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Application of Hydroponic culture in French Guiana—

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Introduction

Market garden production in French Guiana meets with such difficulties that, at certain time of the year, fresh vegetables are practically unavailable on the market, and/or are sold at fabulous prices.
The dificulties encountered are due to factors pertaining to climate, soil, pests and fungus diseases.
In Cayenne, annual rainfall varies between 3500 and 4000 mm (140 to 160 inches). During the rainy season, which lasts from December to July with a short intermission in March, it is practically impossible to produce vegetables without taking protection measures against the rain. Further to that there are serious diseases such as the Solanaceae wilt due to **Pseudomonas solanacearum** and affecting tomatoes, eggplants and sweet peppers. Also found is an acute pest infestation which is difficult to controle due to the very rainfall.
Adding to the list of limiting factors are problems unlikely to be solved in the near future, such as scarcity of labour, lack of organic matter.
To face such various and sand culture complex problems, the IRAT services in French Guiana undertook to make experiments on gravel culture. The objective of this operation was a year-round production of various vegetables to meet the local requirements.
Trials were principally aimed a finding simple and inexpensive methods of minimizing the original investments. The study which initiated in 1965 and carried out in 1966 gave the following results.

Sheds

The vegetable plants must be protected against rainfall. Two types of material are used in French Guiana: hard polyester "Agricultural film" and polyane AL 2F 150 U. All the building structures are made of wood and essembled by the growers themselves.
Sheds should be ventilated at the top to have adequate movement of air.
The erection of hard polyster greenhouses is easy but their cost is 15 to 20 times higher than that of polyane houses.
Care should be taken in the erection of the latter, as plastic is readily torn. The type of shed that we recommend for the time being is made up of 3 m x 3 m (10' x 10') removeable planels which are covered with a polyane sheet folded into a double layer.
These panels are then assembeld on a wooden framework. This polyane sheet can last up to about 9 months, and it is easily replaced. Nevertheless, a rapid ageing can be seen where the sheet is in contact with the framework. We hope to obtain a more durable plastic sheet by improving assembling and by using a new material, polyane AL 3F 200 U.
The choice between the two above mentioned materials must be based on economics. A cheep material allows for a rapid turnover of capital but requires heavier expenses for its maintenace. An expensive durable material requires a 10 year investment but reduces the maintenance expenses for each crop.

Culivation tanks

The measurements of the cultivation tanks are as follows:

1,2 x 20 x 0,25 m or 0,30 m (4' x 66' x 10" or 12"). They are made up of a row of boards 15 or 20 cm (6 to 8") high, supported by small stacks all the way round the container. The bottom of the cultivation tank is made up by a swallow trench dug out in the ground and on which has been laid a sand bed 3 to 4 cm deep (1 to 1.5". A polyane sheet of 150 u is laid down on this sand bed and covers up the inner sides of the boards: thus making up watertight tank.
A small feeding compartment of 20 cm x 20 m (8" x 48") is filled with fine gravel. A layer of fine gravel is laid down on the bottom of the cultivation tank which is then filled up with sand to about 2 cm (1") from the top rim. A draining hole is drilled at the end of this tank.

Growing-Medium

Cayenne beach-sand urend out to be a suitable, cheep and easily avail-able growing-medium. It costs about 10F/m³ (delivered at the farm). Experiments showed that vegetables grew very well on it provided that the following precautions were taken:
1) to wash the sand thoroughly with water before using it in order to remove the salts
2) to fork it out after each crop
3) to leach it after each crop in order to remove saline residues.
The sand used has the following characteristics:
origin: siliceous
particle size distributon: 10% of the particle above 700u

70 to 80% of the particles between 200 u and 700 u
5% of the particles between 100 and 200 u
5% of the particles below 100 u

water holding capacity = 10—13%.
It is important that the sand does not contain more than 10% of fine particles of size less than 100 u. The higher the percentage of particles having a size between 500 u and 1000 u the better will be the quality of the sand.

Water Problem

The problem of water shortage does not arise in French Guiana. But the users should pay great attention to the quality of the water. We recommend to store rain water or to pump up the groundwaters. Marsh water is not only full of various ions but also of bacteria or other microorganisms which may contaminate the plants. In French Guiana where the bacterial wilt of tomato is widespread, we recommend not to use the surface water. In any case, it is necessary to take into account the ions brought in by water when estimating the ion balance.

