Agronomy of a Rice-based Vegetable Cultivation System in Vietnam: Constraints and Recommendations for Commercial Market Integration

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Abstract

A description of the vegetable cultivation system in two villages in the Red River Delta, Hanoi, Vietnam is provided. The production of dry land vegetables takes place in the cool winter season, while in the warm wet summer season, rice is cultivated. Major vegetable crops cultivated belong to the *Brassicaceae, Solanaceae* and *Cucurbitaceae.* Most of the crops are transplanted. Soil type varies from sandy loam to medium loam and soil organic matter content is low. Poor product quality, transplant production and soil conditions were identified as the major constraints for the production of high quality produce for upscale commercial markets. A proposal for a permanent vegetable production system is made.

INTRODUCTION

Tang My and Son Du are two villages located in the Dong Anh district in the Red River Delta, Hanoi Province, Vietnam. The elevation of the district varies between four and fourteen meters above sea level. There are five communes in the Dong Anh district in which agricultural production is more or less specialized in vegetable production. Tang My and Son Du are located in two of these communes. Beside vegetables, the farmers in these villages cultivate paddy rice, corn, groundnut, sweet potato and other crops in order to meet their food and fodder demand.

Vegetable production in the Dong Anh district is an important component in the supply of fresh vegetables to the Hanoi wholesale and retail vegetable market (van den Berg et al., 2003; Gia et al., 2003; Hoi et al., 2003). What follows is a description of the vegetable cultivation system in both villages. Agronomical constraints for commercial market integration are identified and recommendations for improvements are made.

MATERIAL AND METHODS

Data were collected by completing an agronomy checklist, detailing the qualitative characteristics of the vegetable cultivation system in the two villages. Main headings in the agronomy checklist were: climate, physical features, land preparation, cultivation system, crops, fertilizers and farm yard manure. Each heading was comprised of several subheadings. Data collection in the villages took place during visits to the villages between 2002 and 2004. Transects were walked for field observations and individual farmers were interviewed. The results serve as a qualitative agronomic case description at the field level. This work was done in the framework of the larger VEGSYS project for the two villages (website: www.vegsys.nl).

RESULTS

Climate

Dong Anh district has a tropical monsoon climate. Mean annual rainfall is around

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1,660 mm. The dry season, with limited rainfall, runs from November to April. The rainy season lasts from May to October. Monthly precipitation in this period increases to a maximum of more than 300 mm around July to August, then decreases towards January (Table 1). Available radiation, as indicated by the number of sunshine hours, is lowest in January and increases towards a maximum in July. The mean daily temperature follows the same pattern as the mean monthly sunshine hours. The average annual daily temperature is 24^{o}C. Relative humidity does not fluctuate as much during the year as monthly rainfall or monthly sunshine hours.

Soils

The soils in both villages belong to the Plinthic Acrisols or Hapli Plinthic Acrisols (FAO-UNESCO classification) and are mostly composed of kaolinite (Dung and Hoi, 2003). The topsoil has a yellowish brown to yellow orange or greyish yellow brown to light grey colour and generally varies from sandy loam to medium loam (Table 2). The topsoils are mostly acid to medium acid and poor in organic matter and nitrogen. Organic matter contents were found to be in the range of 0.55 to 1.26%. Total nitrogen varied from 0.06 to 0.11%. The phosphorus content of the topsoils showed variation, depending on the history of phosphorus fertilizer application. Potassium content of the soils is low. The Cation Exchange Capacity (CEC) of the topsoils is limited. In Son Du, most of the area had a CEC below 6 meq per 100 g soil. For Tang My, the CEC in the majority of soils was in the range of 6 to 13 meq per 100 g soil (Dung and Hoi, 2003).

The rather light texture of the topsoil implies a limited water holding capacity. In combination with the low CEC, the low pH values and the low organic matter content of the soil, this indicates a low basic soil fertility and a low nutrient holding capacity.

Cropping Seasons

In both villages, there are two yearly rice seasons, followed by one winter season of annual crops and vegetables (Fig. 1). After harvesting summer rice, on most of the higher sandy soil fields, dry land crops are cultivated. The other fields with better soil conditions, near water sources and with easy access, are planted with vegetables. There is hardly a fallow period between crops.

In Son Du, many kinds of vegetables are cultivated. In Tang My, kohlrabi and wax gourd are the major crops. In Tang My, farmers appreciate short-term high value crops such as kohlrabi and cauliflower. In Son Du, farmers have a strategy of spreading family income by cultivating a variety of crops in order not to be dependent on fluctuating market prices for any one particular crop.

