The Vegetable Cultivation System in Two Villages in Sichuan Province, China

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Abstract

A qualitative description was made of the agronomic characteristics of the vegetable cultivation system in two villages, Shengli and Xibei, in the peri-urban area of Pengzhou County, Sichuan Province, China. A great number of different vegetable species are cultivated, of which garlic and lettuce are the most important ones. A description of the climate and soils of the area and details of the cropping system and cultivation techniques of the major vegetables are presented. Winter season is the most important season for vegetable production. Most of the vegetable crops are transplanted and grown in rotation with wet rice. A small area is used for continuous dry land vegetable production. Major constraints in the production of the vegetables were identified. Recommendations to improve the vegetable production focus on variety research, modern transplant production methods, off-season cultivation, and improved knowledge on pest and disease control.

INTRODUCTION

Shengli and Xibei are two villages located near the city of Pengzhou, in Pengzhou county, Sichuan Province, China. Pengzhou county is situated in the northwest of the Chengdu plain, 36 km away from Chengdu, the capital of Sichuan province, between N latitude 30°54′~31°26′ and E longitude 103°40′~104°10′. The landscape of Pengzhou county is high in elevation in the northwest and low in elevation in the southeast, with mountains, hills and plain areas. The elevation in Pengzhou is between 4,312 m and 489 m. Shengli is located in the east part of Pengzhou county, at an elevation of 590-600 meters. Xibei is situated in the north-west part of Pengzhou county, at 620-630 meters. The main vegetable crops cultivated in Shengli and Xibei are lettuce, garlic, radish, spinach, and celery. The main food crop is rice.

The following is a description of the characteristics of the vegetable cultivation systems in both villages.

MATERIALS AND METHODS

The data presented in this paper were collected during visits to the two villages between 2002 and 2005. A questionnaire for agronomic data collection was used, detailing the qualitative characteristics of the vegetable cultivation systems in the two villages. Main headings in the questionnaire were: climate, physical features, land preparation, cultivation system, crops, fertilizers, and farm yard manure. Each heading was comprised of several subheadings. Transects were walked for field observations and individual farmers were interviewed. In addition information obtained by the Rapid Diagnostic Appraisals carried out in both villages (Chen Ybing et al., 2002a, b) was also used. This work was done in the framework of the larger VEGSYS project (website: www.vegsys.nl).

RESULTS

Climate

The thirty-year average annual precipitation for the area is 973 mm. Although about 60% of all rainfall happens in a three-month period, July to September, there is still

substantial rainfall in April, May, and June (Table 1). The summer period, from May to September, is the warmest time of the year, particularly in July (Fig. 1). The colder winter period is from November to March, with especially low temperatures from December to February. Relative humidity is highest from June to October, around 85%. The relative humidity in the other months varies, but is never less than 73%. Total average yearly evaporation is higher than the average total yearly precipitation (Table 1). Only in July, August and September precipitation exceeds evaporation. In the other months, evaporation is higher than precipitation, particularly in March, April and May. During this period, other sources of water must be applied for crop growth, such as river water and groundwater.

Soils

The soils of Shengli and Xibei villages belong to the paddy soils, a grey alluvial soil. Generally, these are fertile soils with a good soil texture. Depending on the soil texture, paddy soils are divided in sandy loam, loam, and heavy loam or light clay (Anon., 1987; Chen Ybing et al., 2003). Average bulk weight of the cultivated horizon is 1.18 g/cm^3. Representative data on soil texture and nutrient content of paddy soils in Shengli and Xibei villages are given in Tables 2 and 3.

Crops

Major vegetable crops cultivated in Shengli and Xibei and representative yield levels are presented in Table 4. The vegetable crop with the largest area in the two villages is garlic, followed by lettuce. Details about cultivation methods and length of period of growth of the major vegetables are given in Table 5. Most of the crops are transplanted. Vegetables directly seeded are thinned to the required planting distance after emergence.

Most of the vegetables are grown with two rows on raised beds, only radish is grown with four rows on a bed. Not all households adopt the planting distances mentioned in Table 5. Some households use planting distances larger than the ones mentioned in this table, because larger planting distance may result in a better shape and higher quality of the product, fetching a better price. The day of the first harvest of a certain vegetable varies because of the use of different cultivars, the growing of crops in different periods of the season or following market price information. Growth after planting is slow in low temperatures. For garlic the length of the period of growth in the field depends on the purpose for which the crop is grown. If the crop is harvested for the plant then the period of growth is much shorter as compared to cultivation for harvesting the cloves.

There are considerable differences between households in terms of choice for the type of vegetables cultivated. Households decide which vegetables to grow according to their expectation of the market value of the crop, their production experience, and the practiced cropping system.

