



Environmentally Friendly Food System

A Sustainability Planning Case in China

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1 *Collect organic waste*



2 *Transport*



3 *Compost*



Anxi Village

4 *Plant vegetables*



Dejia Community



5 *Sell*



1. Background

The composting of organic wastes is a great approach to reduce urban garbage and using compost to plant vegetables. This sustainability planning is conducted for Dajie Urban Community in Hangzhou City in China to recycle the trash and transport the organic waste to rural community compost and use to plant vegetables in rural community.

From 1927 to 1984, organic waste from city of Hangzhou had been taken to farms for composting. The compost was used for growing vegetables such as eggplant, pepper, tomato, and cucumber. Farmers came to downtown to collect organic waste for compost using for fertilizer. The composting techniques used by Hangzhou farmers used to be very successful and the agriculture experts from Hangzhou were invited to give lectures about this compost project for communities in Beijing, Shanghai and Urumqi. After 1984, the farmers didn't do composting anymore partially due to electric heaters were used to warm soil for vegetables germination. Besides, chemical fertilizers became available. Also young people didn't like to be farmers, the available labor force for farming decreased, so this labor-intensive composting practice couldn't be continued. However, many people, especially the elders today feel that the vegetables do not taste as good as they had in the old days when natural fertilizers were used. Chemical fertilizers are easier to use, but over used is not good for the soil, vegetables and people's health. Organic waste compost is a better choice for the soil and the quality of the vegetables. China is facing a big problem of waste management. Therefore, it is the right time to conduct this environmental friendly food system benefit communities and also environment.

Dejia Community is located on the south of Wenxin Street in Jiangcun Commercial Center of western Hangzhou City, which has special stated in Hangzhou since it is Hangzhou's first National-level Urban Residential Construction Demonstration Community and also has been

honored as Chinese Construction Department Urban Residential Construction Excellent Demonstration Community. The community is composed of 38 buildings with 1,009 families and 67 retail shops and service business for the residential area. The population in this community is about 3,000. The attractive European style buildings in this community had won the Golden Medal of National Urban Residence Design Award in 2001, and also attracted middle class and highly educated people with the age of 30-40 living here which counts for 72.68% of total population of the community. The 76.83% of residents' education is Bachelor or higher. Good education and young aged community members are believed the better criteria to launch the program according to communication and acceptance and implementations the ideas.

For this program, Anxi village will be involved as a major stakeholder for vegetable farming. It is only 20 minutes away from Deji Community by car. The village is located in Liangzhu Township, Yuhang District of Hangzhou. It composed of Anxi, Middle Xi, Up Xi, Down Xi and Shiling, five natural villages/settlements with its area about 12 square kilometers. There are 1,029 families and total population is 3,605. Most of the local people are farmers. There are an elementary school and a middle school in the village for the local community which is a good place for public education and for communication the concept such as benefits and technology of program. The organic waste from school cafeteria and other sources also can be another source for composting.

2. Client Requirements

The requirements include the comments from executive staffs and community members from both communities.

- ***Requirements of Deji Community***
 - Residents can get cheaper and healthier vegetables.
 - To strengthen the reputation and image as environmental friendly and social responsible community through the sustainability plan implementation.
 - Getting help to fund the facility for trash collection to initiate the program.
 - Specific guidance of implementation the plan from communication/coordination to program operation, provide necessary training to start the program.
- ***Requirements of Anxi Village***
 - Farmers can get free compost resources for fertilizer, and at the same time, the profit from the program is higher than the normal farming practices.
 - Feasibility of the project such sufficient compost for growing vegetables to supply to the urban community within the project sites. Understand the risk of program implementation.
 - Technological support for experts on agriculture, environment to guide farmers improve their skills on farming by using organic waste to made fertilizer.
 - Ensure that the composting will not pollute their environment such as odor or land pollution through this project.

