

PROFILE

Greenhouse Cucumber Production: Enriching the Chinese Vegetable Basket

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Seasonality of vegetables poses problems for both the consumers and the producers. And add to this the problem of the changing climate pattern which makes food security or more precisely nutrient security a major concern worldwide. Advanced greenhouse technologies like vertical farming, hydroponics, aeroponics have been devised for the purpose. Growing plants in controlled environment (and not greenhouse in the strict sense) have existed since the Roman era¹, followed by the Han and Tang dynasties of China. The area under greenhouse cultivation in China has grown from 9,180 ha in 1981 to 1,397,311 in 1995 and 1,963,000 in 2002². Hence, it would be interesting to study the evolution, diffusion and customization by different farmers who are often perceived as just the receiver of technologies devised by the formal institutions. This story, is about farmers as innovators, fabricators, technology providers, and the co-operation and collaboration among them. It is a case of lateral learning where educational, research or governmental institutions make much less contribution.

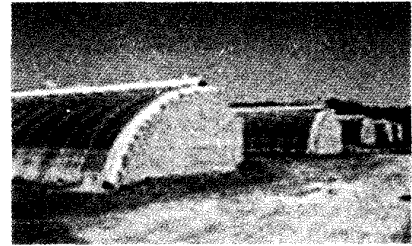
The beginning

The story begins with the modification of greenhouse technology by a group of farmers in Wa Fangdian, Liaoning Province. Till the late 1970's the greenhouses were heated by using coal as fuel, but then China faced coal crisis (and after that the policy on coal mining was changed). It became difficult for the farmers to maintain the greenhouses. This was the time when the idea of using plastic films to build greenhouses was introduced. And, in 1979, Qin Wanshu, from Wa Fangdian started making a greenhouse using plastic films. He was born in Zhang Shanzui production brigade (farming units in China, disbanded during 1982-1985) in 1920.

The smallest units were called vegetable growing groups under a production team in a village. These teams were further grouped under production brigade under a commune. Though good at abacus calculations, he had to discontinue school after only three years of schooling. In the 1950s he worked as an accountant in Zhenjiao commune (later replaced by Gandian community), from 1961 to 1969 he continued as accountant in Zhang Sanzui production brigade and later worked as the head of Zhu Feng production brigade.

Towards a breakthrough

After his retirement around early 1979, he started working as a vegetable growing technician and guided the two vegetable growing groups in the west production team under Zhang Shanzui production brigade. He witnessed the change in the greenhouse technology from glass greenhouses of 1960s to tunnel greenhouses of 1970s. Glass was state controlled in that period and every year only one of the eight groups in the brigade could get it. Qin thought of replacing glass with plastic films which he could try only when he got time from his official duties. When he was serving in Zhu Feng production brigade, Qin visited Shangdong Province in Dalian (previously called Lushun). After several visits he got a chance to explore different greenhouse technologies. These learning trips were organised by the Zhenjiao commune. In one of his visits to Dalian, he saw farmers using stoves to raise the temperature of the greenhouse. The farmers were growing cucumbers and in spite of low yield they could earn profits as they got the off-season advantage. But the drawback with the method was that only the air column was heated up. He reasoned that if by some means the soil could be warmed up then better production could be possible. He thought of advising the



two groups under him to start cultivating cucumbers. But then, he could not risk the farmers' income. To experiment his ideas, he needed time and space.

Around this time in early eighties, he started making a greenhouse in the backyard with the help of his family members. As he had previously seen farmers earning a fair amount from cucumbers, he also decided to grow cucumbers. Qin's house was east facing situated on the roadside. The first greenhouse he made had a back wall with base 1.5 m wide and top was 70-80 cm. Two gables (triangular roof) were built, and bamboo pillars were erected a 3.6 m apart, the structure was tied by iron wires. And then the structure was covered by plastic films. The films were only 1.5 m wide, so he stuck two sheets by ironing the borders to increase the width. The shape of the greenhouse was similar to the glass greenhouses at the brigade, though Qin's were higher (two meter high with a span of six meter and length of 20 m and the brigade's were 1.5 m high with a span of four meter), easy to build (could be built in two hrs compared to the glass ones which took months), and it was easier to clear the snow from the plastic greenhouses. He sowed crop in January in 1980 so that he could reap crop around the Chinese Lunar New Year when there was a special demand for the vegetable. To keep the temperature warm, during the night, Qin put light bulbs over the seedling beds. Further, he took out the electric heating lines from the electric mattresses at

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home and buried them under the soil, so that he could keep the soil warm as well.