Cropping Systems

The average farm size varies between 0.12 to 0.48 ha. The individual fields are small. Field size is between 0.03 and 0.12 ha, with the average around 0.06 ha. At least two crops a year are grown. When vegetables are part of the cropping system, usually three to five crops a year are cultivated. Most vegetables are grown in the winter season. Fewer vegetables are grown in the summer season. During the summer season, demand for vegetables usually is less compared with the demand during wintertime. Also during the summer season, the conditions for long distance transport of vegetables are unfavourable. Generally, rice and vegetable crops are rotated. Rice is commonly part of the cropping system for food security reasons. In addition, it is a low labour demand crop, offering the possibility of off-farm labour to increase income. Rice-vegetable-vegetable and rice-vegetable-vegetable-vegetable are major cropping sequences in Shengli. In Xibei rice-garlic is the common crop sequence. The large acreage of garlic in Xibei is the result of local labour availability, good quality yields, and profitability of the crop, which has created expertise and tradition in garlic production.

Most vegetables are grown in paddy fields, directly after the rice has been harvested. Besides growing vegetables in rotation with rice, some households have fields where they continuously cultivate vegetables. These households usually have more labour available and are more experienced in vegetable cultivation. A recent development is the direct seeding in the field of radish in transparent plastic. On a very small scale, the cultivation of crops in plastic tunnels is starting to be explored.

In general, the small-scale operations result in high production and sales efforts. As market prices fluctuate, the profitability of vegetable cultivation sometimes is under pressure.

Land Preparation

At the beginning of September, after harvesting rice, most of the winter vegetables, such as garlic, spinach, and celery are planted or sown directly on non-tilled fields. At the end of April, after harvesting garlic, the fields for some vegetables that are also cultivated in summer, such as French bean, radish, eggplant and cowpea, are ploughed two times, usually with a two-wheeled tractor, animal traction, or by hand. After ploughing, raised beds and furrows are constructed by hand, using a hoe if the raised bed is adopted.

Seed Supply

Most of the vegetable farmers in Shengli and Xibei buy their seeds in the markets in Pengzhou City and nearby Nongfong town. Most of the seeds originate from national companies, but for some crops foreign cultivars are available (Chen Ybing et al., 2002). Some vegetable farmers use self-produced seeds, such as spinach and Chinese cabbage. Some growers are very keen to obtain a certain cultivar of a vegetable, while others just grow cultivars that are readily available and can be easily cultivated.

Transplant Production

Most of the major vegetable crops cultivated are transplanted (Table 5). Most growers raise transplants by themselves. Some growers buy bare-root transplants, such as Chili pepper, from markets. Transplants are raised on special permanent nursery beds close to the house or in varying locations along field borders. These beds usually have a sandy loam soil, easily irrigated, and drain well. The soil of the nursery bed is ploughed and the seedbed is carefully prepared by hand. Before soil preparation compost or manure and a NPK fertilizer are applied. Sowing is done by hand. The proportion between nursery bed and plant field is 1:50-100. After sowing, the nursery bed is covered by sandy soil, rice husks or rice straw to retain moisture. After emergence, the seedlings are frequently watered. Weak seedlings are removed. To prevent high intensity rainfall damage to seedlings and soil, or to prevent too high temperatures, beds may be covered by structures with bamboo mats. In the winter season, beds may be covered by plastic film for protection against low temperatures. Seedlings are ready for transplanting when they have four to seven leaves, usually at an age of 20-90 days. The age of the seedlings for transplanting is variable following the type of vegetable and sowing time. Observations showed considerable variation in uniformity of the transplants used.

Fertilizer Application and Water Supply

Farmers normally use compound NPK fertilizer (15:15:15) and manure as a base fertilizer. These are mixed and in case the mixture is broadcast, it is done before soil tillage. Alternatively, after soil tillage, the mixture may be placed into small holes of about 5-15 cm deep and covered by soil. Next to the placed fertilizer, the transplants are planted or seeds are sown.

Starting at about ten days after transplanting or after emergence of the seedlings, two ways of fertilizer application are employed. One is to dissolve urea and animal excreta with water and apply this mixture directly around the young plant or broadcast the mixture in the field. Another is to broadcast urea in the field or place urea around the plant just before raining.

The amount of fertilizer applied depends on the type of vegetable, the growth of the crop and soil fertility conditions.

Water supply for vegetable crops is from natural precipitation and irrigation. Two ways of irrigation are adopted in Shengli and Xibei. One is to water the crop by furrow irrigation around the raised beds. Another is to water the vegetable by hand with the water carried in a bucket to the field. The method of irrigation depends on the type of vegetable, the cultivation method, and water resource conditions.