Apart from the short-term vegetables, wax gourd is cultivated during the spring and summer seasons on one-season rice fields or continuously on plots designated especially for wax gourd production.

Crops and Cultivation

Major crops cultivated in Tang My and Son Du are presented in Table 3. The largest single botanical group is the *Brassicaceae*, followed by the *Solanaceae*. Besides the crops in Table 3, a number of minor vegetable crops in terms of the area or frequency of cultivation are grown. At the end of September, after harvesting the rice crop, the fields for vegetable cultivation are ploughed two to three times, usually with animal traction, but a two-wheeled tractor may be used. Ploughing is not very deep, following the assumption that vegetables do not need a deep rooting zone. After ploughing, raised beds and furrows are constructed by hand, using a hoe. Raised beds facilitate furrow irrigation and surface drainage in case of high intensity rainfall. The height and width of the raised beds varies with the size of the crop and farmers preference.

Most of the major crops are transplanted (Table 4) and are grown with two rows on a bed. Planting distances vary with the type of crop. Wax gourd, cucumber and climbing bean are grown on trellis that meet high across the raised beds and are therefore cultivated on rather wide raised beds.

The length of the growing season varies with the day to first harvest and the length of the harvest period. Short season crops include French bean and kohlrabi, while tomato and hot pepper have longer growing periods. Representative yield levels for some major crops are given in Table 5. Yield levels mentioned for South-East Asia by Siemonsma and Kasem Piluek (1994), suggest that there is room for improvement in productivity per unit area.

Transplant Production

All transplants used are bare-root transplants. Most transplants are produced by the farmers' themselves usually in borders adjacent to the production fields. Commercial transplant production in the Dong Anh district is limited and mainly takes place in Van Tri village. For nursery transplant production, raised beds are made with a fine, even soil particle size distribution, so as to provide suitable conditions for seed placement and germination. Usually ash is spread over the beds and mixed thoroughly to improve soil structure. Sowing is done by hand. After sowing, rice husks are spread on the soil surface to retain moisture and to prevent soil temperature from rising too much. Beds may be covered with bamboo mats. During the winter period, plastic tunnels with a bamboo frame are constructed over the beds to protect seedlings from insects, rats and cool winds. Seedlings are ready for transplanting when they have three to five leaves, usually at an age of 20 - 25 days after sowing during sunny weather, or at 30 - 40 days after sowing under dark, cold weather conditions.

Fertilisers and Water

Before transplanting or sowing, farmers mix manure, ash and a small amount of urea and single phosphate together. This mixture is put into small holes about 5-15 cm deep and covered by a thin layer of soil. Transplants will be planted or seeds sown nearby the holes, in order to avoid the negative effects of fertilizers on the roots.

There are two ways to apply fertilizers after growth of the transplants or seedlings has started. One is to dissolve urea and animal excreta with water and apply this mixture directly around the young plant. This is usually done 7-10 days after transplanting or when the seedling has reached sufficient size. Further fertiliser applications consist of applying single nutrient fertilisers or fertilisers of varying nutrient composition, in holes between the rows or between the plants. The growth and condition of the crop determines the composition of the fertiliser and the amount applied.

The crop is watered either by natural precipitation or irrigation. During the winter season, water is mostly supplied by furrow irrigation around the raised beds.

Harvesting and Quality Criteria

The moment of harvesting is dependent on the planting or sowing date and the length of the growing period, as well as market prices. Sometimes crops are ready to be harvested, but farmers will leave them in the field as they wait for better prices. After harvesting, vegetables are sold at the farm gate or brought to markets by bike, motorbike or special transport bike. Some households store wax gourd after harvesting for some months before selling them. Wax gourd are stored at a cool, shady place and sold when prices are attractive.

The price of the vegetables depends on the outer appearance of the product. There are no clear criteria to define quality. Produce that looks good is normally sold in the Hanoi markets. Products of lesser appearance are sold in the local markets.

CONSTRAINTS AND RECOMMENDATIONS

Three major constraints were identified in the vegetable cultivation system. Removal of these constraints is likely to result in better opportunities for farmers to supply upmarket retailers.

Transplant Production

Both purchased and self-produced transplants demonstrated considerable variation in uniformity and quality. This may be due to variation in the origin of seeds or seed size, germination and growing conditions in the seedbed and the experience of the transplant producer. Non-uniform transplants will result in uneven crops and variability in the length of the growing and harvest period (McKee, 1981). For transplanted crops, much of the observed variation in the growing and harvest period may be due to the non-uniformity of the transplant material and a degree of transplant shock after planting. The variation in the length of the growing and harvest period makes it difficult to plan harvest and to meet delivery requirements on set time schedules for upmarket retailers.