Vegetable species and varieties grown in hydroponics in French Guiana

Until now only 4 vegetable species have been studied in French Guiana i.e. lettuce, tomato, cucumber, muskmelon.
The selected varieties are as follows:
a) lettuce
in the season of low light-itensity
Amplus 63
Kwiek

Kordat
Reine de mai race Preferino
Kloek

in the season of high light-itensity
Great Lake 659
Premier Great Lake
Great Lake Mesa

b) Tomato
Naine Primabel
Fournaise F_1

c) cucumber
Hybrid without male flower M10

d) melon
Edisto

Nutrient solutions

The formula that we have temporarily adopted for the vegetables we wanted to grow (tomato, lettuce, melon, cucumber) is the one given by Maxwell BENTLEY in his book "Commercial hydroponics" as Formula no. 19. It includes the following ratios:

	N	P	K	Ca	Mg
ppm	200	80	300	200	50

This formula does not satisfy us completely. The study of the balance between the following ions: NO_3, PO_4, SO_4 CO, K, Ca, Mg, NH_4 will be undertaken in the near future.
From our observations we have already been able to see how important the potassium/nitrogen ratio is. Under French Guiana conditions the K/N ratio in ppm must be about 1.5 for lettuce and 1.3 for tomato, cucumber and melon. p.H. is maintained between 6 and 7 with sodium hydroxide.

Nutrient solution feeder-system

The feeding system that we recommend is based on gravity flow with a nonreturned nutrient solution. A small amount of nutrient solution is allowed to flow through at the botom of the cultivation tank. The growing medium is imbibed by capillarity. This system requires that the cultivation tank be placed in a slanting position. The layer of sand has a depth of 20 cm (8") in the case of plants with a small root-system (e.g. lettuce) and a depth of 25 cm (10") in the case of plants with a large root-system (e.g. tomato, cucumber, melon, etc.).
The cultivation tanks have a slope of 2% and a length of 20 m (66' 8"). Flow takes place during 3 hours in the morning, from 6 to 9 a.m. and 3 hours in the afternoon, from 12 noon to 3 p.m. Roots are aerated in the night when there is not any flow. Daily consumption is about 6 to 8 litre/m^2 (0.13 to 0.17 gal/sq ft/day).

Operation

From a nutrient solution container, the solution flows into a gutter closed at both ends and laid on a compartment filled with fine gravel.

From there, the solution overflows and by gravity goes down and into the layer of fine gravel located at the bottom of the cultivation tank. It is hence discharged through a draining hole. Flow is controlled so as to obtain some seepage at the end of the tank.

Yields

The yields obtained to day are still moderate but they suggest a possible improvement in the near future by the ajustment of balanced formulae. The most important result is that we are able to produce during the whole year while in traditional cultures the production depends on climatic and soil conditions. The present yields are as follows:

1)	lettuce	
	Laitue butter	3 kg/m² (0.66 lb/sq ft)
	Great Lake	4—5 kg/m² (0.88—1.1 lb/sq ft)
2)	cucumber	10—12 kg/m² (2.2—2.6 lb/sq ft)
3)	melon	5—7 kg/m² (1.1—1.5 lb/sq ft)
4)	tomato	7—10 kg/m² (1.5—2.2 lb/sq ft)

Vegetation failures

Besides the fungus diseases and common pests which are more easily controlled than in traditional cultivation, the blossom-drop of tomato and melon is to be noted. It is probably due to excessive aftmospheric moisture and to high temperatures. The use of fruit-setting hormones is going to be tried to obtain a good fruit-setting.

Plants attacked by **Pseudomonas solanacearum** have been found in the crops of growers.

CONCLUSION

The results from hydroponic cultivation are extremely encouraging despite the simple and cheap installations used. The difference between the cost of production of vegetables and their selling price on the local market leaves a sizeable profit for the grower.

This method of cultivation is already used by several growers and particularly by the "Centre de Polyculture de Kourou", the production of which is principally devoted to the staff of the Space Center. We think that the hydroponic cultivation of vegetables can be developed in any country where natural growing conditions are not favourable and where there is a poblem of labour shortage.