Pest, Disease and Weed Control

Farmers apply many types of pesticides. It appears that farmers do have not enough knowledge of pest and disease identity and pesticide application. The farmers cannot always control pests or diseases effectively and economically by applying correct pesticides on time. Farmers are eager to obtain more knowledge on plant protection.

Weed control is considered important to prevent competition between crops and weeds. In certain crops, e.g. eggplant, cowpea, tomato, and garlic, herbicides are used before or shortly after transplanting or shortly after sowing. Weed control in later crop stages is done by hand. In some crops, such as tomato, transparent plastic mulch may be used for weed control.

Harvesting and Quality Criteria

The harvesting time relies on the transplanting or sowing date, the length of the growing period of a cultivar, as well as on the market price of the vegetable. Sometimes vegetables are ready to be harvested, but farmers leave them in the field because they want to wait for better prices. After harvesting, farmers sell their vegetable to middlemen, or sell their vegetable themselves in the wholesale market. Some farmers store garlic for one to six months, waiting for a good price.

The prices of vegetables vary depending on supply (Chen et al., 2002). There are no quality standards for vegetable products in terms of outer quality or grading. As far as quality is concerned, normally buyers and sellers decide on the vegetable price by its appearance, such as colour, cleanliness and uniformity.

CONCLUSION

Vegetable production is an important activity for farmers in Shengli and Xibei. Vegetable cultivation is mainly concentrated in the winter season. The largest single vegetable crop is garlic, followed by lettuce. Although the alternation of wet rice with dry land vegetable production may be good for control of soil borne pests and diseases, the repeated drying, wetting, and tillage of the soil creates a less favourable soil structure for the growth of vegetables and requires a large input of labour. To reduce these negative effects of rotation with wet rice, options for the development of local systems for permanent vegetable production should be explored (Everaarts et al., 2006).

The length of the vegetable growing period varies with the vegetable cultivars and the cultivation period. Some vegetables are sown directly in the field, most vegetables, however, are transplanted. Seed supply is mainly from commercial markets. Both fertilizers and organic manure are used. Pesticides are frequently used for pest and disease control. Herbicides and hand weeding are both employed for weed control. Quality criteria for products are not clearly defined. Prices are positively related to the appearance of the vegetable product. As it may be expected that more products will be sold by supermarkets (Xiaoyong Zhang et al., 2006), the quality of the product and defining product quality standards in terms of outer quality and grading will become more important, as well as the safety of production and products from an environmental point of view (Yao Xiangtan et al., 2005; Zhang Miao and Zhang Peizheng, 2005)

RECOMMENDATIONS

For the present situation of the vegetable production in Shengli and Xibei, four major recommendations can be made, in order to improve the vegetable production.

- Introduction of new cultivars. A good starting point for improvement in the cropping systems is to compare the presently used cultivars with suitable new cultivars, in on-farm trials for performance with regard to yield, quality, pest and disease resistance, harvesting time, and market potential.
- Introduction of new transplant production methods, resulting in uniform and strong transplants. The present use of bare-root transplants may result in transplant shock in the field, delaying crop establishment. The observed variation in size between transplants, results amongst others in uneven crops and variation in the length of the growing and harvest period.
- Introduction of off-season vegetable cultivation. The date of harvesting of a vegetable can be advanced or delayed by using cultivation techniques. This may result in better prices, as prices are better in the present off-season.
- Improvement of knowledge on pest and disease control. The damage from pest and diseases is serious. Incorrect use of pesticides results in high costs, low yields, poor product quality, and environmental pollution. It is important to train farmers to recognize the pests and diseases and to learn them which pesticide can control a certain pest or disease.

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Tables

Table 1. Precipitation (P) and evaporation (E) (mm) during the year (1997-2001).

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Tot
P	11	14	19	59	68	85	166	188	155	38	14	5	822
E	36	43	76	98	139	106	128	110	79	55	41	29	940
P-E	-25	-29	-57	-39	-71	-21	38	78	76	-17	-27	-24	-118

Table 2. Physical characteristics of paddy soils.

Soil type	Colour	Soil particle content (%, <0.01 mm)			Ground water level (m)	Depth of profile (cm)	Bulk weight of cultivated horizon (g cm^{-3})
		Cultivated horizon	Plow sole	Subsoil layer			
Sandy loam (Shatian)	Grey	53	57	44	3-9	36	1.21
Loam (Youshatian)	Grey	55	56	52	2-10	67	1.11
Heavy loam or light clay (Nitian)	Grey	69	69	61	2-10	78	1.22

Table 3. Chemical characteristics of paddy soils.