The introduction of methods to improve the uniformity, handling and storage characteristics of the transplants will benefit crop growth, product quality uniformity, increase the efficiency at harvest and reduce the length of the harvest period. Transplant production could be improved by using uniform seed lots and by germinating and growing transplants in peat blocks or in multi-cell plastic trays. This will result in more uniform crops and shorter growing periods. The use of modular raised transplants transplanted to the field with a rooted soil block will reduce transplant shock. The transplanting of uniform transplants should reduce the length of the growing period in the field, possibly increasing the number of crops that can be grown in the same period.

Quality

According to the farmers, high quality vegetables with a good outer appearance fetch better prices. Apart from quality defects due to bad growth, the outer product quality at harvest is often affected because of the high incidence of pests and diseases in the area (Oanh et al., 2004). Attention to pesticide residues on vegetables (Anh et al., 2004) is another aspect of quality management in vegetable production.

It is in the interest of the farmers to increase the proportion of high quality produce in terms of outer appearance and residue levels. This will enable them to sell more produce to the Hanoi retail market, resulting in a higher income.

A good starting point for improvements in the quality and yields of the crops will be to compare the cultivars currently used with other, new cultivars, in on-farm trials. Better quality and/or higher yields, with the same inputs, will improve farmer's income. Better pest and disease resistance will reduce pesticide use and save costs. To obtain suitable local, national and international cultivars for testing, relevant seed companies and other local sources will have to be identified.

Soils

The low water holding capacity of the soil and the limited soil fertility are major constraints for vegetable cultivation. The repeated wetting, puddling and drying of the soil, because of the rotation with paddy rice, not only negatively influences the structural stability of the soil, but it also requires, two times a year, a considerable labour input. Improvement of soil fertility and soil structure will result in better growth, higher yields and better product quality.

A permanent vegetable cultivation system would offer possibilities to improve soil conditions. It should be considered whether a cropping system can be designed that is based on the continuous dry land cultivation of vegetables only. In this situation, farmers could work systematically towards increasing soil pH by liming and towards increasing soil organic matter content by the application of manure and the conservation of crop residues. Soil structure will benefit greatly from the absence of repeated puddling and drying, leading to a better maintenance of soil condition and thereby better crop growth.

PERMANENT VEGETABLE CULTIVATION

For a permanent vegetable cultivation system, suitable vegetable species and their cultivars must be selected for cultivation during the hot and wet summer season. However, the market and potential product prices should be investigated before

undertaking any such venture. Apart from summer season vegetables, other crops like fruits, flowers or herbs could be considered. Taking into account the soil, temperature and water conditions and market potential, a continuous vegetable cropping system could be designed that is suitable for the local conditions in which a healthy variety of vegetables, and possibly other crops, are produced. Continuous vegetable production is likely to profit from the high summer season vegetable prices (Anh et al., 2004).

With a permanent vegetable cultivation system, the raised beds should have a standard width, adjusted to suit two wheeled tractors or animal traction. The raised beds and the paths between them should remain in the same place, reducing the amount of labour needed for soil tillage. Depending on the crop type, planting distances on the raised beds could be adjusted to suit bed size. The permanent paths are used for furrow irrigation and surface drainage. In permanent vegetable fields, crop residues should remain in the field as much as possible and worked under to improve soil organic matter content. For weed control, rice straw could be used as mulch after sowing and transplanting. In addition, the use of artificial mulching material, such as black plastic, could be evaluated and tried. Rice straw has the advantage of adding organic material into the soil. Fertiliser recommendations should be developed based on crop demand, taking into account soil nutrient supply and unavoidable losses. It has been observed that a few households already are experimenting with permanent vegetable cultivation.

The continuing urbanisation around Hanoi will result in a steady and increasing demand for high quality vegetables throughout the year. This requires planning harvests for fixed delivery dates, especially when retailing through supermarkets (Everaarts, 1999). As compared to the present system, where the moment of vegetable planting depends on the rice harvest date, a continuous vegetable cropping system which makes better use of uniform transplants and high quality cultivars may offer the possibilities to do just that.

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Tables

Table 1. Climatological data of Dong Anh district (Lang – Hanoi Station, 1993-2002).