3. Environmental Friendly Food System (EFFS)

Outlined below are the recommended initiatives:

- ***Action 1: Collection of the organic waste in the urban community***

- Estimation of the amount of organic waste produced by the Dejia, the urban community.

Each individual averagely consumes 1.5 kg of food (including vegetables, fruits, rice, bread, tea and coffee) per day. About 10% the food can be calculated as waste. Therefore, the total amount of organic waste produced in the urban community is about 3.15 ton/ week (3,000 individual \times 0.15 kg \times 7 days). This amount is approximately one small truckload. Based on the amount of the organic waste collected per week, we suggest that the frequencies to transport the waste from the urban community to the rural area is once a week.

- Method to collect organic waste

Step1- Design the container: The organization to implement the project can provide (offer or sale) each family with two trash containers for collecting the organic waste. The volume of the container must be big enough to contain the organic waste produced by a family in a week (approximately 10 to 11 kg). The container should be easy to open, close and leak-proof. The container can be classified into different groups based on various colors. The container for each building has the same color and each family should symbolize its container either by name or the number of its apartment, which will help residents to identify their container easily.

Step 2 - Collection of the waste: **The certain of the week** for example Saturday or Sunday , each family converge its organic waste collected during the week to the rubbish collector or garbage truck at preset time and assigned place. The sanitation administration of the city is responsible for transport the waste to rural community which is 20 minutes away from the urban community by driving.

- **Action 2: Composting waste, collecting methane and storing manure**

Two type of container is needed for the composting process. One is used for decomposing waste, see figure 1 (container 1) and the other is used to store the decomposed manure (container 2). The container 1 (Figure

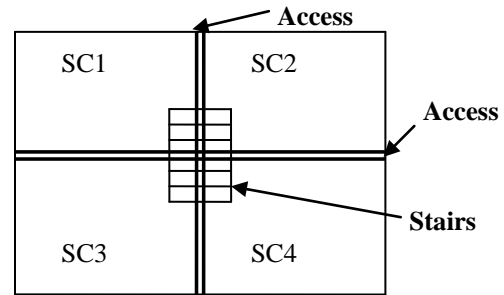


Figure 1. The decomposing container

1) including 4 sub-containers (SC1, 2, 3 and 4). Each sub-container has a volume that can contain the waste produced by the urban community in a month (or 4 to 5 weeks). In other words, it has a volume about 15 to 20 m³. The container 2 should be large enough to store the decomposed manure produced in one year. The compostable refuse will be decomposed in SC for about 4 months and then transported to the container 2. So 4 SC will provide plenty of room to decompose the waste. In addition, a marsh gas (methane) collecting pipe system will be installed in the container 1 (4 sub-containers). The methane produced during the decomposing process will be collected and used as energy resource for farmer's cooking. (We will do more research on this part esp. the technological issues)

- **Action 3: Estimation of the farmland needed and the amount of vegetable production**

The amount of the organic waste that can be produced by the urban community is about 165 ton (0.15kg/per person×3000 people×365 day=164.25 tons). The collectable non-edible part of vegetables plants from farming is about 25 tons (25% of the biomass above the ground) every year. The total amount of the compostable refuse is about 190 ton. The water ratio of the organic waste is about 80-85% and the water ratio of the decomposed manure is about 30%. Than the total amount of the decomposed manure could be about 40 to 50 tons (or cubic meter). This amount of decomposed manure can

provide fertilizer for an area of 10 mu (*i.e.* 1.65 acres) farmland. The vegetable yield could differ from one variety of vegetable to the others. The estimate of the total vegetable yield from 10 mu (*i.e.* 1.65 acres) is about 100,000 pounds per year regardless the yield differences among different varieties. Then, the supply of organic vegetable to the urban community is averagely 250 to 300 pounds per day, which is small amount for a population of 3000. In other word, the vegetable production from the farmer can be consumed by the urban community completely in term of the amount. Every day the farmer can deliver 250 to 300 pound of vegetable to urban community and the residents in urban community can buy vegetables from the farmer at a preset time.