Soil type	pH	OM (%)	Total N (%)	Total P (%)	Extractable Potassium (mg kg^{-1})	Available N	Available P	Available K	CEC (meq 100 g $soil^{-1}$)
						(ppm)			
Sandy loam (Shatian)	5.1	4.3	0.19	0.13	880	165	66	138	9.8
Loam (Youshatian)	4.8	4.1	0.22	0.08	741	174	18	120	12.3
Heavy loam or light clay (Nitian)	5.3	3.8	0.19	0.09	792	154	21	139	12.2

Table 4. Representative yield levels of major crops in Shengli and Xibei in the 2002/2003 season. Source: Unpublished data, VEGSYS project.

Crops	Yield (t ha^{-1})	
	Shengli	Xibei
Cabbage	44.3 (n=28)	53.3 (n=3)
Celery	3.0 (n=2)	-
Chinese cabbage		
headed	52.8 (n=23)	39.8 (n=4)
non-headed	38.3 (n= 28)	-
Chili pepper	-	16.6 (n=8)
Cowpea	24.3 (n=29)	17.6 (n=9)
Cucumber	-	26.1 (n=1)
Eggplant	-	20.5 (n=6)
French bean	14.7 (n=7)	-
Garlic (cloves)	5.8 (n=62)	5.5 (n=131)
Wax gourd	-	36.4 (n=6)
Lettuce	32.3 (n=43)	36.8 (n=27)
Onion	7.5 (n=1)	-
Radish	39.5 (n=23)	30.8 (n=11)
Rape	2.5 (n=36)	-
Spinach	21.7 (n=42)	5.6 (n=2)
Tomato	-	50.0 (n=11)

Table 5. Cultivation details of major vegetables in Shengli and Xibei.

Common name	Direct seeded (S), Transplanted (T)	Planting distance (row× plant, cm)	Raised bed size (height× width, cm)	Days to first harvest (in the field)	Duration harvest period (d)	Main season: Summer (S) Winter (W)
Cabbage	T	40×30	-	60-90	10	W
Carrot	S	15×15	-	80-100	4	W
Celery	S, T	10×10	-	80-100	1	W
Chinese cabbage	T	30×20	-	50-80	10	W
Chilli pepper	T	50×20	10×60	70-90	60	S
Cowpea	S	40×20	10×50	60-70	25	S
Cucumber	T	50×20	10×60	60-80	30	S
Eggplant	T	50×40	10×60	70-90	60	S
French bean	S	40×20	10×50	40-60	20	S
Garlic (cloves)	S	20×10	-	60-150	30	W
Green squash	T	50×30	10×60	70-90	20	S, W
Lettuce	T	30×20	-	60-90	5	W
Onion	T	20×10	-	40-50	10	W
Radish	S	40×30	10×180	60-90	5	W
Rape	T	30×20	-	60-70	60	W
Spinach	S	20×10	-	50-60	30	W
Tomato	T	50×30	10×60	70-90	40	S

Figures

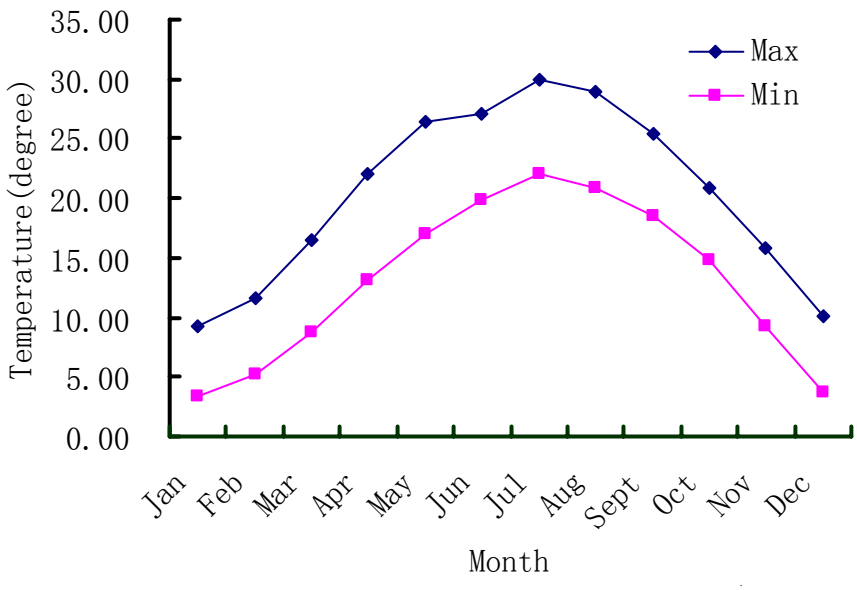

Fig. 1. Maximum and minimum temperature in a year (1997 – 2001 average).