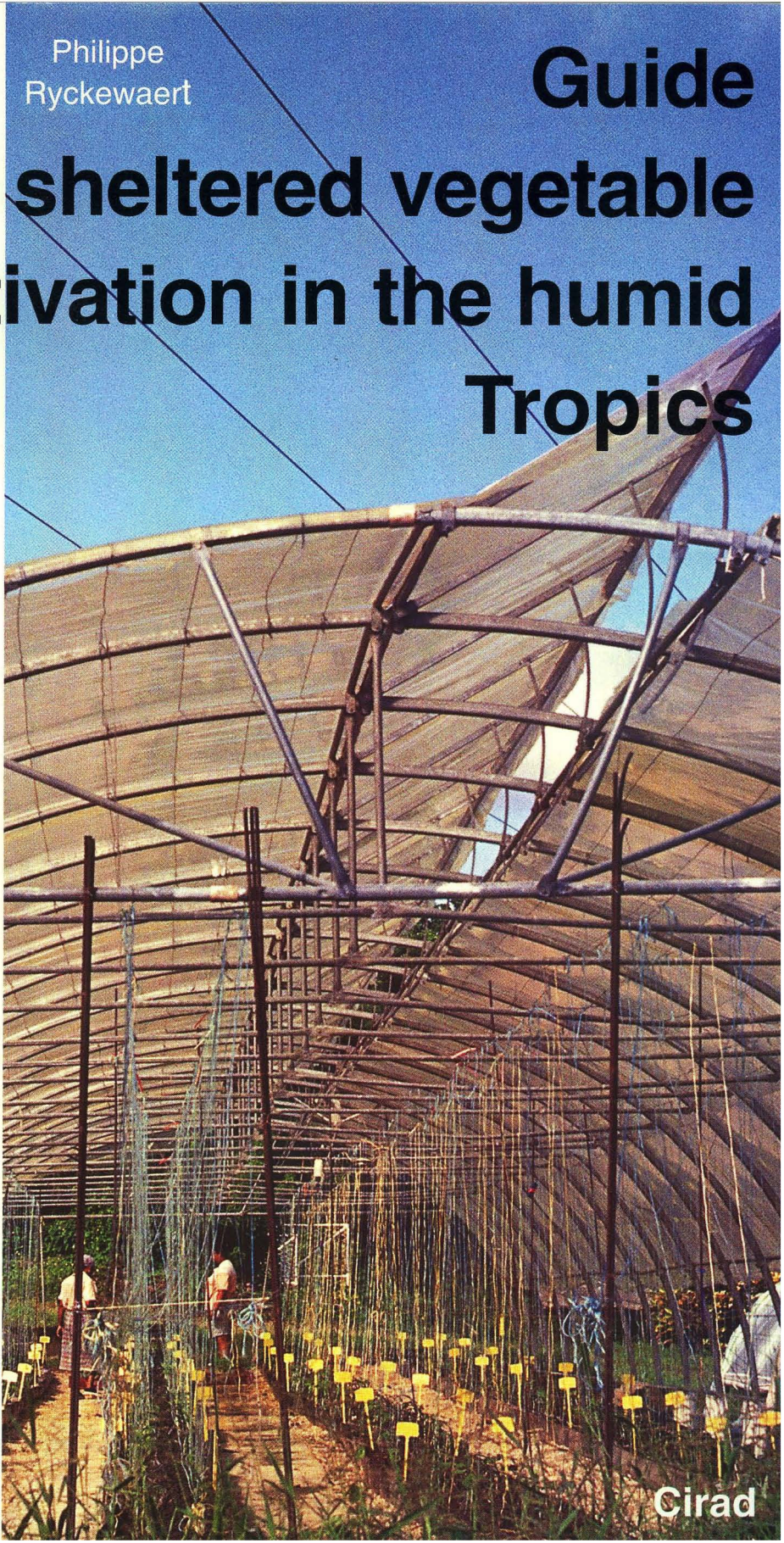
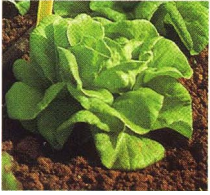