4. Fostering Sustainable Behavior

The success of the program relies on some targeted behaviors change. Table 1 illustrates the target behaviors for residents in Deja Community and farmer in Anxi Village, and the barriers and benefits to change the behaviors. From the behavior analysis, it can be seen barriers of residents in Deja Community seem less than that of farmer in Anxi Village. Meanwhile, due to benefits in Deja Community are less than that of farmer in Anxi Village, it is still difficult to judge behaviors in which community are easier to be changed.

In order to remove the barriers and change behaviors, the following the strategies are identified. Table 2 shows detail actions for strategies.

- ***Organizational structure in support of Sustainability***

Besides Deja Community and Anxi Village, there are some other organizations should be involved in program helping to change residents and farmer's current

behaviors. Figure 2 shows the organizational structure of this program. Dejia Community is going to take the core role of the program. As this program is designed for this community, and finally would benefit the community. Therefore, the community acts the chief coordinator in this program. Anxi Village would be involved in the program as the farm site and is the major stakeholder due to its key role in composing, planting and selling processes.

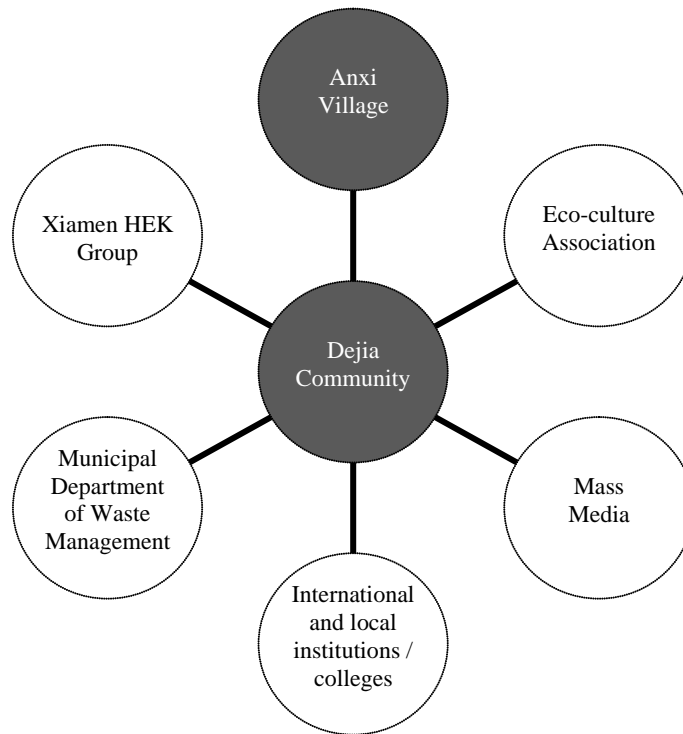


Figure 2: The organizational structure of EFFS program.

Hangzhou Municipal Waste Management Department will be responsible for transportation the organic wastes to the designated sites in countryside. In this case, they will transfer wastes to Anxi Village. As a professional environmental protection non-governmental organization, Hangzhou Eco-culture Association (HZECA) will be the advisor and supervisor of this program. HZECA will provide residential education service and technological support on composting and farming. HZEAC is also going to

do the program assessment. In addition, some institutions such as Clark University and local colleges will provide some technological support. Furthermore, Xiamen HEK Company will buy organic waste containers for residents. And mass media such as *Qianjiang Evening News* and *Zhejiang Television* agree to report the progress of the program, which will help with program promotion and also accelerate the program implementation.

- ***Communication and education***

To motivate public to participate in the project, communicating the environmental, societal and economic and health benefits of the project are very important. At the same time, it is also very necessary to provide basic knowledge and skills of organic waste collection. Easy understanding and eye-catching brochures (*incl. waste segregation guidelines*) need to be produced. Training workshops and lectures also need to be conducted to train the people participated in the program especially for community members. It is also very important to make sure residents understand the different schedules of activities such as participating training or delivering the waste. In additional, Hangzhou Eco-culture Association can play the role of marketing through its network such as website (<http://www.greenzj.com>), events and newsletters (*Green Front*).