Month	J	F	M	A	M	J	J	A	S	O	N	D
Rainfall, mm m^{-1}	15	23	68	75	196	272	312	324	151	132	60	29
Sunshine, hours m^{-1}	69	47	40	90	153	157	161	157	156	157	125	93
Temperature, ^{o}C	18	18	21	25	28	29	30	29	28	26	22	19
Relative humidity, %	78	80	82	84	80	79	80	82	80	77	75	74

Table 2. Soil area classification (ha) based on soil texture (Nguyen Van Dung and Pham Van Hoi, 2003).

Texture, Village	Tang My	Son Du
Sand		11
Sandy loam	64	24
Light loam	20	54
Medium loam	43	2
Heavy loam	5	

Table 3. Major vegetables cultivated in Tang My and Son Du.

Common name	Botanical family	Latin name
Wrapped heart mustard	Brassicaceae	*Brassica juncea* var. *rugosa*
Cauliflower	Brassicaceae	*Brassica oleracea* var. *botrytis*
White cabbage	Brassicaceae	*Brassica oleracea* var. *capitata*
Purple cabbage	Brassicaceae	*Brassica oleracea* var. *capitata*
Kohlrabi	Brassicaceae	*Brassica oleracea* var. *gongylodes*
Broccoli	Brassicaceae	*Brassica oleracea* var. *italica*
Wax gourd	Cucurbitaceae	*Benincasa hispida*
Cucumber	Cucurbitaceae	*Cucumis sativus*
French bean	Leguminosae	*Phaseolus vulgaris* (bushy type)
Climbing bean	Leguminosae	*Phaseolus vulgaris* (climbing type)
Tomato	Solanaceae	*Lycopersicon esculentum*
Eggplant	Solanaceae	*Solanum melongena*
Hot pepper	Solanaceae	*Capsicum frutescens*

Table 4. Cultivation details of major vegetables in Tang My and Son Du.

Common name	Direct seeded (S), Trans-planted (T)	Days to first harvest (in the field)	Duration harvest period (d)
Wrapped heart mustard	S, T	45 - 50	3 - 5
Cauliflower	T	80 - 90	5 - 7
White cabbage	T	45 - 70	7 - 10
Purple cabbage	T	45 - 70	7 - 10
Kohlrabi	T	50 - 60	7 - 10
Broccoli	T	60 - 80	5 - 7
Wax gourd	S	60 - 90	30
Cucumber	S	40 - 50	30 - 40
French bean	S	45 - 50	20
Climbing bean	S	50	30
Tomato	T	60 - 90	90 - 120
Eggplant	T	60	90
Hot pepper	T	60 - 90	150 - 180

Table 5. Yield levels for major crops.

	Season, Yield (t ha^{-1})			
Crops	Summer 2002	Winter 2002	Spring 2003	Summer 2003
Wrapped heart mustard	-	18.6 (n=33)	17.1 (n=27)	15.7 (n=21)
Cauliflower	-	12.3 (n=15)	15.3 (n=1)	-
White cabbage	-	19.2 (n=13)	30.0 (n=1)	-
Kohlrabi	14.9 (5)	15.0 (n=121)	11.0 (n=1)	12.4 (n=3)
Wax gourd	-	8.6 (n=2)	32.1 (n=20)	26.6 (n=26)
French bean	-	5.8 (n=11)	-	-
Tomato	-	12.4 (n=24)	11.0 (n=3)	-

Source: Unpublished data VEGSYS project.

Figures

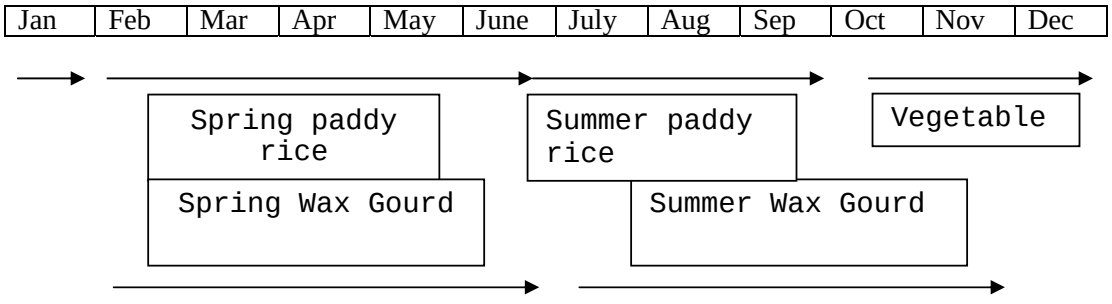

Fig. 1. Crop calendar.