Christian
Langlais

Philippe
Ryckewaert

Guide to sheltered vegetable cultivation in the humid Tropics



Cirad

Christian Langlais
Philippe Ryckewaert

**Guide
to sheltered vegetable
cultivation in the humid
Tropics**

CIRAD

The authors

Christian Langlais, an agronomist specializing in sheltered vegetable cultivation in the Tropics, has been with CIRAD since 1982. He began his career in Africa, and has been based in Martinique since 1993.

Philippe Ryckewaert, an entomologist specializing in integrated pest management in vegetable crops, also works for CIRAD. He was based in Martinique from 1988 to 1999, and has written a thesis on whiteflies in the lesser Antilles.

Copyright CIRAD

ISBN 978-2-7592-0665-0

FOREWORD

This guide is based on knowledge acquired under CIRAD research programmes in Martinique, supported by the *conseil général* in Martinique, the *région* and the European Community. The results obtained were modulated and supplemented by observations made during study missions in various countries in the humid Tropics.

The guide is primarily intended for agricultural technicians who will have to adjust the various recommendations made to fit the prevailing socio-economic conditions in their respective countries.

Production of the guide was funded by the French Ministry for Foreign Affairs.

CONTENTS

Part I. Specificities of sheltered cultivation

Shelters in the humid Tropics	11
Presentation of sheltered cultivation	11
Definitions	11
Pros and cons of sheltered cultivation	11
Species suitable for sheltered cultivation	13
Shelter structure	13
Framework	13
Size	14
Straight sides	14
Floor slope	14
Cover	15
Ventilation	16
Cooling systems	17
Plant water requirements with sheltered cultivation	19
Water quality	19
Chemical quality	19
Biological quality	19
Water quantity requirements	20
Setting up nurseries	23
Location	23
Nursery structure	23
Sowing techniques	24
Compost blocks	24
Sowing on sand	24

Sheltered cultivation in soil	26
Main soil types and constraints	26
Vertisols	26
Ferrallitic soils	27
Allophanes (andosols) and halloysites	28
Soil-borne parasite management	28
Limiting infection potential	28
Corrective measures	29
Weed control	30
Soil disinfection	30
Herbicides	30
Plastic mulch	32
Irrigation of sheltered crops	32
Fertilization	32
Equipment	32
Fertilizer scheme	33
Soilless culture on a substrate	35
Choice between planting in soil and without soil	35
Planting in soil	35
Soilless culture	36
Substrate and containers used for soilless culture	36
Irrigating soilless culture containers	39
Application splitting up	39
Programming irrigation	39
Application to tomato growing	40
Nutrient solution	40
Composition	40
Correcting irrigation water pH	41
Preparing nutrient solutions	42
Checks on the nutrient solution applied	43
Phytosanitary protection: integrated pest management (IPM)	46
Rules for applying phytosanitary treatments	47
Specific case of sheltered cultivation	48

Part II. Individual data sheets on vegetable species

Courgette (<i>Curcubita pepo</i> L.)	53
Cucumber (<i>Cucumis sativus</i> L.)	55
French bean (<i>Phaseolus vulgaris</i> L.)	58
Lettuce (<i>Lactuca sativa</i> L.)	60
Melon (<i>Cucumis melo</i> L.)	63
Pepper (<i>Capsicum annuum</i> L.)	67
Spring onion or Welsh onion (<i>Allium fistulosum</i>)	70
Strawberry (<i>Fragaria</i> spp.)	72
Tomato (<i>Lycopersicon esculentum</i> Mill.)	74
Annex 1.	
List of insecticides and acaricides used for integrated pest management	82
Annex 2.	
List of the main fungicides used for integrated pest management	85
Annex 3.	
List of the main insecticides, acaricides and fungicides used on sheltered crops in the humid Tropics, with composition and manufacturer	88
Bibliography	90

SPECIFICITIES
OF SHELTERED CULTIVATION

SHELTERS IN THE HUMID TROPICS

Presentation of sheltered cultivation

Definitions

Cultivation “in the open” is the traditional method, with no form of protection from the elements.