- ***Questionnaire Survey***

Questionnaire survey is one of the important tools to collect relevant information from residents in Deji Community. The purpose of the survey is to (1) evaluate community members' understanding of organic food and waste; (2) estimate the demand and acceptable prices of vegetables; (3) fix suitable time to collect organic waste and sell vegetables; (4) collect relevant data for program assessment.

Table 1: Fostering Sustainable Behavior

Current behavior		Expected behavior	Barriers	Benefits	Strategies
Dejia Community	All kinds of wastes mixed together	Sort out organic waste (waste segregation)	<ul style="list-style-type: none"> - Limited time - Limited benefit - Lack of knowledge 	<ul style="list-style-type: none"> - Collect organic wastes - Reduce wastes for landfill 	<ul style="list-style-type: none"> - Education and communication (workshops, lectures <i>etc.</i>) - Design and distribute a brochure of EFFS (<i>incl.</i> waste segregation guidelines)
	Deliver wastes anytime	Deliver organic waste separately on specific day every week	<ul style="list-style-type: none"> - Inflexible time schedule 	<ul style="list-style-type: none"> - Reduce the potential pollution 	<ul style="list-style-type: none"> - Survey to find out a appropriate time for most of the residents - Inform the residents
	Use plastic bags to package all the wastes together	Every household and the community need buy organic waste containers	<ul style="list-style-type: none"> - Cost for waste containers - Clean the containers 	<ul style="list-style-type: none"> - Save time to unpack trash bags - Reduce secondary pollution of plastic bags 	<ul style="list-style-type: none"> - Xiamen HEK Company will buy organic containers for the project - Communication
	Buy vegetables from supermarket or agricultural markets	Buy vegetables from the farmer directly	<ul style="list-style-type: none"> - Inflexible shopping time 	<ul style="list-style-type: none"> - Drive the establishment of EFFS through providing benefits to both urban and rural communities 	<ul style="list-style-type: none"> - Survey to find out a appropriate time for most of the residents - Inform the residents
Anxi Village	Buy and use chemical fertilizer	Compost and use organic wastes	<ul style="list-style-type: none"> - May decrease the production - Time consuming - Cost for composting - Lack of technical skills 	<ul style="list-style-type: none"> - Reduce the chemical pollution to - Save cost for fertilizer - Provide renewable energy 	<ul style="list-style-type: none"> - Education and communication - HZECA will provide professional guidance and volunteers assistance
	Leave crop stands in the fields directly	Transfer to composting container to compost	<ul style="list-style-type: none"> - Time consuming - Cost for transportation 	<ul style="list-style-type: none"> - Provide more biogas - Increase the quantity of manure 	<ul style="list-style-type: none"> - Education and communication
	Sell vegetables to middle man	Sell vegetables to residents of Dejia Community directly	<ul style="list-style-type: none"> - Time consuming - Cost of transportation 	<ul style="list-style-type: none"> - Make more profits potentially - Help the establishment of EFFS 	<ul style="list-style-type: none"> - Negotiate a reasonable price to ensure farmer's profits

To assess the effectiveness of the above strategies, the evaluation system should be established. Several actions in Table 2 have been identified and classified for each strategy as indicators to evaluate the strategies.