Though, the yield was not very high, but the "off season" cucumber fetched a good price. In the same year, Qin tried grafting on cold-resistant roots. From his contacts in Yunan province, he learnt the art of engrafting cucumber with black seed pumpkin had several advantages like disease and cold resistance leading to higher yield. The local vegetable seed seller helped him to procure the seeds of black seed pumpkin variety. Charged by the success of film greenhouses, the two vegetable growing groups, whom Qin assisted previously, replaced the glass greenhouses with film ones, applied the process of engrafting and preponed the time of seedling growth to December. The first crop was reaped in late March and early April.

Another beginning at another place, another time

Qin was in his 60s when he had started working on his own greenhouse. He suffered severely from tracheal infections in the early 1980s and hence, he couldn't carry on further research on his greenhouse. However, in 1983, two farmers Tao Yonghua and Li Yongquin from Tao Tun (which is about one km away from Zhang Shanzui) started working on the greenhouse concepts and succeeded in 1985. Tao Yonghua, born in 1946, could study only up to his primary education as his family was classified as landlord, according to the classification by the Chinese communist party. The chances of getting admission in colleges, armed forces, administrative posts or even getting a good match in marriage, etc., depended on the category one was placed in. Hence, in 1966 when the education committee didn't allow him to carry on with his education, he returned to his village and started farming. In 1969, he advanced the sowing time of green onion from early September to early August. With output around 9000 kg per mu (0.15 ha), he obtained valuable experience so as to apply for the post of agricultural technician in production brigade. Li was six years younger to Tao and was a junior high school graduate. He carried out a series of experiments on breeding of high yielding cucumber seeds. Being neighbours, Tao and Li

could discuss their problems and look for solutions.

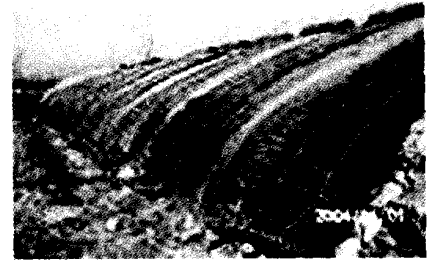
The major improvements done by Tao were increasing the height of the greenhouse and lowering the windows. He had observed earlier that it was transparent through the front windows and obscure through the slope at the top. And the plants closer to the windows had better growth. He reduced the front window to 80 cm from 110 cm and raised the ridges to 260 cm from 220 cm, keeping the span as 7 m which increased the slope of the film and improved the function of spectral absorbance. With these modifications, cucumber started yielding in 2.5 months only. Encouraged by experimental success, he advised lifting the window to 90 cm while building a greenhouse in Shandong which was located at a lower latitude and had five degree higher temperature.

Scientists begin to learn from Tao

In 1984, Tao's greenhouse was torn down due to land expropriation for road building. He built another one later. Li's was sold to a farmer and he built another in the east of the village. In 1985, they began to use non-dripping film to build the greenhouse and cover it with double layers of straw curtains to retain the heat. The sowing time was advanced to November, and the first harvesting was done during the Chinese New Year, which fetched the farmers a good amount of money owing to higher demand in the festive season. Once, Tao, an expert in the field was called by The Agricultural Administrative Bureau of Qinhe to share his view on the parabolic curve greenhouse which was proposed by two



professors of Shandong Agriculture University. Tao said that though parabolic curved greenhouse could give more space; it was not good for vegetable



cultivation. To explain, he asked a simple question, "If there are two rooms of 20 m with respective height of five meters and three meters, then which room will have higher temperature? The authorities got their answer! And a research done later proved Tao's conviction.