“Sheltered” cultivation involves protecting the plants under some form of shelter; it calls for permanent irrigation. With “sheltered cultivation in soil”, the soil is kept, while with “sheltered soilless (hydroponic) cultivation”, the plants are grown either on an inert substrate or without a substrate (*Nutrient Film Technology* or *NFT*, aeroponics, aquaponics, etc.). This type of method calls for permanent fertilizer-enriched irrigation (nutrient solution).

Pros and cons of sheltered cultivation

During the rainy season characteristic of humid tropical climates, the waterlogged soils cannot be cultivated and the heavy rains destroy plants and fruits while facilitating the development of certain diseases, notably those caused by fungi. Vegetable production in such climates is thus limited, yet the high population densities seen in both island and peri-urban areas result in strong demand for vegetables.

To increase vegetable production in these regions, it is therefore essential to overcome the constraints linked to the high rainfall levels in the humid Tropics. Sheltered cultivation is an interesting alternative: it protects plants from the rain, enabling all-year-round production. Moreover, it also enables soilless or hydroponic cultivation which overcomes certain constraints linked to soil type: mineral deficiencies, unsuitable physical structure, existence of pathogens, etc. Lastly, through better control of diseases and water and mineral supplies, sheltered cultivation ensures better yields than cultivation in the open, and more attractive fruits that therefore sell better. In short, it enables increased production on smaller areas.

However, although sheltered cultivation solves the specific problems related to heavy rainfall, it entails other constraints linked to the climate, parasites or nutrition.

Climatic factors

For plants grown under shelter, the resulting greenhouse effect tends to increase the already high temperatures seen in the Tropics. At the same time, the material used for the shelters (generally plastic film) filters the sunlight. In tropical zones, from May to September, there is already less solar radiation than in southern France, while temperatures are at their peak. There is therefore an imbalance between increased respiration due to high temperatures and reduced photosynthesis as a result of moderate radiation levels, which adversely affects crop metabolism.

Again as a result of the humid tropical climate, there is a high hurricane risk in these areas, which needs to be taken into account when designing shelters.

Parasite factors

While the lack of rain under the shelters alleviates the impact of many fungal and bacterial diseases on vegetable crops, the environment created favours insect and mite development. For sheltered cultivation to be economically feasible, it is important to control such pests effectively.

Nutritional factors

For individual farmers in the Tropics, the investment required to build a shelter is relatively high. To make it cost-effective, farmers need to cultivate the sheltered area intensively, which means maintaining high soil chemical, physical and biological fertility.

Species suitable for sheltered cultivation

The main vegetable crops suitable for all-year-round sheltered cultivation are tomatoes, lettuces, peppers, courgettes, French beans and herbs, including spring onions.

Others such as carrots and bulb onions also perform well, but the stiff competition from cheap imports means that sheltered cultivation is not necessarily cost-effective.

“Charentais cantaloup” type melons can be grown under shelter during the rainy season—i.e., out of season—in zones with high sunshine levels, for instance southern Martinique.

Chayotes can also be grown under shelter in cool areas, since the technique prevents the fungus *Mycosphaerella* sp., which causes blight, from multiplying.

Some species such as aubergines, cabbages, water melons or pimentos easily withstand the rain, and sheltered cultivation would not be worthwhile

Shelter structure

Framework

There is a high hurricane risk throughout the Caribbean. Martinique is hit by a major hurricane every nine years on average, but there are storms with winds of over 100 km/h almost every year.

On the islands of Martinique and Guadeloupe, the structures used for sheltered cultivation were chosen in line with the risks: farmers use tunnels