Table 2: Evaluation for Strategies of Changing Behaviors

Strategies	Actions
Establish a team for EFFS	Contact relative organizations to created a team for this project
	Team meeting for knowing each other and splitting the work
	Recruit volunteers especially for education process
Conduct questionnaire survey	Recruit experts for composting and planting processes
	Design a questionnaire
	Conduct survey
Fund Raising	Writing proposals for funders
	Raise fund from HEK company for organic waste containers
	Raise fund from governmental department / foundations
Education and communication	Design a brochure including waste list
	Organize lectures in urban community to increase the awareness of the residents
	Organize workshop to ensure the responsibility of all the participators
	Inform all the residents the supposed waste collecting time and vegetable buying time
	Invite mass media to report the general idea the current progress of the program to create a great atmosphere for residents' participation
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5. Additional Recommendations

Subsequent to successful implementation of the initiatives described above, below are provided future initiatives for consideration:

- ***Diversify the Vegetables***

The urban residents need to consume vegetable everyday and likewise the farmer wants to sale its products every day. Therefore, we suggest that the vegetables to be planted should have the character of long-lasting harvest duration (For example, tomato, green or red pepper, eggplant, leek, green been, cucumber, squash and so on) instead of one-off harvest. It is also will be very helpful to conduct a simple survey about Dejia community members' preference to decide what kind of vegetables to plant.

- ***Vegetable Online Marketing System***

In the future, the program could be improved in its marketing system through online purchase. Residents can purchase organic vegetables online, phone call or filling a form to drop on a mail box. Then, the farmers could deliver the vegetables to the clients as door-to-door service with extra charge of 5-10% for delivering. By doing so, community members and farmers both get benefit.

6. Cost and benefit analysis

Cost-benefit analysis can help us to assess the program and provide direct information for the decision maker. In this case, cost and benefit can be divided into urban and rural communities shown in Table 3.

Table 3: Cost-benefit Analysis for the EFFF Program

Cost / Benefit		Items & Categories	Estimated (\$K US)
Cost	Dejia Community	Organic waste containers	5~7
		Organic Waste Transportation	4 ^a
		Education and communication expense	3
		Administration Cost (<i>incl.</i> time)	1 ^b
		<i>Total</i>	<u>9~11; 4^a</u>
	Anxi Village	Farmland cost	1 ^a
		Composting container	7
		Biogas utility	0.9
		Vegetable transportation	5 (truck); 2 ^a
		Other sales related costs	1 ^a
		Vegetables production cost	2 ^a
		Program implementing cost (<i>incl.</i> time and labor)	1 ^b
	<i>Total</i>	<u>18; 3^a</u>	
	Total Costs		
Benefit	Dejia Community	Cheaper organic vegetables	17~20 ^a
		Health benefit	N/A
		Reputation	N/A
		<i>Total</i>	<u>17~20^a</u>
	Anxi Village	Higher profit from vegetables	40~50 ^a
		Cost reduction for buying chemical fertilizer	6~8 ^a
		Saving energy from using biogas	0.5~0.8 ^a
		Reputation	N/A
		<i>Total</i>	<u>46.5-58.8^a</u>
Total Benefits			63.5~78.8^a

In this table, “a” means this value is every year. “b” means the estimated value is not include time, which is too complicated to be calculated.

- ***Cost analysis***

Every household of Deji Community need buy two organic waste container and every building (block group) need to equipment with bigger waste container for collecting the waste from each householder. Moreover, residents need spend extra time probably less than 10 minutes to manage the waste in daily base. So in total, 2000 householder trash can and 10 community trashcans will cost about \$5,000-7,000.

Another cost is organic waste transportation. This responsibility will take by Waste Management Department since they have resources.

Furthermore, there are also some expense such as administration, communication and the training.

For Anxi village, some hardware investments are the major sources. First, 10 mu (i.e. 1.65 acres) of farmland is needed. Also, four composting containers and a conservation container should be constructed, which cost about \$7,000. In addition, biogas pipe system would cost about \$900. In order to transport the vegetables to Deji community, the farmer need buy a mini truck. The cost of transportation and labor also need to be considered.

- ***Benefit analysis***

The primary benefit and direct benefit for the residents in urban community is that they could buy organic vegetables at a lower price. It estimated that they can save 40%-50% for organic vegetables compare to other resources. They are also benefited in health through the healthy vegetables in the long term.