Though he lacked formal education, the scientist in him was vigilant and observant. Wherever Tao was called to advice for greenhouse, he used to carry a compass with him. Further, the experts advised farmers that to exploit the maximum efficiency of the incident spectrum (the sun light falling on the roof), the greenhouse in Wa Fangdian should be facing south east rather than south west (at that time they faced south). Tao differed by saying that they should be facing five to ten degrees west. His reason was that the highest diurnal temperature was reached at 1330 hours and if at that time, the angle of incidence could be structured to fall at 90 degrees, then it should maximise the penetration of light in the greenhouse. He had also observed that the leaves drooped if the night temperature fell below ten degrees. He reasoned that lower temperature during the night affected the process of water and nutrient intake in cucumber roots. At day break, with faster evaporation, the leaf cells lost turgidity making them droopy. He concluded that optimal temperature for fruit bearing was 35 degrees during the day and not less than nine degrees during the night. This proved that his innovations were not serendipitous but based on scientific observations, made without a formal degree in plant physiology. His greenhouse was his laboratory!

Tao was invited to the neighbouring villages to diffuse his ideas. Though Tao was kicked out of his job when people had learnt the techniques well, he did

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not hesitate to help others. If that is the way, the world would treat the selfless innovators who go out of their way to help others then this might be one of the reasons why IPR and patents are the talk of the day. We at HBN and at CHIN pay our tribute to such innovators who selflessly give away their expertise!

The cascading effects, the trails!

In 1988, a vegetable vendor named Wang Xinmin from San Yuanzhu village of Shandong village used to buy cucumbers from Tao tun and sell in his village. This fetched him good profits, since the farmers of San Yuanzhu village did not know the art of greenhouse cucumber cultivation. Wang Leyi the party secretary of the village asked Wang to bring technicians from Tao tun who would teach them the art. Tao was the obvious choice owing to his proven expertise in the field. But he could not go, owing to his mother's illness. Moreover, he was being asked to do only two greenhouses there which was not a fair deal for his time and efforts. However, another farmer called Han Yongshan, though he was not that well equipped with the intricacies of the technology, agreed to go there. Fortunately, the natural conditions in Shouguang were much more favourable than Wa Fangdian. Han helped farmers to build 17 greenhouses in 1989. And a rewarding harvest was achieved. In 1990, a team was organised to popularise winter production of cucumbers, and Han Yongshan and Wang Leyi became the technical supervisors. Han shifted his family to Shouguang where he was given a house and 30,000 yuan as an honorarium for his service. He passed away in 1992 at the age of 42. The journey forth was carried on tirelessly by Wang Leyi and his team.

Wang Leyi, born in 1941, had studied up to primary school only. He was the deputy in the 15th, 16th and 17th National Congress of the Communist Party of China (CPC). He took the post of party secretary of the village in 1978, after a surgical operation. He was committed to the popularisation of greenhouse cucumber production which he believed could increase the income of the farmers. Wang's team went to the northern part of Xinjiang, Gansu and south-western part of inner Mongolia to spread the technology. Wang Leyi was also helped by his elder brother, Wang Lequan, who was serving as the deputy governor of Shangdong province and later became the party secretary of Xinjiang Uygur Autonomous Region. Though articles mentioning his contribution to the cause could not be traced, still it cannot be ignored. Institutional interventions did help in creating a pull for technological innovation here. Local government helped in establishing 30 large specialized markets and 40 big food process enterprises. It extended the supply of materials for constructing greenhouses to various villages and towns (WU Guisheng, TU Junb and GU Shulin, 2003, http://www.sinal.redesist.ie.ufrj.br/globelics/pdfs/GLOBELICS_0087_WU.pdf downloaded on December 30, 2010).

Particularly in Shouguang province, the government policies helped to spread the technology faster than in Wa Fangdian where the technology was born. But here, one may notice, that the idea was born due to the institutional inefficiencies; the situation of tight supply of glass and rising price of coal required shift in the building material. Though much of the changes in architectural design took place through farmers' ingenuity, Wa Fangdian experience illustrates the merit of farmer to farmer learning while Shandong adds to our understanding of the favourable public institutions in diffusion of farmers' innovations.