Meanwhile, Deji community will gain the reputation if the program is successful. Reputation is one of the indicators for government to appraise community.

Higher reputation for the community means they would gain more support from the government.

Essentially, farmers can get more direct benefit from program implementation. From door to door sale, farmers can get more than 30% of profit comparing to selling to salesman. Usually, farmers need to invest about \$150 for 1 mu (*i.e.* 0.165 acre) land buying chemical fertilizer per year. It is both costly and polluted. Through this program, farmers can save \$150 for using the compost, which also can decrease the risk of the chemical using to environment and human health. Meanwhile, the construction of biogas can save energy cost for farmers, which is estimated \$500-1,000 per year. Therefore, from aforementioned cost and benefit analysis, it is concluded that farmers can get turned back the investments in one year.

Additionally, benefits could also be seen in other aspects and stakeholders. For instance, it is estimated that at least 500 m³ of space of landfill would be saved annually, because of the reduction of waste need to be filled.

- ***Conclusion***

Table 1 represents the costs and benefits analysis of the program. Both Deji and Anxi communities, the bulk of investments are one-time. Besides, every year, \$10,000 should be added for this program. Compared with costs, benefits could be seen as continuous. \$17,000-20,000 and \$46,500-58,800 benefits would be taken respectively by urban and rural communities. That means to the farmer, if the program run successfully, they can get back all the investments and in first year.

The benefit is significant. For the first year, about \$30,000-40,000 net benefits will be produced. From the second year, the benefits would increase to \$50,000-70,000.

Besides, even though the benefits are great, health benefits are still excluded due to its complication. However, people can easily realize it, and to some extent, they'd rather to pay extra money for healthy foods.

7. Program Monitoring Plan

It is also important to evaluate if the program achieves expected economic, environmental and social goals and benefits, having the value to leverage in the larger scale. In order to be independent and equal, all the assessments in this program will be conducted by HZECA. After program implementation one year, the assessment should be conducted, at the same time, the lessons and experiences should be all included for better practices for scale up in the future. The details please see the Table 4.

- ***Economic Impact Assessment***

It is important to figure out whether the residents of Deji Community and farmers of Anxi Village have gotten expected economic benefits from the program. Another important indicator is farmer's payback period.

- ***Environmental Impact Assessment***

The second step is to evaluate the impact to environment. The reduction of chemical fertilizers usage benefits the soil structure and eliminates pollutant emission. Besides, according to the decline of waste to be filled, the landfill could be in service for longer time.

- ***Social Impact Assessment***

By conducting this program, residents in both communities can better understand environmentally friendly concept. Meanwhile, the two communities can gain reputation in terms of increasing media reports on the implementation and benefits of this program, which would encourage them to participate in other greening community activities, such as energy and water saving actions. Besides, health impact could not be ignored although it seems difficult to evaluate in a short term.

Table 4: Environmental Friendly Food System Program Monitoring Matrix

Monitoring Objectives	How	When	Indicators
If farmers got enough economic benefit/profit and can return the benefit in the expected time?	Collect Data from Farmers	Quarterly	Hardware Investment
			Vegetables Produced and Sale Volume
			Biogas
			Fertilizer cost
If urban community members got expected organic vegetables in estimated low rate (30-50%)?	Questionnaires Survey / Community Member's self-report	After one year program implementation	Vegetable prices
If the reduce landfill use have the significant economic value?	Collect Data from farmers	After one year program implementation	Estimate the space saved from the exact organic waste used for the program
If the reduction fertilizer using benefit the environment?	Collect data from farmers	Annually statistics, randomly collecting data	Reduction using fertilizer Using
If the communities gain reputation from the project implementations?	Questionnaire Survey	End of the one year project	People's awareness
If people's environmental awareness raised through participating the program	Questionnaire Survey	End of the one year project	People's awareness

8. The Program Risk Analysis

Generally, there are two categories of risks to conduct this program, including natural and anthropogenic risks. The risk of natural disasters such as drought, flood, typhoon, snowstorm, massive insect damage can have negative impact to farming and the farmers will lost their investment and also will not get profit. However, this risk is low according to the history. If this happens, if the farmers can't provide the vegetables, the farmers should not be responsible of Dejia community members' lost not getting the vegetables.

The second risk is that the Dejia community members couldn't see the long-term benefit in short time and might lose the passion and interest to participate in the program. However, this depends on long-term and consistent communication to sustain people's recycling behavior. Education and communication is very important for the program successful implementation.

The third risk is that the farmers see the benefit by selling the organic vegetables and they might sell the products from other farms to Dejia community. To avoid this risk, the farmers need sign a pledge that they only sell their own products from the program. For the first year, should have the limit of the vegetable which is 250 to 300 pounds per day to sell to the Dejia community. Generally speaking, this project is lower risk, higher economic, environmental and social benefits and easily implemented project.

9. Possible Future Expansion of the *EFFS* Program

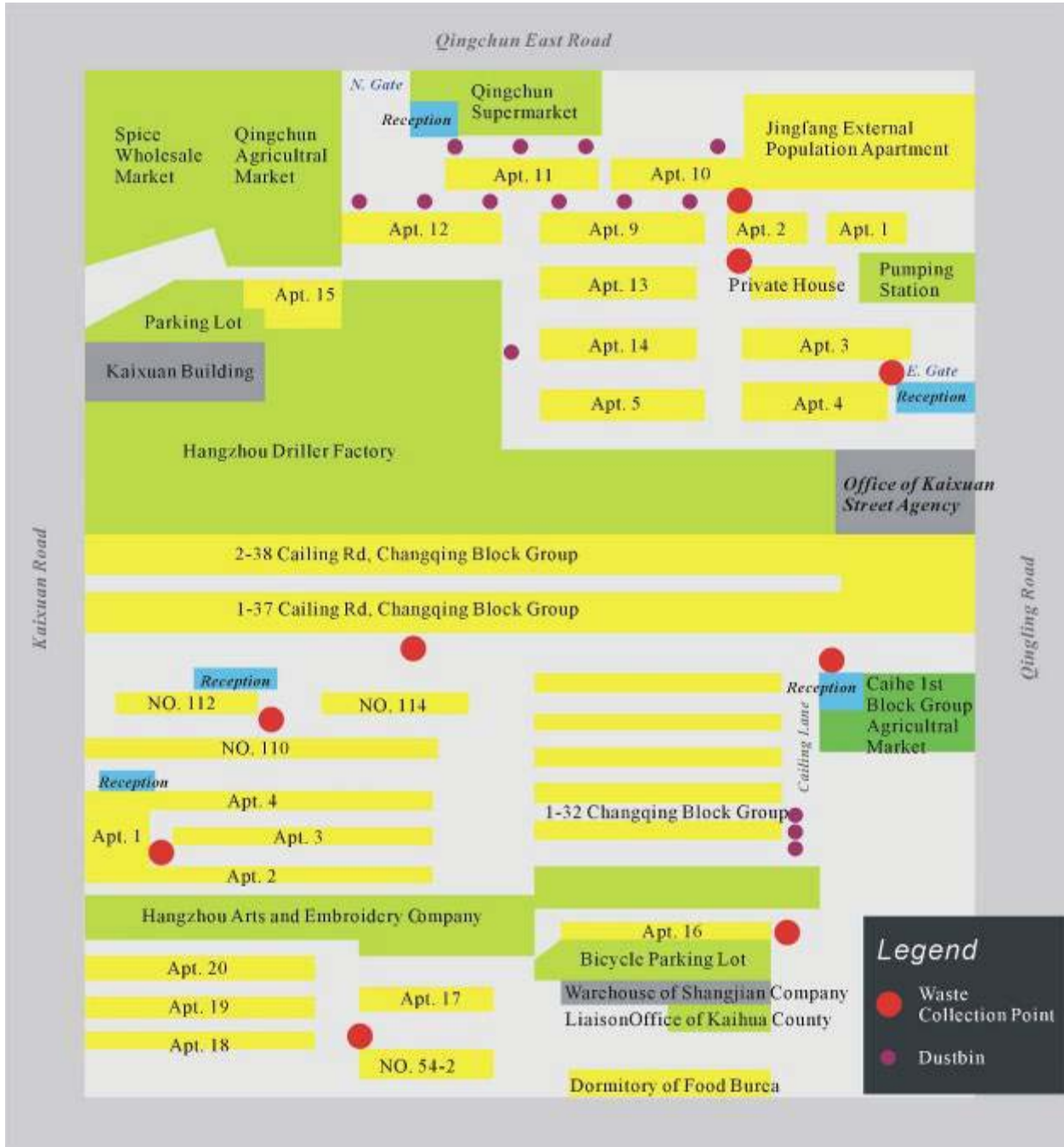
With the traditional thrifty culture, it is feasible that this program could be replicated and gradually expanded across China based on successful implementation of *EFFS* in Dejia Community and Anxi Village.

Essentially, the bulk of the rural regions of China have no landfills. The successful replication of the EFFS program can reduce a lot of wastes in rural areas. Therefore, it is believed local government would support this kind of initiatives. Some researches showed there have been already some attempts for waste composting in Laiyang City in Shandong Province (Reference).

In order to start replication, more demonstration communities should be selected in Hangzhou City, especially neighbor communities to Deji, as well as more farmers would be involved in Anxi Village. The success of this step should be recognized by governments at vary levels of Hangzhou City, which is crucial to replication in China. After that, the program can be promoted in the entire city. However, due to the differences of climatic, ecological, administrative, agricultural, economic factors *etc.*, it is very complicated to replicate this program nationwide. More researches are required in the future.

Appendix: 1

Current Waste Collection Containers in Deja Community



Source from Deja Community

Appendix: 2

Questionnaire for Environmental Friendly Food System

This questionnaire is specially designed for the program of Environmental friendly food system, which is to be implemented in your community. The program, which will benefit both your health and the environment, needs your support and participation. Please feel free to answer the following questions. Your information and opinion will help us to improve the system of the program so that you can receive the best service from the programs you expected.

Name: _____ *Apartment No.:* _____

1. How many members are there in your family in present?
1. Two 2.Three 3.More than three
2. How much vegetables and fruits are approximately consumed by your family every day?
1. One kg 2.One and half kg 3. Two kg 4. More than Two kg
3. How much do you know about organic food?
1. Very much 2. Some 3. A little
4. Are you interested in knowing more about organic food?
1. Yes 2. No 3. It doesn't matter
5. If you know what organic food is and if the cost to consume organic vegetable is a little more than what you spend on vegetables as usual, do you prefer organic vegetables?
1. Yes 2. No
6. If yes, how much more do you expect to pay for organic vegetables?
1. 10% 2. 20% 3. 30% 4. More than 30%
7. If no, do you want to win an opportunity to consume organic vegetables in usual prices by spending a few more minutes to deliver your waste food separately to public trash bins?
1. Yes 2.No
8. If yes, what day is convenient for you to deliver your waste to trash bins?
1. Mon. 2. Tues. 3. Wed. 4. Thur. 5. Fri. 6. Sat. 7. Sun.
9. If you want to consume organic vegetables, what day is convenient for you to purchase them in your area?
1. Mon. 2. Tues. 3. Wed. 4. Thur. 5. Fri. 6. Sat. 7. Sun.
10. If you want to consume organic vegetables, what are your preferred vegetables and how much do you want approximately every day? Please give detail information by filling the table below.

Name of vegetable							
Amount (500g)							

- Thank you very much for the co-operation! -